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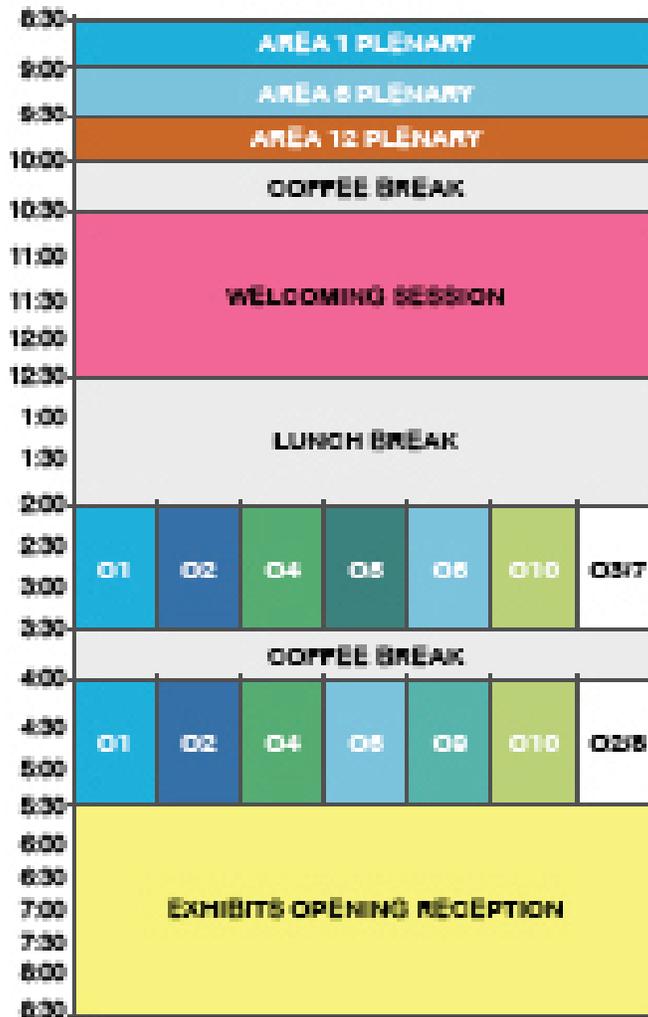
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Pages 1-706



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MONDAY PROGRAM SUMMARY



MONDAY PROGRAM SUMMARY

	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 1 - Plenary	
8:30 - 9:00 AM	Ballroom 3-4
Fundamentals and New Concepts for Future Technologies	

Chair: Jessica Adams

- 8:30 (1) **A direct thin-film path towards low-cost large-area III-V photovoltaics**
 Ali Javey
UC Berkeley, Berkeley, CA, USA

Area 6 - Plenary	
9:00 - 9:30 AM	Ballroom 3-4
Organic Photovoltaics	

Chair: Moritz Riede

- 9:00 (2) **Tackling the performance limits of organic heterojunction solar cells**
 Jenny Nelson
Department of Physics and Centre for Plastic Electronics, Imperial College London, UK

Area 12 - Plenary	
9:30 - 10:00 AM	Ballroom 3-4
Reliability of PV	

Chair: Sarah Kurtz, Ralph Gottschalg

- 9:30 (3) **Quality requirements from a lenders/investors point of view**
 Felix Holz
Vice President, Expertenteam Greentech, Deutsche Bank AG

10:00 - 10:30 AM	Ballroom Pre-function
Coffee Break	

Keynote - Plenary	
10:30 - 12:35 PM	Ballroom 3-4
Welcoming Session	

Chair: Richard King, Angèle Reinders

10:30 **(4) Opening Remarks**
Richard R. King

10:40 **(5) Keynote Speech - NREL**
Dana Christensen
*National Renewable Energy
Laboratory*



11:00 **(6) Keynote Speech - DOE**
Michael Knotek
Department of Energy



11:20 **(7) Morton Prince Recognition
and Introcuton**
Larry Kazmerski

11:25 **(8) Morton Prince Recognition
Speech**
Morton Prince



11:35 **(9) Conference Plenary - The
Case For Design And Discovery
Of Functional Materials**
Alex Zunger
University of Colorado



12:00 **(10) PVSC Young Professional
Award Presentation**
Kyle Montgomery, Oliver Schultz-
Wittmann

12:05 **(11) Cherry Award
Introduction**
Jerry Olson

12:10 **(12) Cherry Award Speech**
Ron Sinton
Sinton Instruments



TECHNICAL PROGRAM

MONDAY AM

Joint Session: Areas 3,7 - Orals

2:00 - 3:30 PM

MR 505-507

Highest Efficiency Space and CPV Solar Cells

Chair(s): Myles Steiner, Takeshi Ohshima

- 2:00 **(13) Application of InGaP/GaAs/InGaAs Triple Junction Solar cells to Space Use and Concentrator Photovoltaic**
Tatsuya Takamoto, Hidetoshi Washio, Hiroyuki Juso
SHARP Corp., Yamatokoriyama, Japan 1
- 2:30 **(14) Development of high efficiency wafer bonded 4-junction solar cells for concentrator photovoltaic applications**
Frank Dimroth¹, Thomas N.D. Tibbits¹, Paul Beutel¹, Christian Karcher¹, Eduard Oliva¹, Gerald Siefer¹, Maïke Wiesenfarth¹, Rainer Krause², Matteo Piccin², Nicolas Blanc², Charlotte Drazek², Eric Guiot², Thierry Salvatat³, Aurélie Tauzin³, Thomas Signamarcheix³, Thomas Hannappel⁴
¹Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany, ²SOITEC S.A., Bernin, France, ³CEA-LETI, Grenoble, France, ⁴Helmholtz-Zentrum Berlin HZB, Berlin, Germany 6
- 2:45 **(15) Continued progress on direct bonded 5J space and terrestrial cells**
Philip T Chiu, Daniel L Law, Robyn L Woo, Scott B Singer, William D Hong, Abdallah Zakaria, Joseph C Boisvert, Shoghig Mesropian, Richard R King, Nasser H Karam
Spectrolab Inc., Sylmar, CA, USA 11
- 3:00 **(16) Terrestrial Concentrator Four-junction Inverted Metamorphic Solar Cells With Efficiency > 45%**
Nate Miller, Pravin Patel, Claudia Struempel, Chris Kerestes, Dan Aiken, Paul Sharps
Emcore Photovoltaics, Albuquerque, NM, USA 14
- 3:15 **(17) Quadruple Junction Inverted Metamorphic Concentrator Devices**
Ryan M France¹, John F Geisz¹, Myles A Steiner¹, Ivan Garcia^{1,2}, William E McMahon¹, Daniel J Friedman¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Instituto de Energia Solar, Universidad Politecnica de Madrid, Madrid, Spain N/A

Area 1 - Orals

2:00 - 3:30 PM

Ballroom 1AB

Light Management 1: Spectral Shaping

Chair(s): Jeremy Munday, Louise Hirst

- 2:00 **(18) Enhancing Light Capture By Silicon - With The Help Of Molecules**
Tom Markvart¹, Nick Alderman^{1,2}, Lefteris Danos³, Liping Fang¹, Thomas Parel¹
¹Solar Energy Laboratory, University of Southampton, Southampton, UK, ²Department of Chemistry, University of Ottawa, Ottawa, ON, Canada, ³Department of Chemistry, University of Lancaster, Lancaster, UK 17

- 2:30 **(19) Can a hot-carrier solar cell also be an efficient up-converter?**
 Daniel J Farrell, Hassanet Sodabanlu, Yunpeng Wang, Masakazu Sugiyama, Yoshitaka Okada
Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8504, Japan, Tokyo, Japan N/A
- 2:45 **(20) Increasing Efficiency of Dual Junction Solar Cells by Intermediate Mirror Optimization**
 Vidya Ganapati, Chi-Sing Ho, Eli Yablonovitch
University of California, Berkeley, Berkeley, CA, USA N/A
- 3:00 **(21) Enhance Current Density and Power Conversion Efficiency in Solar Cells by Using luminescent downshifting phosphor**
 Hau-Vei Han¹, Chien-Chung Lin², Wein-Yi Lin¹, Yu-Lin Tsai¹, Tien-Lin Shen¹, Hao-Chung Kuo¹, Peichen Yu¹
¹National Chiao Tung University, Hsinchu, Taiwan, ²National Chiao Tung University, Tainan, Taiwan 22
- 3:15 **(22) Color, Graphic Design and High Efficiency for Photovoltaic Modules**
 Efthymios Klampafitis¹, David Ross¹, Bryce S. Richards^{1,2}
¹Heriot-Watt University, Edinburgh, UK, ²Nelson Mandela African Institute of Science and Technology, Tengeru, Tanzania 25

Area 2 - Orals	
2:00 - 3:30 PM	MR 502-504
Kesterite 1	

Chair(s): Rakesh Agrawal, Guy Brammertz

- 2:00 **(23) Current Status and Future Prospects of Earth Abundant Kesterite Photovoltaics**
 David B. Mitzi¹, Teodor Todorov¹, Oki Gunawan¹, Tayfun Gokmen¹, Wei Wang¹, Mark T. Winkler¹, Richard Haight¹, Sean Seefeld¹, Liang-Yi Chang¹, Byungha Shin¹, Talia Gershon¹, Supratik Guha¹, Masaru Kuwahara², Akimasa Nakamura², Homare Hiroi³, Hiroki Sugimoto³
¹IBM T. J. Watson Research Center, Yorktown Heights, NY, USA, ²Tokyo Ohka Kogyo Co., Ltd., Kawasaki, Japan, ³Solar Frontier K. K., Atsugi, Japan N/A
- 2:30 **(24) Over 12% Efficiency Cu₂ZnSn(SeS)₄ Solar Cell Via Hybrid Buffer Layer**
 Homare Hiroi^{1,2}, Jeehwan Kim³, Masaru Kuwahara⁴, Teodor K Todorov³, Dhruv Nair³, Marinus Hopstaken³, Yu Zhu³, Oki Gunawan³, David B. Mitzi³, Hiroki Sugimoto^{1,2}
¹Showa Shell Sekiyu K.K., Kanagawa, Japan, ²Solar Frontier K.K., Kanagawa, Japan, ³IBM Corporation, Yorktown, NY, USA, ⁴Tokyo Ohka Kogyo Co., Ltd., Kanagawa, Japan 30
- 2:45 **(25) Different bandgaps in Cu₂ZnSnSe₄; A high temperature coevaporation study**
 Alex Redinger, Jan Sendler, Rabie Djemour, Thomas Paul Weiss, Germain Rey, Susanne Siebentritt
University of Luxembourg, Laboratory for photovoltaics, Belvaux, Luxembourg N/A

- 2:45 **(26) Fabrication and Optoelectronic Properties of CZTSe Single Crystals**
Douglas M. Bishop¹, Brian E. McCandless¹, Richard Haight², Robert Birkmire¹
¹Institute of Energy Conversion, University of Delaware, Newark, DE, USA, ²IBM T. J. Watson Research Center, Yorktown Hts, NY, USA N/A
- 3:15 **(27) Vibrational and Structural Properties of $\text{Cu}_x\text{ZnSn}(\text{S}, \text{Se})_{4-x}$ ($0 \leq x \leq 1$) Solid Solutions**
Mirjana Dimitrievska¹, Galina Gurieva², Haibing Xie¹, Xavier Fontané¹, Andrew Fairbrother¹, Rene Günder², Edgardo Saucedo¹, Alejandro Pérez-Rodríguez^{1,3}, Victor Izquierdo-Roca¹, Susan Schorr^{2,4}
¹IREC, Barcelona, Spain, ²HZB, Berlin, Germany, ³IN2UB, Barcelona, Spain, ⁴FUB, Berlin, Germany 33

Area 4 - Orals

2:00 - 3:30 PM

Ballroom 1EF

Material Characterization

Chair(s): Tonio Buonassisi, Kyotaro Nakamura

- 2:00 **(28) Photoluminescence Spectroscopy and Topography of Defects in Photovoltaic Silicon**
Michio Tajima^{1,2}
¹Institute of Space and Astronautical Science/JAXA, Sagamihara, Japan, ²Meiji University, Kawasaki, Japan N/A
- 2:30 **(29) Recombination via Nano-precipitates ... a New Mechanism for Efficiency Loss in Solar Silicon?**
Anthony R Peaker¹, Bruce Hamilton¹, Simon Leonard¹, Vladimir P Markevich¹, Khaled Youssef², George Rozgonyi²
¹Photon Science Institute, The University of Manchester, Manchester, UK, ²North Carolina State University, Materials Science, Raleigh, NC, USA 37
- 2:45 **(30) Temperature Dependence of Band-Band Absorption and Radiative Recombination in Crystalline Silicon from Spectral Photoluminescence**
Hieu T. Nguyen, Fiacre E. Rougieux, Simeon C. Baker-Finch, Daniel Macdonald
Research School of Engineering, College of Engineering and Computer Science, The Australian National University, Canberra, Australia N/A
- 3:00 **(31) Grain boundary characterization in multicrystalline silicon using joint EBSD, EBIC, and atom probe tomography**
Andreas Stoffers¹, Oana Cojocaru-Miréidin¹, Otwin Breitenstein², Winfried Seifert^{3,4}, Stefan Zaefferer¹, Dierk Raabe¹
¹Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany, ²Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany, ³Brandenburgische Technische Universität, Cottbus, Germany, ⁴IHP, Frankfurt (Oder), Germany 42
- 3:15 **(32) Quantification of Iron Redistribution between Acceptors in co-doped Silicon**
T Bartel¹, F Gibaja¹, M Kaes¹, A Turenne²
¹Calisolar GmbH, Berlin, Germany, ²Silicor Materials Inc, San Jose, CA, USA 47

Area 5 - Orals	
2:00 - 3:30 PM	Ballroom 2B
Light Management	

Chair(s): Franz-Josef Haug, Matthias Meier

- 2:00 **(33) Coupling Incident Light to Guided Modes in Thin-Film Tandem Solar Cells with Intermediate Reflector**
 André Hoffmann, Karsten Bittkau, Chao Zhang, Tsvetelina Merdzhanova, Uwe Rau
IEK5 – Photovoltaik, Forschungszentrum Jülich GmbH, Jülich, Germany N/A
- 2:30 **(34) Improved Light-In-Coupling via Anti-Reflection Films in Thin Film Microcrystalline Silicon Solar Cells on Honeycomb-Patterned Substrates**
 Hitoshi Sai¹, Takuya Matsui¹, Michio Kondo¹, Isao Yoshida²
¹National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan, ²Photovoltaic Power Generation Technology Research Association, Tsukuba, Japan N/A
- 2:45 **(35) Development of Double-Textured ZnO:B Substrates for Microcrystalline Silicon Solar Cells**
 Yusuke Abe¹, Taijiro Kagei¹, Keiichi Nishikubo¹, Porponth Sichanugrist¹, Makoto Konagai^{1,2}
¹Department of Physical Electronics, Tokyo Institute of Technology, 2-12-1, O-okayama, Meguro-ku, Tokyo, Japan, ²Photovoltaic Research Center (PVREC), Tokyo Institute of Technology, 2-12-1, O-okayama, Meguro-ku, Tokyo, Japan N/A
- 3:00 **(36) Electrodeposited Zinc Oxide Nanostructured electrodes as Light Trapping Structures in Amorphous Silicon Solar Cells**
 Regina-Elisabeth Nowak¹, Peng Hui Wang², Martin Vehse¹, Nies Reininghaus¹, Oleg Sergeev¹, Alexandre G. Brolo², Karsten von Maydell¹, Carsten Agert¹
¹NEXT ENERGY, EWE Research Centre for Energy Technology, Oldenburg, Germany, ²University of Victoria, Department of Chemistry, Victoria, BC, Canada N/A
- 3:15 **Best Student Presentation Award Finalist (37) New Approaches to Improve the Performance of Thin Film Radial Junction Solar Cells Built over Silicon Nanowire Arrays**
 Soumyadeep Misra, Linwei Yu, Martin Foldyna, Pere Roca i Cabarrocas
Ecole Polytechnique, Palaiseau, France N/A

Area 6 - Orals

2:00 - 3:30 PM

Ballroom 2A

Organic Semiconductor Based PV

Chair(s): Dana Olson, Moritz Riede

- 2:00 **(38) All-Polymer Blend Solar Cells with Efficiencies Approaching 7%**
Antonio Facchetti
Polyera Corp and Northwestern University, Evanston, IL, USA N/A
- 2:30 **Best Student Presentation Award Finalist (39) Enhancing Exciton Diffusion in Organic Photovoltaics Cells Incorporating Dilute Donor Layers**
S. Matthew Menke, Russell J. Holmes
University of Minnesota, Minneapolis, MN, USA 51
- 2:45 **(40) Kinetic Monte Carlo Modeling of Low-Bandgap Polymer Solar Cells**
Tim Albes, Bogdan Popescu, Dan Popescu, Marius Loch, Francesco Arca, Paolo Lugli
Technical University Munich, Institute of Nanoelectronics, Munich, Germany 57
- 3:00 **(41) Fully printed organic tandem cells and modules: from concepts to demonstration**
Ning Li¹, George Spyropoulos², Tayebah Ameri¹, Christoph Brabec^{1,2}
¹Institute of Materials for Electronics and Energy Technology (i-MEET), Friedrich-Alexander University Erlangen-Nürnberg, Martensstraße 7, 91058 Erlangen, Germany, ²Bavarian Center for Applied Energy Research (ZAE Bayern), Haberstraße 2a, 91058 Erlangen, Germany N/A

Area 10 - Orals

2:00 - 3:30 PM

Ballroom 1CD

Solar Resource Assessment and Forecasting

Chair(s): Ken Sauer, Rhonda Bailey

- 2:00 **(42) Evaluation of Global Horizontal Irradiance to Plane of Array Irradiance Models at Locations across the United States**
Clifford W. Hansen¹, Andrew Pohl¹, Matthew Lave², William Hayes³, Will Hobbs⁴
¹Sandia National Laboratories, Albuquerque, NM, USA, ²Sandia National Laboratories, Livermore, CA, USA, ³First Solar Inc., San Francisco, CA, USA, ⁴Southern Company, Atlanta, GA, USA N/A
- 2:30 **(43) Benchmarking Solar Power and Irradiance Forecasting Accuracy: SMUD Solar Forecasting Trial and Analysis**
T Vargas¹, O Bartholomy², C Hansen³, A Phol⁴, M Simone⁵
¹SMUD, Sacramento, CA, USA, ²SMUD, Sacramento, CA, USA, ³Sandia National Labs, Albuquerque, NM, USA, ⁴Sandia National Labs, Albuquerque, NM, USA, ⁵SMUD, Sacramento, CA, USA 63

- 2:45 **(44) A New Operational Solar Resource Forecast Model Service for PV Fleet Simulation**
Richard R. Perez¹, Adam Kankiewicz², James Schlemmer¹, Karl Hemker, Jr.¹, Sergey Kivalov¹, Thomas E. Hoff²
¹ASRC, The University at Albany, Albany, NY, USA, ²Clean Power Research, Napa, CA, USA 69
- 3:00 **(45) Short-Term PV Power Forecasts Based on a Real-Time Irradiance Monitoring Network**
Antonio T. Lorenzo, William F. Holmgren, Alexander D. Cronin
University of Arizona, Tucson, AZ, USA 75
- 3:15 **(46) An Operational, Real-Time Forecasting System for 250 MW of PV Power Using NWP, Satellite, and DG Production data**
William F. Holmgren¹, Antonio T. Lorenzo¹, Michael Leuthold², Chang Ki Kim², Alexander D. Cronin¹, Eric A. Betterton²
¹University of Arizona, Department of Physics, Tucson, AZ, USA, ²University of Arizona, Department of Atmospheric Sciences, Tucson, AZ, USA 80

3:30 - 4:00 PM	Ballroom Pre-function
Coffee Break	

Joint Session: Areas 2,8 - Orals	
4:00 - 5:30 PM	MR 505-507
Characterization Methods for CdTe and CZTS	

Chair(s): Harvey Guthrey, Rebekah Feist, Yoshihiro Hishikawa

- 4:00 **(47) S-Te interdiffusion within grains and GBs in CdTe solar cells: direct structure property correlation through aberration-corrected STEM**
Chen Li^{1,2}, Jonathan Poplawsky^{1,3}, Naba Paudel⁴, Timothy J. Pennycook^{5,6}, Sarah J. Haigh⁷, Mowafak Al-Jassim⁸, Yanfa Yan⁴, Stephen J. Pennycook³
¹Oak Ridge National Laboratory, Oak Ridge, TN, USA, ²Vanderbilt University, Nashville, TN, USA, ³University of Tennessee, Knoxville, TN, USA, ⁴The University of Toledo, Toledo, OH, USA, ⁵University of Oxford, Oxford, UK, ⁶SuperSTEM Laboratory, Daresbury, UK, ⁷University of Manchester, Manchester, UK, ⁸National Renewable Energy Laboratory, Golden, CO, USA N/A
- 4:30 **(48) Atom Probe Tomography for Nanoscale Characterization of CdTe Device Absorber Layers and Interfaces**
David R Diercks, Jiaojiao Li, Colin A Wolden, Brian P Gorman
Colorado School of Mines, Golden, CO, USA 85
- 4:45 **(49) Simultaneous Measurement of Minority-Carrier Lifetime in Single-Crystal CdTe using Three Transient Decay Techniques**
Steve Johnston¹, Katherine Zaunbrecher^{1,2}, Richard Ahrenkiel^{1,3}, Darius Kuciauskas¹, David Albin¹, Wyatt Metzger¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado State University, Fort Collins, CO, USA, ³Lakewood Semiconductors, Lakewood, CO, USA N/A

- 5:00 **Best Student Presentation Award Finalist**
(50) Direct evaluation of defect distributions from admittance spectroscopy
 Thomas P. Weiss, Alex Redinger, David Regesch, Marina Mousel, Susanne Siebentritt
Laboratory for Photovoltaics, University of Luxembourg, Belvaux, Luxembourg N/A
- 5:15 **(51) Nanometer-Scale Study of Resistance on CdTe Solar Cell Device**
 Huan Li^{1,2}, Chun-Sheng Jiang¹, Wyatt Metzger¹, Chih-Kang Shih², Mowafak Al-Jassim¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²University of Texas at Austin, Austin, TX, USA 90

Area 1 - Orals	
4:00 - 5:30 PM	Ballroom 1AB
Quantum Well and Superlattice Solar Cells	

Chair(s): Christopher Bailey, Raymond Hoheisel, Jessica Adams

- 4:00 **(52) Strain-balanced Quantum Wells as an Efficiency Booster for III-V Solar Cells**
 Masakazu Sugiyama
The University of Tokyo, Tokyo, Japan 95
- 4:30 **(53) Four-fold MQWs Absorption Enhancement in a 430 nm Thick InGaAs/GaAsP MQWs Solar Cell**
 Benoît Behaghel^{1,2}, Ryo Tamaki³, Nicolas Vandamme¹, Kentaroh Watanabe³, Christophe Dupuis¹, Nathalie Bardou¹, Hassanet Sodabanlu³, Andrea Cattoni¹, Yoshitaka Okada³, Masakazu Sugiyama³, Stéphane Collin¹, Jean-François Guillemoles²
¹LPN-CNRS, Marcoussis, France, ²IRDEP-CNRS, Chatou, France, ³RCAST-The University of Tokyo, Tokyo, Japan 99
- 4:45 **(54) Effect of barrier thickness on lattice-matched quantum well solar cells**
 Michael K. Yakes¹, Christopher G. Bailey², Louise C. Hirst², Matthew P. Lumb³, David V. Forbes⁴, Maria Gonzalez⁵, Kenneth J. Schmieder², Joeseoph G. Tischler¹, Seth M. Hubbard⁴, Robert J. Walters¹
¹Naval Research Laboratory, Washington, DC, USA, ²NRC Postdoc residing at NRL, Washington, DC, USA, ³George Washington University, Washington, DC, USA, ⁴Rochester Institute of Technology, Rochester, NY, USA, ⁵Sotera Defense Solutions, Herndon, VA, USA N/A
- 5:00 **Best Student Presentation Award Finalist**
(55) Improving Epitaxial Regrowth Interfaces as a Means of Improving Doping Superlattice Solar Cell Performance
 Michael A. Slocum, David V. Forbes, Nichole M. Hoven, Seth M. Hubbard
Rochester Institute of Technology, Rochester, NY, USA 102
- 5:15 **Best Student Presentation Award Finalist**
(56) Carrier Time-of-Flight Measurement Using a Probe Structure for Direct Evaluation of Carrier Transport in Quantum Structure Solar Cells
 Kasidit Toprasertpong¹, Naofumi Kasamatsu³, Hiromasa Fujii¹, Tomoyuki Kada³, Shigeo Asahi³, Yunpeng Wang², Kentaroh Watanabe², Masakazu Sugiyama¹, Takashi Kita³, Yoshiaki Nakano¹
¹School of Engineering, the University of Tokyo, Tokyo, Japan, ²Research Center for Advanced Science and Technology, Tokyo, Japan, ³Graduate School of Engineering, Kobe University, Kobe, Japan N/A

Area 2 - Orals	
4:00 - 5:30 PM	MR 502-504
CIGS 1	

Chair(s): Susanne Siebentritt

- 4:00 **(57) Introduction of Si PERC rear contacting design to boost efficiency of ultra-thin Cu(In,Ga)Se₂ solar cells**
 Bařt Vermang¹, Jörn T. Wätjen¹, Viktor Fjällström¹, Fredrik Rostvall¹, Marika Edoff¹, Ratan Kotipalli², Frederic Henry², Denis Flandre²
¹Ångström Solar Center (University of Uppsala), Uppsala, Sweden, ²ICTEAM (Université catholique de Louvain), Louvain-la-Neuve, Belgium N/A
- 4:30 **(58) Improved Performance of Ultrathin Cu(InGa)Se₂ Solar Cells With a Backwall Superstrate Configuration**
 Hamed Simchi^{1,2}, Jes Larsen¹, William Shafarman^{1,2}
¹Institute of Energy Conversion, University of Delaware, Newark, DE, USA, ²Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA N/A
- 4:45 **(59) The importance of sodium control in CIGSe superstrate solar cells**
 Marc D. Heinemann¹, Varvara Brackmann², Reiner Klenk¹, Thomas Unold¹, Hans-Werner Schock¹, Christian Kaufmann¹
¹Helmholtz Zentrum Berlin, Berlin, Germany, ²Leibniz Institut für Festkörper- und Werkstoffforschung, Dresden, Germany N/A
- 5:00 **(60) Resent R&D Progress in Solar Frontier's Small-sized Cu(InGa)(SeS)₂ Solar Cells**
 Motoshi Nakamura, Nobutaka Yoneyama, Kyouhei Horiguchi, Yasuaki Iwata, Koji Yamaguchi, Hiroki Sugimoto, Takuya Kato
 Energy Solution Business Center, Showa Shell Sekiyu K.K., Atsugi, Japan 107
- 5:15 **(61) A study of Fluorine Doping AZO Transparent Conductive Oxide Films for Thin Film Copper Indium Gallium Selenide Solar Cells on Flexible Substrates**
 Swati Sevvana, Bob Zubeck, Kee Kee Cheung, Neil Mackie
 Miasole Hi-Tech Corp., Santa Clara, CA, USA 111

Area 4 - Orals

4:00 - 5:30 PM

Ballroom 1EF

Analysis

Chair(s): Paul Basore, Adeline Sugianto

- 4:00 **(62) Quantifying the Optical Losses in Back-contact Solar Cells**
Keith R McIntosh¹, Kean C Fong², Teng C Kho², Yimao Wan², Simeon C Baker-Finch¹, Malcolm D Abbott¹, Soe Zin², Da Wang², Nicholas E Grant², Er-Chien Wang², Matthew Stocks², Evan Franklin², Andrew W Blakers²
¹PV Lighthouse, Coledale, Australia, ²Australian National University, Canberra, Australia 115
- 4:30 **(63) A GUI for comfortable batch simulation of luminescence intensity combining PC1D electrical simulation with analytical optical models**
Hannes Höffler, Johannes Greulich, Jonas Haunschild, Stefan Rein
Fraunhofer ISE, Freiburg, Germany 124
- 4:45 **Best Student Presentation Award Finalist**
(64) Multi-Probe Characterization of Inversion Charge for Parameterization of HIT™ Cells
Raghu V. K. Chavali¹, Sanchit Khatavkar², Brij Mohan Arora², Pradeep Nair², Jeffery L. Gray¹, Muhammad A. Alam¹
¹School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, ²School of Electrical Engineering, Indian Institute of Technology, Bombay, Mumbai, India N/A
- 5:00 **(65) Parameterization of Carrier Mobility Sum in Silicon as a Function of Doping, Temperature and Injection Level: Extension to p-type Silicon**
Peiting Zheng, Fiacre E. Rougieux, Daniel Macdonald, Andres Cuevas
Research School of Engineering, College of Engineering and Computer Science, The Australian National University, Canberra, Australia 129
- 5:15 **(66) Sponge LID – a new degradation mechanism?**
Christian Fahrland¹, Yvonne Ludwig¹, Friederike Kersten², Kai Petter¹
¹Hanhwa Q Cells GmbH, Bitterfeld-Wolfen, Germany, ²TU Bergakademie Freiberg, Freiberg, Germany 135

Area 6 - Orals**4:00 - 5:30 PM****Ballroom 2A****Novel OPV Concepts and Perovskite Solar Cells****Chair(s): Sumit Chaudhary, Dana Olson**

- 4:00 **Best Student Presentation Award Finalist (67) Highly Efficient (11.1%) Small Molecule Multi-junction Organic Photovoltaic Cells**
Xiaozhou Che¹, Xin Xiao², Stephen R. Forrest^{1,2,3,4}
¹Applied Physics Program, University of Michigan, Ann Arbor, MI, USA, ²Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA, ³Department of Physics, University of Michigan, Ann Arbor, MI, USA, ⁴Department of Materials Science and Engineering, University of Michigan, Ann Arbor, MI, USA 140
- 4:30 **Best Student Presentation Award Finalist (68) Organic photovoltaic cell relying on energy transfer with over 20% efficiency in indoor lighting**
Kjell Cnops^{1,2}, Eszter Voroshazi¹, Carl Hart de Ruijter¹, Paul Heremans¹, David Cheyns¹
¹imec, Leuven, Belgium, ²ESAT, KU Leuven, Leuven, Belgium 143
- 4:45 **(69) Comprehensive Device Modeling of Plasmon-Enhanced and Optical Field-Dependent Photocurrent Generation in Organic Bulk Heterojunctions.** Devin M. Rourke¹, Sungmo Ahn², Alexandre Nardes³, Jao v.d. Lagemaat³, Nikos Kopidakis³, Wounghang Park². ¹Department of Physics, University of Colorado, Boulder, CO, USA, ²Department of Electrical, Computer, and Energy Engineering, University of Colorado, Boulder, CO, USA, ³National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO, USA. 147
- 5:00 **(70) All-solid Sn halide perovskite sensitized solar**
Shuzi Hayase
Kyushu Institute of Technology, Kitakshu, Japan 151
- 5:15 **(71) Organometal Halide Perovskites: Optical Absorption Edge and Perspectives for Silicon-Based Tandem Solar Cells**
Philipp F.H. Löper¹, Jakub Holovsky³, Soo-Jin Moon², Björn Niesen¹, Zdenek Remes³, Martin Ledinsky^{1,3}, Franz-Josef Haug¹, Jun-Ho Yum², Stefaan De Wolf¹, Christophe Ballif^{1,2}
¹Photovoltaics and Thin-Film Electronics Laboratory, Ecole Polytechnique Fédérale de Lausanne (EPFL), Neuchâtel, Switzerland, ²PV Center, Centre Suisse d'Electronique et de Microtechnique (CSEM), Neuchâtel, Switzerland, ³Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic N/A

Area 9 - Orals

4:00 - 5:30 PM

Ballroom 2B

Manufacturing and Module Technology

Chair(s): Scott Norquist, Franck Zhang

- 4:00 **(72) Challenges and Opportunities of modern PV manufacturing**
Peter Fath
Rena / RCT Solutions, Konstanz, Germany 156
- 4:30 **(73) Economic Measurements of Polysilicon for the Photovoltaic Industry: Market Competition and Manufacturing Competitiveness**
Ran Fu, Michael Woodhouse, Ted L. James
National Renewable Energy Laboratory (NREL), Golden, CO, USA N/A
- 4:45 **(74) Printed monolithic interconnects for photovoltaic applications**
Jeremy D. Fields, Matthew S. Dabney, Vincent P. Bollinger, Maikel F.A.M. van Hest
National Renewable Energy Laboratory, Golden, CO, USA 162
- 5:00 **(75) Progress Toward Developing a Novel Module Architecture for Increased Reliability and Reduced Costs**
Kurt L. Barth^{1,2}, Davis Hemenway^{1,2}
¹Direct Solar LLC, Fort Collins, CO, USA, ²Colo. State University, Fort Collins, CO, USA 166
- 5:15 **(76) Resistive power loss analysis of PV modules made from half-cut 15.6×15.6cm² silicon PERC solar cells with efficiencies up to 20.0%**
Jens Mueller, David Hinken, Susanne Blankemeyer, Heike Kohlenberg, Ulrike Sonntag, Karsten Bothe, Thorsten Dullweber, Marc Koentges, Rolf Brendel
Institute for Solar Energy Research Hamelin (ISFH), Hamelin, Germany N/A

Area 10 - Orals

4:00 - 5:30 PM

Ballroom 1CD

System Modeling and Energy Predictions

Chair(s): Billy Hayes, Matthew Lave

- 4:00 **Best Student Presentation Award Finalist**
(77) Introduction to the open source PV_LIB photovoltaic system modelling package
Robert W. Andrews¹, Joshua S. Stein², Cliff Hansen², Dan Riley²
¹Calama Consulting Inc, Toronto, ON, Canada, ²Sandia National Laboratories, Albuquerque, NM, USA 170
- 4:30 **(78) Which Models Matter: Uncertainty and Sensitivity Analysis for Photovoltaic Power Systems**
Clifford W Hansen, Andrew Pohl
Sandia National Laboratories, Albuquerque, NM, USA 175
- 4:45 **(79) Determining Uncertainty for I-V Translation Equations**
Benjamin C Duck^{1,2}, Christopher J Fell¹, Mark Campanelli², Brian Zaharatos², Bill Marion², Keith Emery²
¹CSIRO, Newcastle, Australia, ²NREL, Golden, CO, USA 181
- 5:00 **(80) Ashes to Ashes, Dust to Dust: Averting a Showstopper for Solar Photovoltaics**
Lawrence L. Kazmerski^{1,2}, Mohammed Al Jordan^{1,3}, Yasser Al Jnoobi^{1,3}, Yousef Al Shaya^{1,3}, Jim John⁴
¹NREL, Golden, CO, USA, ²University of Colorado, Boulder, CO, USA, ³K.A.CARE, Riyadh, Saudi Arabia, ⁴IIT-Bombay, Mumbai, India 187
- 5:15 **(81) Determination of a Minimum Soiling Level to Affect Photovoltaic Devices**
Patrick D. Burton, Bruce H. King
Sandia National Laboratories, Albuquerque, NM, USA 193

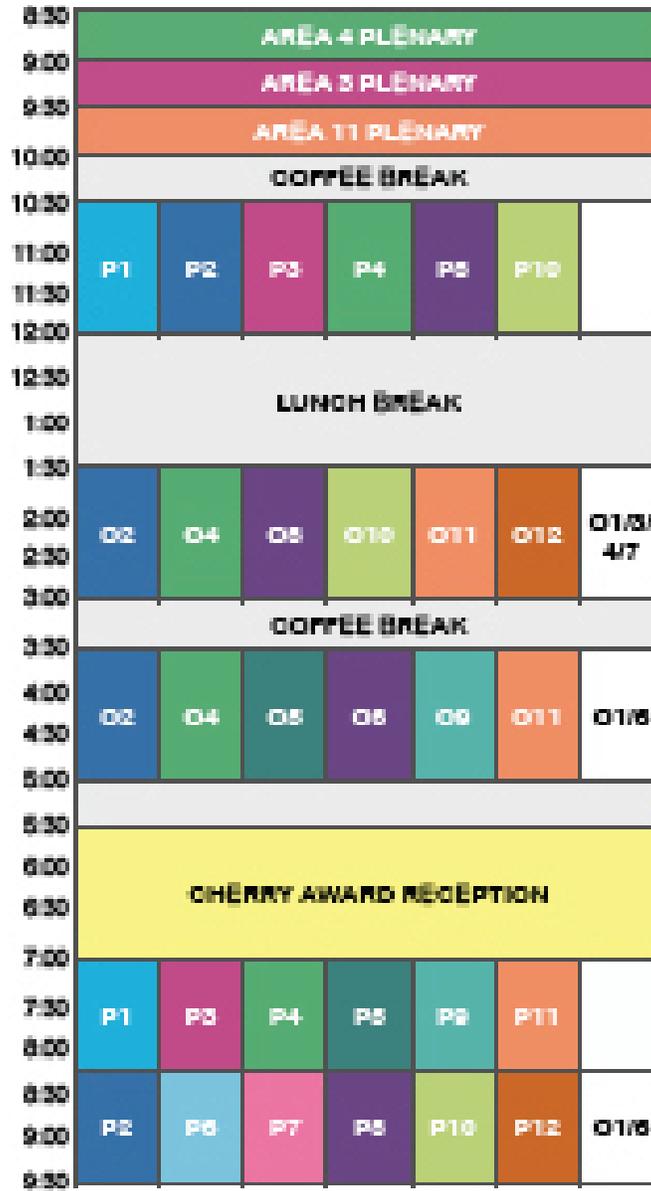
5:30 - 8:30 PM

Exhibit Hall D

Exhibits Opening Reception

TUESDAY PROGRAM SUMMARY

TUESDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 4 - Plenary	
8:30 - 9:00 AM	Ballroom 3-4
Crystalline Silicon Photovoltaics	

Chair: Stefan Glunz, Ron Sinton

- 8:30 (82) Status and future of crystalline silicon PV
Richard Swanson
Sunpower Corp. N/A

Area 3 - Plenary	
9:00 - 9:30 AM	Ballroom 3-4
III-V and Concentrator Technologies	

Chair(s): Frank Dimroth

- 9:00 (83) Engineering a Path Forward for Low Cost Concentrator Photovoltaic Systems
Scott Burroughs
Semprius, Durham, NC, USA N/A

Area 11 - Plenary	
9:30 - 10:00 AM	Ballroom 3-4
PV Deployment	

Chair(s): Martha Symko-Davies

- 9:30 (84) Energy Systems Integration – leveraging other technologies to integrate high levels of solar into the energy system
Benjamin Kroposki¹, Bryan Hannegan¹, Mark O'Malley²
¹National Renewable Energy Laboratory, Golden, CO, USA, ²University College Dublin, Dublin, Ireland N/A

10:00 - 10:30 AM	Exhibit Hall D
Coffee Break	

Area 1 - Posters

10:30 - 12:00 PM

Exhibit Hall D

Pioneering Concepts and Materials

Chair(s): Stephen Bremner, Glenn Teeter, Tom Markvart

(85-A1) **Optical Characterization of SixGe_{1-x} Films Grown on Nanostructured Si Substrates.** Ayu Wazira Azhari^{1,2}, Adnan Ali³, Kamaruzzaman Sopian¹, Uda Hashim⁴, Saleem H. Zaidi¹. ¹Universiti Kebangsaan Malaysia, Bangi, Malaysia, ²Universiti Malaysia Perlis, Kangar, Malaysia, ³Government College University, Faisalabad, Pakistan, ⁴Universiti Malaysia Perlis, Kangar, Malaysia. 198

(86-A4) **Fabrication of 0.9 eV bandgap a-Si/c-Si_{1-x}Gex heterojunction solar cells.** Ryuji Oshima, Mitsuyuki Nakayama, Hitoshi Kawanami, Isao Sakata, Koji Matsubara. AIST, Tsukuba, Japan. 202

(87-A7) **Grain boundaries characterization of semiconducting BaSi₂ thin films on a polycrystalline Si substrate.** Masakazu Baba¹, Kosuke O. Hara², Kentaro Watanabe¹, Weijie Du¹, Daichi Tsukahara¹, Kaoru Toko¹, Karolin Jiptner³, Takashi Sekiguchi³, Noritaka Usami^{2,4}, Takashi Suemasu^{1,4}. ¹University of Tsukuba, Tsukuba, Japan, ²University of Nagoya, Nagoya, Japan, ³NIMS, Tsukuba, Japan, ⁴JST-CREST, Tokyo, Japan. 206

(88-A10) **Electrical and Optical Characterizations of an n-BaSi₂/p-Si Hetero-junction for Solar Cell Applications.** Weijie Du¹, Masakazu Baba¹, Kaoru Toko¹, Noritaka Usami^{2,3}, Takashi Suemasu^{1,3}. ¹Institute of Applied Physics, University of Tsukuba, Tsukuba, Japan, ²Materials, Physics and Energy Engineering, Nagoya University, Nagoya, Japan, ³JST-CREST, Tokyo, Japan. 209

(89-A13) **Performance Enhanced of MOS-Structure Silicon Solar Cell Based on the Integration of Photovoltaic Biasing Source.** Wen-Jeng Ho, Min-Chun Huang, Guo-Chang Yang, Chia-Ming Chan, Yi-Yu Lee, Zhong-Fu Hou, Jian-Jyun Liao. National Taipei University of Technology, Taipei, Taiwan. 213

(90-A16) **Non-pn-junction-based Solar Cells: Charge Carrier Separation in Solar Cells with Bound Surface Charges.** Fude Liu¹, Wentao Wang¹, Chor Man Lau¹, Lei Wang¹, Guandong Yang¹, Dawei Zheng¹, Zhigang Li². ¹The University of Hong Kong, Hong Kong, Hong Kong, ²The Hong Kong University of Science and Technology, Hong Kong, Hong Kong. 216

(91-A19) **Multi-Stage Photovoltaic Devices with a Cutoff Wavelength of ~3 μ m.** Hossein Lotfi¹, Robert T. Hinkey^{1,2}, Lu Li¹, Rui Q. Yang¹, John F. Klem³, Joel C. Keay², Matthew B. Johnson². ¹School of Electrical and Computer Engineering, University of Oklahoma, Norman, OK, USA, ²Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman, OK, USA, ³Sandia National Laboratories, Albuquerque, NM, USA. 220

(92-A22) **Embedded InN Dot-Like Structures with Modulating Growth Temperature in Nitride-Based Solar Cell.** Lung-Hsing Hsu^{1,3}, Chien-Chung Lin², Yen-Hua Lo², Hau-Vei Han³, Da-Wei Lin³, Hao-Chung Kuo³. ¹Institute of Lighting and Energy Photonics, National Chio Tung University, Tainan, Taiwan, ²Institute of Photonics System, National Chio Tung University, Tainan, Taiwan, ³Institute of Photonics, National Chio Tung University, Hsinchu, Taiwan. 224

(93-A25) **Local conductivity characteristics of individual ErAs nanoparticle for solar cell tunnel junction application.** Chao-Yu Hung, Tomah Sogabe, Naoya Miyashita, Yasushi Shoji, Shunya Naito, Yoshitaka Okada. *Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan.* 228

(94-A28) **Enhanced Light Trapping and Carrier Collection in Glancing Angle Deposited Nanostructures.** Hilal Cansizoglu, Mehmet F. Cansizoglu, Tansel Karabacak. *University of Arkansas at Little Rock, Little Rock, AR, USA.* 233

(95-A31) **N⁺ and P⁺ double diffused GaSb PV cells with interdigitated back contacts for monolithically interconnected modules.** Jose M Borrego¹, Eric Brown², Paul Greif³, Amy W K Liu⁴, Geeta Rajagopalan⁵. ¹MTPV Power Corp., Austin, TX, USA, ²MTPV Power Corp., Austin, TX, USA, ³MTPV Power Corp., Austin, TX, USA, ⁴IQE, Bethlehem, PA, USA, ⁵United Semiconductor LLC, Rensselaer, NY, USA. N/A

(96-A34) **Numerical Method to Separate the Photo-Current and Contact Injection Current in Solar Cells.** Raghu V. K. Chavali, Jeffery L. Gray, John R. Wilcox. *School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA.* 238

(97-A37) **Characterization, Modeling and Analysis of InAlAsSb Schottky Barrier Solar Cells Grown on InP.** Matthew P Lumb^{1,2}, Maria Gonzalez^{2,3}, Joshua Abell², Joseph G Tischler², David S Scheiman², Michael K Yakes², Igor Vurgaftman², Jerry R Meyer², Robert J Walters². ¹The George Washington University, Washington, DC, USA, ²US Naval Research Laboratory, Washington, DC, USA, ³Sotera Defense Solutions, Crofton, MD, USA. 243

(98-A40) **ALD grown absorber materials for bulk heterojunction solar cells.** Neha Mahuli, Shaibal K Sarkar. *Indian Institute of Technology Bombay, Mumbai, India.* 247

(99-A43) **Chemical and Spatial Control of Substitutional Intermediate Band Materials: Toward the Atomic Layer Deposition of V_{0.25}In_{1.75}S₃.** Robert F McCarthy¹, Matthew S Weimer^{1,2}, Adam S Hock^{1,2}, Alex B F Martinson¹. ¹Argonne National Laboratory, Argonne, IL, USA, ²Illinois Institute of Technology, Chicago, IL, USA. 250

(100-A46) **Structural and morphological studies of Cuprous Oxide Thin Film Developed via Potentiostatic Electrodeposition.** Chandan Das¹, Balasubramaniam Kavaipatti¹. ¹Indian Institute of Technology Bombay, Mumbai, India, ²Indian Institute of Technology Bombay, Mumbai, India. 254

(101-B1) **“The Effects of Alkali Metal Diffusion in Zinc Phosphide Thin Films”.** Brooke E. Paquin, Alex Cimaroli, Yanfa Yan., , . 257

(102-B4) **Computational design of p-type transparent conductors for photovoltaic applications.** Cynthia S Lo, Maria Stoica, Alireza Faghaninia, Xiaodi Sun. *Washington University, St. Louis, MO, USA.* 260

(103-B7) **Characterization of sulfurised CuSbS₂ thin films for PV applications.** Enzo Peccerillo, Ken Durose, Jon Major, Laurie Phillips, Robert Treharne. *Stephenson Institute for Renewable Energy, Liverpool, UK.* 266

(104-B10) **Photonic Curing of Ligand-Capped CuInSe₂ Nanocrystal Films.** C. Jackson Stolle, Taylor B Harvey, Brian A Korgel. *The University of Texas at Austin, McKetta Department of Chemical Engineering, Texas Materials Institute, Center for Nano- and Molecular Science, Austin, TX, USA.* 270

(105-B13) **Enhancement of Hybrid Tandem Photovoltaic Thermoelectric Devices by Fishnet through Metamaterials and Nanoporous TE Materials.** Mouli Ramasamy¹, Sechang Oh¹, Pratyush Rai¹, Vijay K Varadan^{1,2,3,4}. ¹Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA, ²Department of Biomedical Engineering, University of Arkansas, Fayetteville, AR, USA, ³Penn State Hershey Medical Center, Hershey, PA, USA, ⁴Global Institute of Nanotechnology, Fayetteville, AR, USA. 275

(106-B16) **The Limiting Efficiency of Four-Band Cells Revisited.** Rune Strandberg. University of Agder, Grimstad, Norway. 280

(107-B19) **Metal/Insulator/Semiconductor Carrier Selective Contacts for Photovoltaic Cells.** Raisul Islam, Krishna C. Saraswat. Stanford University, Stanford, CA, USA. 285

(108-B21) **Investigation of RF-Sputtered Tin Sulfide Thin Films with in situ Heating for Photovoltaic Applications.** Rona E Banai, Hyeonseok Lee, Nicholas J. Tanen, Jacob J. Cordell, Mark W. Horn, Jeffrey R.S. Brownson. The Pennsylvania State University, University Park, PA, USA. 290

(109-B23) **Single Junction GaAs - Ge Stacked Thin Film Solar Cell.** Noura Al Wahshi, Ammar Nayfeh. Institute Center for Future Energy Systems (iFES), Department of Electrical Engineering and Computer Science (EECS), Masdar Institute of Science and Technology,, Abu Dhabi, United Arab Emirates. 295

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CIGS and CZTS	

Chair(s): Yanfa Yan, Hiroki Sugimoto, James Burst, Jesse Frantz

(110-B26) **Nd:YAG Laser Annealing Investigation of Screen-printed CIGS Layer on PET: Layer Annealing Method for Photovoltaic Cell Fabrication Process.** Ahmed M. AlSaggar^{1,2,3}, Erkki Alarousu¹, Samir Boulfrad³, Alexander Rothenberger^{1,3}. ¹Solar and Photovoltaic Engineering Research Center, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia, ²Saudi Aramco, Dhahran, Saudi Arabia, ³Physical Science and Engineering Division, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia. 299

(111-B29) **ALD Processed MgZnO Buffer Layers for Cu(In,Ga)S₂ Solar Cells.** Johnathan C Armstrong^{1,2}, Jingbiao Cui³, Tar-Pin Chen^{1,2}. ¹Arkansas GREEN Research Center for Solar Cells, Little Rock, AR, USA, ²Department of Physics and Astronomy, University of Arkansas at Little Rock, Little Rock, AR, USA, ³Department of Physics, University of Memphis, Memphis, TN, USA. 304

(112-B32) **Ultrasonically Sprayed TCO Layers for Thin Film Solar Cells.** Panagiota Arnou, Jake W. Bowers, John M. Walls. CREST (Centre for Renewable Energy Systems and Technology), Department of Electronic and Electrical Engineering, Loughborough University, Loughborough, Leicestershire, UK. 308

(113-B35) **Effect of selenium evaporation rate on ultrathin Cu(In,Ga)Se₂ films.** Krishna Aryal¹, Grace Rajan¹, Tasnuva Ashrafee¹, Vikash Ranjan¹, Angus Rockett², Robert W Collins³, Sylvain Marsillac¹. ¹Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, ²Dept. of Materials Science & Engineering, Univ. of Illinois Urbana-Champaign, Urbana, IL, USA, ³Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA. 314

(114-B38) **Real time spectroscopic ellipsometry studies of ultrathin CIGS films deposited by 1-stage, 2-stage and 3-stage co-evaporation processes.** Krishna Aryal¹, Grace Rajan¹, Tasnuva Ashrafee¹, Vikash Ranjan¹, Puruswottam Aryal², Angus Rockett³, Robert W Collins², Sylvain Marsillac¹. ¹Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, ²Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA, ³Dept. of Materials Science & Engineering, Univ. of Illinois Urbana-Champaign, Urbana, IL, USA. 318

(115-B41) **Growth Studies and Characterization of Atomic Layer Deposited (Zn,Mg)S Thin Films for Solar cell Applications.** Tasnuva Ashrafee¹, Yunus Erkaya¹, Krishna Aryal¹, Grace Rajan¹, Angus Rockett², Robert W Collins³, Sylvain Marsillac¹. ¹Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, ²Dept. of Materials Science & Engineering, Univ. of Illinois Urbana-Champaign, Urbana, IL, USA, ³Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA. N/A

(116-B44) **H₂S reaction of Se-capped metallic precursors to form CIGS_{Se} absorber layers.** Dominik M. Berg, Frank Cheng, William N. Shafarman. *University of Delaware, Institute of Energy Conversion, Newark, DE, USA.* 323

(117-B47) **Influence of H₂S annealing on CZTS solar cells sputtered from a quaternary compound target.** Patrice Bras^{1,2}, Jan Sterner¹. ¹Midsummer AB, Järfälla, Sweden, ²Uppsala University, Uppsala, Sweden. 328

(118-C2) **Characterization of Group I-Rich Growth During (Ag,Cu)(In,Ga)Se₂ Three-stage Co-evaporation.** Lei Chen^{1,2}, JinWoo Lee¹, William N. Shafarman^{1,2}. ¹Institute of Energy Conversion, University of Delaware, Newark, DE, USA, ²Department of Physics and Astronomy, University of Delaware, Newark, DE, USA. 332

(119-C5) **Surface passivation of CIGS solar cells.** Tzu-Huan Cheng¹, Chia-Hung Tsai², Wei-Lun Xu³. ¹Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei City, Taiwan, ²Department of Materials Science and Engineering, National Cheng Kung University, Tainan City, Taiwan, ³Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore. N/A

(120-C8) **Metastable Changes to the Temperature Coefficients of Thin-film Photovoltaic Modules.** Michael G. Deceglie, Timothy J Silverman, Bill Marion, Sarah R. Kurtz. *National Renewable Energy Laboratory, Golden, CO, USA.* 337

(121-C11) **Novel Application of Yttria Stabilized Zirconia as a Substrate for Thin Film CIGS Solar Cells.** David Fobare¹, Pradeep Haldar¹, Harry Efsthadiadis¹, David Metacarpa¹, John Wax¹, John Olenick², Viswanathan Venkateswaran², Kathy Olenick². ¹US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA, ²ENrG Inc., Buffalo, NY, USA. 341

(122-C14) **Effect of Na on Cu(In,Ga)Se₂ in-plane conductance and Seebeck coefficient.** Robert V. Forest^{1,2}, Erten Eser², Brian E. McCandless², Jingguang G. Chen³, Robert W. Birkmire². ¹Department of Chemical and Biomolecular Engineering, University of Delaware, Newark, DE, USA, ²Institute of Energy Conversion, University of Delaware, Newark, DE, USA, ³Department of Chemical Engineering, Columbia University, New York, NY, USA. 345

(123-C17) **Microstructured ZnO Coatings for Improved Performance in Cu(In,Ga)Se₂ Photovoltaic Devices.** Jesse A. Frantz¹, Jason D. Myers¹, Robel Y. Bekele², Jasbinder S. Sanghera¹. ¹*U.S. Naval Research Laboratory, Washington, DC, USA*, ²*University Research Foundation, Greenbelt, MD, USA*. 350

(124-C20) **Efficient and Stable CIGS Solar Cells with ZnOS Buffer Layer.** Rebekah L. Garris, Miguel A. Contreras, Kannan Ramanathan, Lorelle M. Mansfield, Brian Egaas, Jian V. Li, Ana Kanevce. *National Renewable Energy Laboratory, Golden, CO, USA*. 353

(125-C23) **Co-electroplated Cu₂ZnSnS₄ Thin-film Solar Cells: the Role of Precursor Metallic Composition.** Jie Ge¹, Jinchun Jiang², Pingxiong Yang³, Junhao Chu^{2,3}, Yanfa Yan¹. ¹*Department of Physics & Astronomy, and Wright Center for Photovoltaics Innovation and Commercialization, The University of Toledo, Toledo, OH, USA*, ²*Shanghai Center for Photovoltaics, Shanghai, China*, ³*Key Laboratory of Polar Materials and Devices (MOE), East China Normal University, Shanghai, China*. 357

(126-C26) **H₂S/H₂ annealing as a controlled method for defect reduction and efficiency improvement in SnS solar cells.** Katy Hartman¹, R. Jaramillo¹, Vera Steinmann¹, Helen H. Park², Rupak Chakraborty¹, Jasmin Hofstetter¹, Alex Polizzotti¹, Riley E. Brandt¹, Jeremy Poindexter¹, Yun S. Lee¹, Roy G. Gordon², Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA*, ²*Harvard University, Cambridge, MA, USA*. 362

(127-C29) **Fabrication and Characterization of Cu₂ZnSn(S, Se)₄ Solar Cells by Spray-deposited Precursor Stacks.** Wei-Chih Huang¹, Shih-Yuan Wei¹, Xin Zeng², Lydia Wong², Chih-Huang Lai¹. ¹*Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan*, ²*School of Materials Science & Engineering, Nanyang Technological University, Singapore, Singapore*. 365

(128-C32) **XPS analysis and structural characterization of CZTS thin films prepared using solution and vacuum based deposition techniques.** Mikel Hurtado², Saul Daniel Cruz⁴, Raul Becerra², Clara Lilia Calderón¹, Pascual Bartolo Perez³, Gerardo Gordillo¹. ¹*Universidad Nacional de Colombia, Bogotá, Columbia*, ²*Universidad Nacional de Colombia, Bogotá, Columbia*, ³*CINVESTAV-IPN, Merida, Mexico*, ⁴*Universidad Autónoma de Nuevo León, Monterrey, Mexico*. 368

(129-C35) **Solar Cells with Thin Cu(In_{1-x}Ga_x)Se₂ Absorbers: Optical Modeling and Quantum Efficiency Predictions.** Abdel-Rahman Ibdah¹, Puruswattom Aryal¹, Puja Pradhan¹, Grace Rajan², Jian Li¹, Angus A. Rockett³, Sylvain Marsillac², Robert W. Collins¹. ¹*Center for PV Innovation & Commercialization and Dept. Physics & Astronomy, Univ. Toledo, Toledo, OH, USA*, ²*Virginia Institute of Photovoltaics, Old Dominion Univ., Norfolk, VA, USA*, ³*Dept. Materials Science & Engineering, Univ. Illinois Urbana-Champaign, Urbana, IL, USA*. 373

(130-C38) **Tin Sulfide Thin Films Prepared by Thermal Evaporation and Sulfurization.** Ming-Jer Jeng. *Chang Gung University, Taoyuan, Taiwan*. 379

(131-C41) **Impact of buffer and absorber properties in vicinity of the interface on wide-gap Cu(In,Ga)Se₂ solar cells performance.** Ana Kanevce, Kannan Ramanathan, Miguel Contreras. *National Renewable Energy Laboratory, Golden, CO, USA*. 382

(132-C44) **In-situ stress and thermal stability studies of molybdenum bilayer back contacts for photovoltaic applications.** Sreejith Karthikeyan, Liyuan Zhang, Stephen A Campbell. *Department of Electrical and Computer Engineering, Minneapolis, MN, USA*. 387

(133-C47) **Sulfurization Approach Using Sulfur Vapor, Graphite Box and H₂S gas Atmospheres for Co-sputtered Cu₂ZnSnS₄ Thin Film.** Arun Khalkar¹, Kwang-Soo Lim¹, Seong-Man Yu¹, Jin Hyeok Kim², Ji-Beom Yoo¹. ¹SKKU Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan University, Suwon, Korea, ²Department of Materials Science and Engineering, Chonnam National University, Gwangju, Korea. 390

(134-D2) **Multi-Stage co-evaporation process for active Ga gradient control in CIGS solar cells.** Torben Klinkert^{1,2,3}, Marie Jubault^{1,2,3}, Frederique Donsanti^{1,2,3}, Daniel Lincot^{1,2,3}, Jean-François Guillemoles^{1,2,3}. ¹EDF R&D, Institute of Research and Development on Photovoltaic Energy (IRDEP), Chatou, France, ²CNRS, IRDEP, UMR 7174, Chatou, France, ³Chimie ParisTech, IRDEP, Chatou, France. 395

(135-D5) **Raman investigation of epitaxial Cu₂ZnSnSe₄ layers from annealed Sn/Cu/ZnSe(001) precursors on GaAs(001).** Christoph Krämmer¹, Mario Lang¹, Johannes Sachs¹, Lukas Pfaffmann², Chao Gao¹, Dagmar Gerthsen², Heinz Kalt¹, Michael Powalla³, Michael Hetterich¹. ¹Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, ²Laboratory for Electron Microscopy, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, ³Light Technology Institute, KIT, and Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Stuttgart, Germany. 398

(136-D8) **Defects in Cu₂ZnSn(S,Se)₄ solar cells investigated by Photoluminescence, Admittance and IVT.** Sergiu Levenco¹, J Just¹, G Larramona², S Bourdais², G Dennler², T Unold¹. ¹Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, ²IMRA Europe S.A., Sophia Antipolis, France. 402

(137-D11) **The Importance of Selenium Partial Pressure in the Laser Annealing of CuInSe₂ Precursors.** Helene J. Meadows¹, David Regesch², Sudhajit Misra³, Brian J. Simonds⁴, Mike A. Scarpulla^{3,4}, Viktor Gerliz⁵, Levent Gütay⁵, Phillip J. Dale¹. ¹Laboratory for Energy Materials, University of Luxembourg, Belvaux, Luxembourg, ²Laboratory for Photovoltaics, University of Luxembourg, Belvaux, Luxembourg, ³Electrical and Computer Engineering, University of Utah, Salt lake City, UT, USA, ⁴Materials Science and Engineering, University of Utah, Salt lake City, UT, USA, ⁵Laboratory for Chalcogenide Photovoltaics, University of Oldenburg, Oldenburg, Germany. 405

(138-D14) **Flexible CZTS Solar Cells on Flexible Corning® Willow® Glass Substrates.** Chien-Yi Peng^{1,2}, Tara P. Dhakal^{2,3}, Pravakar Rajbhandari^{2,3}, Sean M. Garner⁴, Patrick Cimo⁴, Susan Lu¹, Charles R. Westgate^{2,3}. ¹Department of Systems Science and Industrial Engineering, Binghamton University, Binghamton, NY, USA, ²Center for Autonomous Solar Power (CASP), Binghamton University, Binghamton, NY, USA, ³Department of Electrical and Computer Engineering, Binghamton University, Binghamton, NY, USA, ⁴Corning Incorporated, Corning, NY, USA. 409

(139-D17) **In-Situ Cu(In,Ga)Se₂ Composition Control by Optical Emission Spectroscopy During Hybrid Co-Sputtering/Evaporation Process.** Jorge Posada¹, Marie Jubault¹, Angélique Bousquet², Eric Tomasella², Daniel Lincot¹. ¹Institute of Research & Development of the Photovoltaic Energy (IRDEP), EDF - CNRS - Chimie ParisTech UMR 7174, Chatou, France, ²Institute of Chemistry of Clermont-Ferrand (ICCF), UMR CNRS 6926 – Université Blaise Pascal, Aubière, France. 413

(140-D20) **High VOC Cu₂ZnSnSe₄/CdS:Cu based solar cell: evidences of a Metal-Insulator-Semiconductor (MIS) type hetero-junction.** Yudania Sánchez¹, Markus Neuschitzer¹, Mirjana Dimitrievska¹, Moisés Espindola-Rodríguez¹, Juan López-García¹, Víctor Izquierdo-Roca¹, Osvaldo Vigil-Galán², Edgardo Saucedo¹. ¹Catalonia Institute for Energy Research, Sant Adrià del Besòs-Barcelona, Spain, ²Escuela Superior de Física y Matemáticas-Instituto Politécnico Nacional (IPN), México DF, Mexico. 417

(141-D23) **Transparent Back Contacts for Superstrate (Ag,Cu)(In,Ga)Se₂ Thin Film Solar Cells.** Hamed Simchi^{1,2}, Jes Larsen¹, William Shafarman^{1,2}. ¹Institute of Energy Conversion, University of Delaware, Newark, DE, USA, ²Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA. N/A

(142-D26) **Experimental and Theoretical Study on Band Gap Tuning of Cu₂ZnSn(S_{1-x}Se_x)₄ Absorbers for Thin-Film Solar Cells.** Weiwei Sun¹, Xiumei Geng¹, Johnathan C. Armstrong¹, Jingbiao Cui², Tar-pin Chen¹. ¹Arkansas GREEN Research Center for Solar Cells, Department of Physics and Astronomy, University of Arkansas at Little Rock, Little Rock, AR, USA, ²Department of Physics, University of Memphis, Memphis, TN, USA. 421

(143-D29) **Impact of Mo density on Mo/CIGSe interfaces : an XPS study.** HAREL sylvie, TOMASSINI Mathieu, ARZEL Ludovic, GAUTRON Eric, BARREAU Nicolas. IMN - Université de Nantes, Nantes, France. 425

(144-D32) **Improvement of the open-circuit voltage of Cu₂ZnSnS₄ cells using a two-layered process.** Shin Tajima, Tadayoshi Itoh, Hirofumi Hazama, Keiichiro Ohishi, Ryoji Asahi. Toyota Central R&D Labs., Inc., Nagakute, Japan. 431

(145-E3) **On the Impact of Defects in Solar Modules and the Interaction between Monolithically Interconnected Cells.** Thi Minh Hang Tran, Bart Elger Pieters, Andreas Gerber, Uwe Rau. Forschungszentrum Jülich GmbH, Jülich, Germany. 435

(146-E6) **Combinatorial Study of Co-sputtered Cu₂ZnSnS₄ Thin-film Stoichiometry for Photovoltaic Devices.** Matteo Valentini^{1,2}, Claudia Malerba^{1,3}, Enrico Salza¹, Marta de Luca², Mario Capizzi², Alberto Mittiga¹. ¹ENEA, Roma, Italy, ²Sapienza University of Rome, Roma, Italy, ³University of Trento, Trento, Italy. 439

(147-E9) **Sputtered Zinc Selenide buffer layers for Cu(InGa)Se₂ Substrate and Superstrate Solar Cells.** Peipei Xin, Christopher P. Thompson, Jes K. Larsen, William N. Shafarman. Institute of Energy Conversion, University of Delaware, Newark, DE, USA. 443

(148-E12) **Effects of Spin Speed on the Properties of sulfurized Cu₂ZnSnS₄ Thin Films Deposited by Spin Coating Using DMSO-based Precursors.** Yue Yu, Jie Ge, Tejas Prabhakar, Yanfa Yan. University of Toledo, Toledo, OH, USA. 448

(149-E15) **Drive-Level Capacitance Profiling of Cu(In,Ga)Se₂ Solar Cells for Different Cu/III Ratios.** Geordie Zapalac, Korhan Demirkan, Neil Mackie. MiaSole Hi-Tech Corp, Santa Clara, CA, USA. 452

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III-V Epitaxy and Solar Cells**Chair(s): Ryan France, Philip Chiu**

(150-E19) **Numerical Simulation of Temperature Dependent Performance of InP-based Tunnel Junctions.** Chaffra A. Affouda¹, Matthew P. Lumb^{1,2}, Maria Gonzalez^{1,3}, Michael K. Yakes¹, Christopher G. Bailey¹, Robert J. Walters¹. ¹Naval Research Laboratory, Washington, DC, USA, ²The George Washington University, Washington, DC, USA, ³Sotera Defense Solutions, Annapolis Junction, MD, USA. 456

(151-E22) **Homojunction GaAs Solar Cells Grown by Close Space Vapor Transport.** Jason W. Boucher, Andrew J. Ritenour, Ann L. Greenaway, Shannon W. Boettcher. *University of Oregon, Eugene, OR, USA.* 460

(152-E25) **Growth, Characterization and Analysis of Record Performance High Band Gap Tunnel Junctions for Multijunction Solar Cells.** C Zachary Carlin, John R Hauser, Jeff L Harmon, Geoff K Bradshaw, Joshua P Samberg, Peter C Colter, Salah M Bedair. *North Carolina State University, Raleigh, NC, USA.* N/A

(153-E28) **Optimization Tool for Multijunction Photovoltaic Systems.** Kevon C Charles, John R Wilcox, Jeffery L Gray. *Purdue University, West Lafayette, IN, USA.* 465

(154-E31) **Power maximization in III-V sub-millimeter, radial front contacted cells for thin micro-concentrators.** Jose L. Cruz-Campa, Anna Tauke-Pedretti, Jeffery G. Cederberg, Carlos A. Sanchez, Gerald R. Girard, Charles Alford, Brandon A. Aguirre, Ian E. Addington-Luna, Murat Okandan, Jeffrey S. Nelson, Gregory N. Nielson. *Sandia National Laboratories, Albuquerque, NM, USA.* 471

(155-F2) **Modeling and Simulation of InAs/GaAs Quantum Dot Solar Cells in SILVACO TCAD.** Boqun Dong¹, Christopher G. Bailey², Andrei Afanasev³, Mona E. Zaghoul¹. ¹The George Washington University, Washington, DC, USA, ²Naval Research Lab, Washington, DC, USA, ³The George Washington University, Washington, DC, USA. 476

(156-F5) **Optimization of Multijunction Solar Cells Through Indoor Energy Yield Measurements.** Iván Garcia^{1,2}, Myles A. Steiner¹, William E. McMahon¹, John F. Geisz¹, Aron Habte¹, Daniel J. Friedman¹. ¹National Renewable Energy Laboratory, Golden, CO, USA, ²Instituto de Energía Solar - U.P.M., Madrid, Spain. N/A

(157-F8) **Study on 2.05 eV Al_{0.13}Ga_{0.87}InP sub-cell and its hetero-structure cell.** Xinyi Li, Wei Zhang, Dayong Zho, Hongbo Lu. *Shanghai Institute of Space Power-source, Shanghai, China.* 479

(158-F10) **Decreasing Dark Current in Long Wavelength InAs/GaSb Thermophotovoltaics via Bandgap Engineering.** Abigail S. Licht¹, Dante DeMeo¹, J. B. Rodriguez², Thomas E. Vandervelde¹. ¹Tufts University, Medford, MA, USA, ²University of Montpellier II, Montpellier, France. 482

(159-F12) **Characterization and Analysis of Ultra-thin GaAs Single-Junction Solar Cells with Reflective Back Scattering.** Shi Liu, Weiquan Yang, Jacob J Becker, Ying-Shen Kuo, Yong-Hang Zhang. *Center for Photonics Innovation and School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ, USA.* 487

(160-F14) **Development of InGaAs Solar Cells for >44% Efficient Transfer-Printed Multi-junctions.** Matthew P Lumb^{1,2}, Matthew Meitl³, John Wilson³, Salvatore Bonafede³, Scott Burroughs³, David V Forbes⁴, Christopher G Bailey², Nichole M Hoven⁴, Maria Gonzalez^{2,5}, Michael K Yakes², Stephen J Polly⁴, Seth M Hubbard⁴, Robert J Walters². ¹*The George Washington University, Washington, DC, USA*, ²*Naval Research Laboratory, Washington, DC, USA*, ³*Semprius Inc., Durham, NC, USA*, ⁴*Rochester Institute of Technology, Rochester, NY, USA*, ⁵*Sotera Defense Solutions, Annapolis Junction, MD, USA*. 491

(161-F16) **Highly Efficient and Reliable Mechanically Stacked Multi-Junction Solar Cells Using Advanced Bonding Method with Conductive Nanoparticle Alignments.** Kikuo Makita, Hidenori Mizuno, Ryuji Oshima, Takeyoshi Sugaya, Hironori Komaki, Koji Matsubara. *National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan*. 495

(162-F18) **Defect Creation in Low Lattice-Mismatched Epitaxial Structures.** Aymeric Maros, Nikolai Faleev, Christiana Honsberg. *School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA*. 499

(163-F20) **Effect of substrate offcut angle on AlGaInP and GaInP solar cells grown by molecular beam epitaxy.** Taizo Masuda, Stephanie Tomasulo, Jordan R. Lang, Minjoo Larry Lee. *Yale University, New Haven, CT, USA*. 505

(164-F22) **GaAs solar cells for Indoor Light Harvesting.** Ian Mathews, Gerard Kelly, Paul J. King, Ronan Frizzell. *Bell Labs, Alcatel-Lucent, Dublin, Ireland*. 510

(165-F24) **Modeling and fabrication of GaAs solar cells with high dislocation tolerance.** Akhil Mehrotra, Wei Wang, Alex Freundlich. *University of Houston, Houston, TX, USA*. 514

(166-F26) **Concentrating Photovoltaic Properties of GaInNAsSb/Ge Dual Junction Tandem Solar Cell.** Naoya Miyashita, Nazmul Ahsan, Yoshitaka Okada. *The University of Tokyo, Tokyo, Japan*. 520

(167-F28) **Development of ZnO-InP Heterojunction Solar Cells for Thin Film Photovoltaics.** Kyle H. Montgomery¹, Qiong Nian², Xin Zhao¹, Haoyu U. Li³, Gary J. Cheng², Thomas N. Jackson³, Jerry M. Woodall¹. ¹*University of California, Davis, CA, USA*, ²*Purdue University, West Lafayette, IN, USA*, ³*The Pennsylvania State University, University Park, PA, USA*. 524

(168-F30) **Selfconsistent Model of Photoconversion Efficiency for Multijunction Solar Cells.** Anatoliy V. Sachenko¹, Anatoli I. Shkrebti², Vitaliy P. Kostilyov¹, Mykola R. Kulish¹, Igor O. Sokolovsky¹. ¹*V. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine, Kyiv, Ukrenia*, ²*University of Ontario Institute of Technology, Oshawa, ON, Canada*. 528

(169-F32) **Hybrid Triple-Junction Solar Cells by Surface Activate Bonding of III-V Double-Junction-Cell Heterostructures to Ion-Implantation-Based Si Cells.** Naoteru Shigekawa¹, Li Chai¹, Masashi Morimoto¹, Jianbo Liang¹, Ryusuke Onitsuka², Takaaki Agui², Hiroyuki Juso², Tatsuya Takamoto². ¹*Osaka City University, Osaka, Japan*, ²*Sharp Corporation, Yamatokoriyama, Japan*. 534

(170-F33) **Low Cost III-V Solar Cells Grown by Hydride Vapor Phase Epitaxy.** John Simon, David Young, Aaron Ptak. *NREL, Golden, CO, USA*. 538

(171-F34) MBE-grown InGaP/GaAs/InGaAsP triple junction solar cells fabricated by advanced bonding technique.

Takeyoshi Sugaya¹, Kikuo Makita¹, Hidenori Mizuno¹, Akihiro Takeda², Toru Mochizuki², Ryuji Oshima¹, Koji Matsubara¹, Yoshinobu Okano², Shigeru Niki¹. ¹AIST, Tsukuba, Japan, ²Tokyo City University, Tokyo, Japan. 542

(172-F35) Bonded InGaAs Cells for Microsystems Enabled Photovoltaics.

Anna M Tauke-Pedretti, Jeffrey G Cederberg, Charles Alford, Jose L Cruz-Campa, Carlos A Sanchez, Ian Luna, Jeffrey S Nelson, Gregory N Nielson. Sandia National Laboratories, Albuquerque, NM, USA. 546

(173-F36) GaNAsSb 1-eV Solar Cells For Use in Lattice-Matched Multi-Junction Architectures.

Tomos Thomas¹, Markus Führer¹, Ned Ekins-Daukes¹, Kian Hua Tan², Satrio Wicaksono², Wan Khai Loke², Soon Fatt Yoon², Andrew Johnson³. ¹Imperial College London, London, UK, ²Nanyang Technological University, Singapore, Singapore, ³IQE plc, Cardiff, UK. 550

(174-F37) Advancement in the MOVPE technology to increase the process yield and expand the band gap engineering possibilities.

Gianluca Timo¹, Nicola Armani¹, Giovanni Abagnale¹, Bernd Schineller². ¹RSE, Piacenza, Italy, ²RSE, Piacenza, Italy, ³RSE, Piacenza, Italy, ⁴AIXTRON, Herzogenrath, Germany. 554

(175-F38) Development of the Monolithically Interconnected InGaP/GaAs Dual Junction Solar Cell with Bypass Diode for Ultrahigh Concentrator Application.

Kentaroh Watanabe¹, Minato Seno², Masakazu Sugiyama², Yoshiaki Nakano². ¹Resarch Center for Advanced Science and Technology, University of Tokyo, Tokyo, Japan, ²Department of Electrical Engineering and Information Systems, University of Tokyo, Tokyo, Japan. 559

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Exhibit Hall D

Surface Passivation I

Chair(s): Oliver Schultz-Wittmann, Benedicte Demaurex, Laura Ding

(176-F39) Reactive Ion Etched Black Silicon Texturing: A Comparative Study.

Thomas G. Allen¹, James Bullock¹, Andres Cuevas¹, Simeon C. Baker-Finch^{1,2}, Fouad Karouta³. ¹Research School of Engineering, College of Engineering and Computer Science, Australian National University, Canberra, Australia, ²PV Lighthouse, Coledale, Australia, ³ANFF, Research School of Physics and Engineering, Australian National University, Canberra, Australia. 562

(177-G3) AlOx Passivation Of Ion Implanted B Emitters Using Batch ALD Process.

Vikram M Bhosle¹, Mac Hathaway², Christopher E Dube¹. ¹Applied Materials, Varian Semiconductor Equipment, Gloucester, MA, USA, ²Center for Nanoscale Systems, Harvard University, Cambridge, MA, USA. 567

(178-G7) Controlled Field Effect Surface Passivation of Crystalline N-Type Silicon and its Application to Back-Contact Silicon Solar Cells.

Ruy S Bonilla¹, Christian Reichel², Martin Hermle², Semih Senkader¹, Peter Wilshaw¹. ¹Department of Materials, University of Oxford, Oxford, UK, ²Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany. 571

(179-G11) **High VOC on Thin Silicon Solar Cells.** Stuart Bowden, Stanislau Y Herasimenka, William J Dauksher, Clarence J Tracy, Christiana B Honsberg. *Arizona State University, Temp, AZ, USA.* 577

(180-G15) **Study of the passivation mechanism of c-Si by Al₂O₃ using in situ infrared spectroscopy.** Rohan P Chaukulkar¹, William Nemeth², Arrelaine Dameron², Paul Stradins², Sumit Agarwal¹. ¹*Colorado School of Mines, Golden, CO, USA,* ²*National Renewable Energy Laboratory, Golden, CO, USA.* 582

(181-G19) **Anodic Aluminium Oxide Rear Passivated Laser-Doped Selective-Emitter Solar Cells.** Jie Cui, Xi Wang, Dong Lin, Pei Hsuan Lu, Alison J Lennon. *School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia.* 586

(182-G23) **The role of back contact patterning on stability and performance of Si IBC heterojunction solar cells.** Ujjwal K. Das, Hsiang-Yu Liu, Jianbo He, Steven Hegedus. *Institute of Energy Conversion, University of Delaware, Newark, DE, USA.* 590

(183-G27) **Optical Properties of Screen-Printed Aluminum Contacts.** Kristopher O Davis^{1,2,3}, Jianing Sun⁴, Kaiyun Jiang⁵, Winston V Schoenfeld^{1,2,3}. ¹*Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA,* ²*CREOL, College of Optics and Photonics, University of Central Florida, Orlando, FL, USA,* ³*c-Si Division, U.S. Photovoltaic Manufacturing Consortium, Orlando, FL, USA,* ⁴*J.A. Woollam Co., Inc., Lincoln, NE, USA,* ⁵*Gebr. Schmid GmbH & Co., Freudenstadt, Germany.* 594

(184-G31) **Conventionally-Processed Silicon Nanowire Solar Cells Demonstrating Efficiency Improvement Over Standard Cells.** Michael P. Jura¹, Jeff B. Miller¹, Joanne W. L. Yim¹, Joanne Forziati¹, Brian Murphy¹, Richard Chleboski¹, Ian B. Cooper², Ajeet Rohatgi², Marcie R. Black¹. ¹*Bandgap Engineering, Salem, NH, USA,* ²*University Center of Excellence for Photovoltaics Research and Education, Georgia Institute of Technology, Atlanta, GA, USA.* 598

(185-G35) **Study on Surface Passivation by YZO/AlOx Stacking Double Layer for Crystalline Si Solar Cells.** Takaaki Katsumata^{1,2,4}, Norihiro Ikeno¹, Shin-inchi Satoh^{3,4}, Haruhiko Yoshida^{3,4}, Koji Arafune^{3,4}, Toyohiro Chikyow^{2,4}, Atsushi Ogura^{1,4}. ¹*Meiji university, Tama-ku, Kawasaki, Kanagawa, Japan,* ²*NIMS, Tsukuba, Ibaraki, Japan,* ³*University of Hyogo, Himeji, Hyogo, Japan,* ⁴*JST-CREST, Kawaguchi, Saitama, Japan.* 601

(186-G39) **Optimizing Inverted Pyramidal Grating Texture for Maximum Photoabsorption in Thick to Thin Crystalline Silicon Photovoltaics.** K. Kumar, A. Khalatpour, E.G. Liu, J. Nogami, P.R. Herman, N.P. Kherani. *University of Toronto, Toronto, ON, Canada.* 605

(187-H3) **Al₂O₃ Surface Passivation of Silicon Solar Cells by Low Cost ALD Technology.** Vladimir Kuznetsov¹, Marius Ernst², Ernst Granneman³. ¹*Levitech BV, Almere, Netherlands,* ²*Levitech BV, Almere, Netherlands,* ³*Levitech BV, Almere, Netherlands.* 608

(188-H7) **Heterojunction Rear Passivated Contact for High Efficiency n-Cz Si Solar Cells.** Benjamin G Lee, William Nemeth, Hao-Chih Yuan, David L Young, Paul Stradins. *National Renewable Energy Lab, Golden, CO, USA.* 612

(189-H11) **Effect of Post Deposition Annealing of Printed AlOx Film on PERC Solar Cells.** Yung-Sheng Lin¹, Jui-Yi Hung², Tsung-Cheng Chen¹, Chen-Hao Ku¹, Jung-Ching Wang³, Shian-Wen Chen³. ¹*E-ton Solar Tech, Tainan, Taiwan,* ²*New E Materials, Kaohsiung, Taiwan,* ³*Eternal Chemical, Kaohsiung, Taiwan.* 615

(190-H15) **Stored Charge Properties of Anodic Aluminium Oxide on Silicon Substrate.** Zhong Lu¹, Pei Hsuan Lu¹, Ziv Hameiri², Kai Wang¹, Jie Cui¹, Yang Li¹, Alison Lennon¹. ¹*The School of Photovoltaics and Renewable Energy Engineering, The University of New South Wales, Sydney NSW, Australia,* ²*Solar Energy Research Institute of Singapore, National University of Singapore, Singapore.* 619

(192-H23) **Double-scale texturing for light trapping in Thin Film Crystalline Silicon Solar Cells.** Xianqin Meng^{1,2,4,*}, Emmanuel Drouard^{1,2}, Guillaume Gomard^{1,2,5}, Valérie Depauw³, Rafael Kleiman⁴, Christian Seassal^{1,2}. ¹*Institut des Nanotechnologies de Lyon (INL), Ecole Centrale de Lyon, Lyon, France,* ²*Institut des Nanotechnologies de Lyon (INL), INSA de Lyon, Lyon, France,* ³*Imec, Leuven, Belgium,* ⁴*Engineering Physics, McMaster University, Hamilton, ON, Canada,* ⁵*Light Technology Institute (LTI), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany.* 622

(193-H27) **Inductively coupled plasma deposited amorphous silicon alloys using industrial equipment for heterojunction silicon solar cells.** Thomas Mueller¹, Jia Ge¹, Muzhi Tang¹, Johnson Wong¹, Zhi Peng Ling¹, Zhenhao Zhang², Manfred Doerr², Torsten Dippell², Oliver Hohn², Marco Huber², Peter Wohlfart². ¹*Solar Energy Research Institute of Singapore (SERIS), Singapore, Singapore,* ²*Singulus Technologies AG, Kahl am Main, Germany.* 625

(194-H31) **Dielectric Stack Passivation and Optimization on N-Type Diffused Surfaces.** Bill Nemeth¹, Hao-Chih Yuan¹, Matt Page¹, Vincenzo LaSalvia¹, Rohan Chaulkulkar², Lynn Gedvilas¹, Jian Li¹, Robert White¹, Paul Stradins¹. ¹*National Renewable Energy Laboratory, Golden, CO, USA,* ²*Colorado School of Mines, Golden, CO, USA.* 629

(195-H35) **p+ Emitters on n-Type c-Si dry-etched with nitrogen trifluoride and passivated with ALD aluminum oxide.** Tim Reblitz, Clarence Tracy, Bill Dauksher, Stuart Bowden. *Arizona State University, Tempe, AZ, USA.* 634

(196-H39) **Improved Cleaning Process for Post-Texture Surface Contamination Removal for Single Heterojunction Solar Cells on ~25µm Thick Exfoliated and Flexible Monocrystalline Silicon Substrates.** Sayan Saha¹, Emmanuel U Onyegam¹, Sushant S Sonde¹, Mohamed M Hilali¹, Dharmesh Jawarani², Rajesh A Rao³, Leo Mathew³, Ajay Upadhyaya⁴, Sanjay K Banerjee¹. ¹*University of Texas - Austin, Austin, TX, USA,* ²*AstroWatt, Inc., Austin, TX, USA,* ³*Applied Novel devices, Austin, TX, USA,* ⁴*Georgia Institute of Technology, Atlanta, TX, USA.* 637

(197-13) **Growth of Graded SixNy ARC for High Efficiency and Lower Cell-to-Module Power Loss in Multi-crystalline Silicon Solar Cells in a High Volume In-Line Production.** Virender Sharma^{1,2}, D.N Singh¹, Abhishek Verma², R.B Gupta¹, V.K Jain², C.M Kumar¹. ¹*INDOSOLAR LTD, Greater Noida, India,* ²*Amity University, Noida, India* N/A

(198-17) **Micro-concentrated Silicon Heterojunction Solar Cell: PC2D Device Simulation for Harvesting Infrared Light.** Jianwei Shi, Zachary Holman. *Arizona State University, Tempe, AZ, USA.* 641

(199-111) **Apparent doping-dependence of the a-Si:H/c-Si interface degradation upon ITO sputtering.** Igor P SOBKOWICZ^{1,2}, Antoine SALOMON¹, Pere ROCA i CABARROCAS². ¹TOTAL New Energies,, Paris La Défense, France, ²LPICM CNRS Ecole Polytechnique, Palaiseau, France. 645

(200-115) **Some Challenges in Making Accurate and Reproducible Measurements of Minority Carrier Lifetime in High-Quality Si Wafers.** Bhushan Sopori¹, Srinivas Devayajanam^{1,2}, Prakash Basnyat^{1,2}, Vishal Mehta^{1,2}, Helio Moutinho¹, William Nemeth¹, Vincenzo LaSalvia¹, Steven Johnson¹, NM Ravindra², Jeff Binns³, Jesse Appel⁴. ¹National Renewable Energy Laboratory, Golden, CO, USA, ²New Jersey Institute of Technology, Newark, NJ, USA, ³Sun Edison, StPeters, MT, USA, ⁴Sun Edison, Portland, OR, USA. 649

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Characterization I

Chair(s): Mowafak Al-Jassim, Rebekah Feist, Keith Emery

(201-K29) **Measuring Refractive Index Profiles within Thin-Film Photovoltaics with High Spatial Resolution using the Modified IM-IWKB Method.** Yutong T Pang^{1,2}, Matthew D Eisaman^{1,2}. ¹Brookhaven National Laboratory, Upton, NY, USA, ²Department of Physics and Astronomy, Stony Brook University, Stony Brook, NY, USA. 655

(202-K32) **InGaAs/GaAs MQWs: Correlation of crystal and physical properties.** Matthias M. Karow¹, Nikolai N. Faleev¹, David J. Smith², Christiana B. Honsberg¹. ¹Solar Power Laboratory, Ira A. Fulton Schools of Engineering, Arizona State University, Tempe, AZ, USA, ²Department of Physics, Arizona State University, Tempe, AZ, USA. 660

(203-K35) **Investigation on the effects of phosphine doping in Si nanocrystal material.** Lingfeng Wu, Ivan Perez-Wurfl, Ziyun Lin, Xuguang Jia, Tian Zhang, Binesh Puthen-Veetil, Terry Chien-Jen Yang, Hongze Xia, Gavin Conibeer. *University of New South Wales, Sydney, Australia.* 666

(204-K38) **Selective Passivation of Nitrogen Clusters and Impurities in GaInNAs Solar Cells.** M Fukuda¹, V. R. Whiteside¹, J. C. Keay¹, M. B. Johnson¹, M. Leroux², M. Al Khalfioui², K. Hossain³, T. D. Golding³, I. R. Sellers¹. ¹Department of Physics, University of Oklahoma, Norman, OK, USA, ²CRHEA-CNRS, Valbonne, France, ³Amethyst Research Inc., Ardmore, OK, USA. 669

(205-L1) **Mapping Spectroscopic Ellipsometry of CdTe Solar Cell Processes: Optimization of Cu Incorporation for Different CdS/CdTe Thicknesses.** Prakash Koirala¹, Xinxuan Tan¹, Jian Li¹, Nikolas J Podraza¹, Sylvain Marsillac², Angus A Rockett³, Robert W Collins¹. ¹The University of Toledo, Toledo, OH, USA, ²Old Dominion University, Norfolk, VA, USA, ³University of Illinois Urbana-Champaign, Urbana, IL, USA. 674

(206-L4) **Application of Non-contact Corona-Kelvin Metrology for Characterization of PV Dielectrics on Textured Surfaces.** Marshall Wilson¹, Ziv Hameri², Naomi Nandakumar^{2,3}, Shubham Duttagupta^{2,3}. ¹Semilab SDI LLC, Tampa, FL, USA, ²Solar Energy Research Institute of Singapore, Singapore, Singapore, ³Department of Electrical and Computer Engineering, National University of Singapore, Singapore, Singapore. 680

(207-L7) **Electrical Characterization of Interface Recombination and its Dependence on Band Offset, Barrier Height, and Inversion in Certain Heterojunction Solar Cells.** Jian V. Li, Sachit Grover, Ingrid L. Repins, Brian M. Keyes, Miguel A. Contreras, Kannan Ramanathan, Rommel Noufi. *National Renewable Energy Lab, Golden, CO, USA.* 686

(208-L10) **High-quality Cu(InGa)Se₂ Crystalline Thin Film by Two-step Selenization.** JINXIN HE, SEN ZHANG, DONG WANG. *PEKING UNIVERSITY, BEIJING, China.* N/A

(209-L13) **Assessing Local Voltage in CIGS Solar Cells by Nanoscale Resolved Kelvin Probe Force Microscopy and Sub-Micron Photoluminescence.** Elizabeth Tenysson^{1,2}, Joe Garrett^{2,3}, Chen Gong^{1,2}, Jesse Frantz⁴, Jason Myers⁴, Robel Bekele⁴, Jas Sanghera⁵, Jeremy Munday^{2,6}, Marina Leite^{1,2}. ¹*Department of Materials Science and Engineering, UMD, College Park, MD, USA,* ²*Institute for Research in Electronics and Applied Physics, UMD, College Park, MD, USA,* ³*Department of Physics, UMD, College Park, MD, USA,* ⁴*U. S. Naval Research Laboratory, Washington, DC, USA,* ⁵*University Research Foundation, Greenbelt, MD, USA,* ⁶*Department of Electrical and Computer Engineering, UMD, College Park, MD, USA.* 691

(210-L16) **Direct imaging of quasi Fermi level splitting in photovoltaic absorbers.** Laurent Lombez, Myriam Paire, Amaury Delamarre, Gilbert ElHajje, Pierre Rale, Jean Rodière, Daniel Ory, Jean-François Guillemoles. *IRDEP, Institute of R&D on Photovoltaic Energy, UMR 7174, CNRS-EDF-Chimie ParisTech 6 Quai Watier-BP 49, 78401, Chatou, France.* 695

(211-L19) **EMIL: The Energy Materials In-Situ Laboratory Berlin.** Klaus Lips¹, David E. Starr¹, Marcus Bär^{1,2}, Tim F. Schulze¹, Bernd Rech¹, Silke Christiansen¹, Roel van de krol¹, Simone Raoux¹, Gerd Reichardt¹, Franz Schäfers¹, Stefan Hendel¹, Rolf Follath^{1,3}, Johannes Bahrtdt¹, Axel Knop-Gericke¹, Michael Hävecker¹, Robert Schlögl¹. ¹*Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany,* ²*Inst. f. Physik und Chemie, Brandenburgische TU Cottbus-Senftenberg, Cottbus, Germany,* ³*Paul-Scherrer Institut, Villingen, Switzerland,* ⁴*Inorganic Chemistry Department, Fritz-Haber-Institute of the Max-Planck-Society, Berlin, Germany.* 698

(212-L22) **Cadmium Chloride Assisted Re-Crystallization of CdTe: The effect of annealing over-treatment.** Ali Abbas¹, Geoff D West¹, Jake W Bowers¹, Piotr M Kaminski¹, Biancamaria Maniscalco¹, Kurt L Barth², W.S. Sampath², John M Walls¹. ¹*Loughborough University, Loughborough, UK,* ²*Colorado State University, Fort Collins, CO, USA.* 701

(213-L25) **Correlation of Dynamical, Vibrational and Optical Properties in c-Si with Bond-Centered-Hydrogen and Other Hydrogen Complexes.** Zahraa A. Ibrahim, Anatoli I. Shkrebtii, Frederick Zimmer-De Iuliis, Franco Gaspari. *Faculty of Science, University of Ontario Institute of Technology, Oshawa, ON, Canada.* 707

(214-L28) **Experimental Study on the Role of Parameters Affecting Surface Recombination and Emitter Passivation.** Marshall Wilson, Andrew Findlay, John D'Amico, Alexandre Savtchouk, Jacek Lagowski. *Semilab SDI LLC, Tampa, FL, USA.* 713

(215-L31) **Bulk Defect Generation during B-Diffusion and Oxidation of CZ Wafers: Mechanism for Degradation of Solar Cell Performance.** Bhushan Sopori¹, Hao-Chih Yuan¹, Srinivas Devayajanam^{1,2}, Prakash Basnyat^{1,2}, Vincenzo LaSalvia¹, Andrea Norman¹, Mathew Page¹, William Nemeth¹, Pauls Stradins¹. ¹*National Renewable Energy Laboratory, Golden, CO, USA,* ²*New Jersey Institute of Technology, Newark, NJ, USA.* 719

(216-M2) **Epitaxial Growth: Model of Crystal Defect Creation.** Nikolai N Faleev, David J. Smith, Christiana B. Honsberg. 724

(217-M5) **Solar Wafer Emitter Measurement by Infrared Reflectometry for Process Control: Implementation and Results.** Gordon Deans¹, Steven McDonald¹, Carsten Baer², Kenneth Cadien³. ¹*Aurora Control Technologies Inc., North Vancouver, BC, Canada*, ²*Hanwha Q CELLS GmbH, Bitterfeld-Wolfen, Germany*, ³*University of Alberta, Dept. of Chemical and Materials Engineering, Edmonton, AB, Canada*. 729

(218-M8) **Temperature Dependence of Equivalent Circuit Parameters Used to Analyze Admittance Spectroscopy and Application to Cases of Dopant Freezeout Such as CZTSSe.** A. E. Caruso¹, D.S. Pruzan², V. Kosyak², A. Bhatia², E. A. Lund^{1,3}, C. Beall⁴, I. Repins⁴, M. A. Scarpulla^{1,2}. ¹*Electrical and Computer Engineering, University of Utah, Salt Lake City, UT, USA*, ²*Materials Science and Engineering, University of Utah, Salt Lake City, UT, USA*, ³*Chemical Engineering, University of Utah, Salt Lake City, UT, USA*, ⁴*National Renewable Energy Laboratory, Golden, CO, USA*. 733

(219-M11) **Contactless Optical and Electrical Characterization of Si Wafers Using Hg Probes.** Harold J. Hovel. *IBM Corporation, Yorktown Hts, NY, USA*. N/A

(220-M14) **Evaluation of Lights Soaking in Hydrogenated Polymorphous Silicon Solar Cells Structures.** Leon Hamui¹, Betsabee M. Monroy¹, Pere Roca i Cabarrocas², Guillermo Santana¹. ¹*IIM, UNAM, Mexico, Mexico*, ²*LPICM, Ecole polytechnique, Palaiseau, France*. 737

Area 10 - Posters

10:30 - 12:00 PM

Exhibit Hall D

Performance Modeling and Validation 1

Chair(s): Lauren Ngan, Dirk Jordan, Jessica Forbess

(221-N15) **Estimating the performance of product integrated photovoltaic (PIPV) cells under indoor conditions for the support of design processes.** Georgia Apostolou¹, Martin Verwaal¹, Angele H.M.E. Reinders^{1,2}. ¹*Design for Sustainability, Faculty of Industrial Design Engineering Delft University of Technology, Delft, Netherlands*, ²*Department of Design, Production and Management, Faculty of Engineering Technology University of Twente, Enschede, Netherlands*. 742

(222-N19) **Modeling and Comparative Analysis of Jet Impingement Cooling and Conventional Channel Cooling for Photovoltaic Strings.** Haitham M.S. Bahaidarah¹, Ahmer A.B. Baloch², Palanichamy Gandhidasan². ¹*Center of Research Excellence in Renewable Energy, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia*, ²*Mechanical Engineering Department, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia*. 748

(223-N23) **Clear sky models performance quantification for PV production forecast over Non-Interconnected Territories.** Sylvain Cros¹, Jean-Baptiste Gadan¹, Cyril Voyant², Nicolas Schmutz¹. ¹*Reuniwatt, Sainte-Clotilde, France*, ²*University of Corsica, Ajaccio, France*. N/A

(224-N27) **Inter-system time lag due to clouds in an urban PV ensemble.** Boudewijn Elsinga, Wilfried G. J. H. M. Van Sark. *Copernicus Institute of Sustainable Development, Utrecht, Netherlands*. 754

(225-N31) **CPV Field Performance Modeling using Semprius' System Performance Model (SPM).** Brent R. Fisher¹, Kanchan Ghosal¹, Dan Riley², Cliff Hansen², Bruce King², Scott Burroughs¹. ¹*Semprius, Inc., Durham, NC, USA*, ²*Sandia National Laboratories, Albuquerque, NM, USA*. 759

(226-N35) **Economic Potential for Thermophotovoltaic Electric Power Generation in the Steel Industry.** Lewis M Fraas. *JX Crystals Inc, Issaquah, WA, USA*. 766

(227-N39) **Evaluation of a CdTe Spectrally Matched c-Si PV Reference Cell for Outdoor Applications.** Michael Gostein¹, J. Riley Caron², Bodo Littmann². ¹*Atonometrics, Austin, TX, USA*, ²*First Solar, San Francisco, CA, USA*. 771

(228-N43) **The Effect of Building Integration on the Temperature and Performance of Photovoltaic Panels – A UK perspective.** Airlangga Gunawan¹, KT Tan², Stuart Elmes², Pritesh Hiralal¹, Gehan Amaratunga¹. ¹*University of Cambridge, Cambridge, UK*, ²*Viridian Solar, Cambridge, UK*. 776

(229-N47) **A simple hybrid MPPT technique for photovoltaic systems under rapidly changing partial shading conditions.** Lianlian Jiang, Douglas L Maskell. *Nanyang Technological University, Singapore, Singapore*. 782

(230-O3) **Bifacial PV Module Installations: Design Factors and Performance Prediction.** Lev Kreinin¹, Asher Karsenty¹, Dov Grobgeld¹, Nelly Bordin¹, Naftali Eisenberg¹. ¹*b-Solar, Jerusalem, Israel* N/A

(231-O7) **Development of An Irradiance Sensor Network to Model Photovoltaic Plant-Average Irradiance Time Series.** Houtan Moaveni, David K. Click, Anthony Pappalardo. *University of Central Florida, Florida Solar Energy Center, Cocoa, FL, USA*. 788

(232-O11) **Simulation of the impact of moving clouds on large scale PV-plants.** Kasper M. Paasch¹, Morten Nymand¹, Søren B. Kjær². ¹*University of Southern Denmark, Odense, Denmark*, ²*Danfoss Solar Inverters A/S, Nordborg, Denmark*. 791

(233-O15) **Image Aided Dynamic Reconfiguration of SPV Array under Non-Uniform Illumination.** Bhawani Patnaik¹, Aswani Uppada¹, Gargi Sarkar², Siddhartha P Duttagupta¹. ¹*IIT Bombay, Mumbai, India*, ²*MPSTME, Mumbai, India*. 797

(234-O18) **An Estimation Method of Maximum Power Point for Solar Units in Series under Uneven Lighting Conditions.** Wang Yun Ping¹, Ruan Xin Bo¹, Li Ying¹. ¹*Nanjing University of Aeronautics and Astronautics, Nanjing, China*, ²*Nanjing University of Aeronautics and Astronautics, Nanjing, China*, ³*Nanjing University of Aeronautics and Astronautics, Nanjing, China*. 803

(235-O21) **Validation of the MERRA Dataset for Solar PV Applications.** David B. Richardson¹, Robert W. Andrews². ¹*University of Toronto, Toronto, ON, Canada*, ²*Calama Consulting Inc., Toronto, ON, Canada*. 809

(236-O23) **1.6 Suns at 58°20'N – the Solar Resource in Southern Norway.** Georgi H. Yordanov¹, Tor Oskar Saetre¹, Ole-Morten Midtgård². ¹*University of Agder (UiA), Grimstad, Norway*, ²*Norwegian University of Science and Technology (NTNU), Trondheim, Norway*. 815

Joint Session: Areas 1,3,4,7 - Orals

1:30 - 3:00 PM

MR 505-507

III-V on Silicon Materials

Chair(s): Thomas Hannappel, Tyler Grassman

- 1:30 **(237) Potential and Present Status of III-V/Si Tandem Solar Cells**
Masafumi Yamaguchi
Toyota Technological Institute, Nagoya, Japan 821
- 2:00 **(238) Dual-Junction GaAsP/SiGe on Silicon Tandem Solar Cells**
Martin B. Diaz¹, Li Wang¹, Andrew Gerger², Anthony Lochtefeld², Chris Ebert³, Robert Opila⁴, Ivan Perez-Wurfl¹, Allen Barnett¹
¹School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia, ²AmberWave Inc., Salem, NH, United States, ³Veeco MOCVD, Somerset, NJ, United States, ⁴Department of Electrical Engineering, University of Delaware, Newark, DE, United States 827
- 2:15 **Best Student Presentation Award Finalist (239) Towards high efficiency GaAsP1-x solar cells on (001) GaP/Si**
Kevin Nay Yaung, Jordan R. Lang, Minjoo L. Lee
Yale University, New Haven, CT, United States 831
- 2:30 **(240) Results from Coupled Optical and Electrical Sentaurus TCAD Models of a Gallium Phosphide on Silicon Electron Carrier Selective Contact Solar Cell.**
Steven Limpert¹, Kunal Ghosh², Hannes Wagner³, Stuart Bowden², Christiana Honsberg², Stephen Goodnick², Stephen Bremner¹, Anita Ho-Baillie¹, Martin Green¹
¹University of New South Wales School of Photovoltaic and Renewable Energy Engineering, Sydney, Australia, ²Arizona State University School of Electrical, Computer and Energy Engineering, Tempe, AZ, United States, ³Massachusetts Institute of Technology, Cambridge, MA, United States 836
- 2:45 **(241) Structural and Electrical Investigations of GaN-Si Interface for a Heterojunction Solar Cell**
Joshua J. Williams^{1,2}, April M. Jeffries¹, Mariana I. Bertoni¹, Todd L. Williamson², Stuart G. Bowden¹, Christiana B. Honsberg¹
¹Arizona State University, Tempe, AZ, United States, ²Los Alamos National Laboratory, Los Alamos, NM, United States 841

Area 2 - Orals

1:30 - 3:00 PM

MR 502-504

Kesterite 2**Chair(s): Ayodhya Tiwari, Glenn Teeter**

- 1:30 **(242) Defect characterization in $\text{Cu}_2\text{ZnSnSe}_4$ -CdS-ZnO solar cells**
Guy Brammertz^{1,2}, Souhaib Oueslati^{1,2,3,4}, Marie Buffiere^{5,6}, Jonas Bekaert⁷, Christine Koeble⁸, Marc Meuris^{1,2}, Jef Poortmans^{5,6}
¹imec division IMOMECA - partner in Solliance, Diepenbeek, Belgium, ²Institute for Material Research (IMO) Hasselt University, Diepenbeek, Belgium, ³KACST-Intel Consortium Center of Excellence in Nano-manufacturing Applications (CENA), Riyadh, Saudi Arabia, ⁴Department of Physics, Faculty of Sciences of Tunis, El Maner, Tunisia, ⁵imec, Heverlee, Belgium, ⁶Department of Electrical Engineering, KU Leuven, Heverlee, Belgium, ⁷Condensed Matter Theory group, Department of Physics, University of Antwerp, Antwerp, Belgium, ⁸Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany N/A
- 2:00 **(243) Vacuum-Free Preparation of $\text{Cu}_2\text{ZnSn(S,Se)}_4$ Solar Cells - Comparison Of SnSe_2 And Elemental Se As Se-Source**
Thomas Schnabel, Tobias Abzieher, Erik Ahlswede
Centre for Solar Energy and Hydrogen Research, Stuttgart, Germany N/A
- 2:15 **(244) Efficiency Improvement of $\text{Cu}_2\text{ZnSn(S,Se)}_4$ Submodule with Graded Band Gap and Reduced Backside ZnS Segregation**
Takuya Kato^{1,2}, Noriyuki Sakai^{1,2}, Hiroki Sugimoto^{1,2}
¹Energy Solution Business Center, Showa Shell Sekiyu K.K., Atsugi, Kanagawa, Japan, ²Atsugi Research Center, Solar Frontier K.K., Atsugi, Kanagawa, Japan 844
- 2:30 **(245) Impact of Cu Content in High Performance $\text{Cu}_2\text{ZnSn(Se,S)}_4$ Solar Cells**
Oké Gunawan, Wei Wang, Tayfun Gokmen, Teodor Todorov, David Mitzi
IBM T. J. Watson Research Center, Yorktown Heights, NY, USA N/A
- 2:45 **(246) Photoelectron Spectroscopy, and Photovoltaic Device Study of $\text{Cu}_2\text{ZnSnSe}_4$ and $\text{ZnO}_x\text{S}_{1-x}$ Buffer Layer Interface**
K. Xērēs Steirer, Rebekah Garris, Carolyn Beall, Ana Kanevce, Ingrid Repins, Glenn Teeter, Craig Perkins
National Renewable Energy Laboratory, Golden, CO, USA 847

Area 4 - Orals

1:30 - 3:00 PM

Ballroom 1EF

n-Type Cells and Young Professional Award

Chair(s): Alison Lennon, Arthur Weeber

- 1:30 **(247) Development of High-Efficiency Crystalline Silicon Solar Cells: Choices, Choices, Choices. (Young Professional Award)**
Oliver Schultz-Wittmann
TetraSun / First Solar, Inc. N/A
- 2:00 **(248) Building blocks for back-junction back-contacted cells and modules with ion-implanted poly-Si junctions**
Robby Peibst¹, Udo Römer¹, Yevgeniya Larionova¹, Henning Schulte-Huxel¹, Tobias Ohrdes¹, Michael Häberle¹, Bianca Lim¹, Daniel Stichenoth², Tobias Wütherich², Claus Schöllhorn², John Graff³, Rolf Brendel¹
¹*Institute for Solar Energy Research Hamelin, Emmerthal, Germany*, ²*Bosch Solar Energy AG, Arnstadt, Germany*, ³*Applied Materials/Varian Semiconductor Equipment Associates, Inc., Gloucester, MA, USA 852*
- 2:30 **(249) Influence of the emitter coverage on interdigitated back contact (IBC) silicon heterojunction (Si-HJ) solar cells**
Thibaut Desrues, Sylvain de Vecchi, Guillaume d'Alonzo, Delfina Munoz, Pierre-Jean Ribeyron
CEA-INES, Le Bourget du Lac, France 857
- 2:45 **(250) Towards industrial advanced front-junction n-type silicon solar cells**
Yimao Wan¹, Chris Samundsett¹, Teng Kho¹, Josephine McKeon¹, Lachlan Black¹, Daniel Macdonald¹, Andres Cuevas¹, Jian Sheng², Yun Sheng², Shengzhao Yuan², Chun Zhang², Zhiqiang Feng², Pierre J. Verlinden²
¹*Research School of Engineering, The Australian National University, Canberra, Australia*, ²*State Key Lab of PV Science and Technology, Trina Solar Limited, Changzhou, China, 862*

Area 8 - Orals

1:30 - 3:00 PM

Ballroom 2A

Luminescence Characterization Methods

Chair(s): Dean Levi, Andreas Bett

- 1:30 **(251) Harmonically Modulated Luminescence: Bridging Conceptual Gaps in Carrier Lifetime Metrology across the PV Production Chain**
Johannes A Giesecke, Martin C Schubert, Wilhelm Warta
Fraunhofer Institut für Solare Energiesysteme, Freiburg, Germany N/A
- 1:45 **(252) Determining the Maximum Open Circuit Voltage from Absorber Photoluminescence in the Presence of Tail States**
John K. Katahara, Hugh W. Hillhouse
Department of Chemical Engineering, Seattle, WA, USA 866

- 2:00 **(253) Cathodoluminescence Study of Carrier Transport Across Grain Boundaries in CdTe**
 Harvey L Guthrey¹, John Moseley^{1,2}, James Burst¹, Wyatt Metzger¹, Mowafak Al-Jassim¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado School of Mines, Golden, CO, USA 869
- 2:15 **(254) Dual Sensor Technique for the Advanced Characterization Of Recombination Parameters in Photovoltaic Materials**
 Richard Ahrenkiel^{1,2}, Steve Johnston², Darius Kuciauskas², Jerry Tynan²
¹Lakewood Semiconductors, Lakewood, CO, USA, ²National Renewable Energy Laboratory, Golden, CO, USA 873
- 2:30 **Best Student Presentation Award Finalist (255) Photovoltaic Material Characterization with Steady-State and Transient Photoluminescence**
 Xufeng Wang¹, Jayprakash Bhosale¹, James Moore¹, Rehan Kapadia^{2,3}, Peter Bermel¹, Ali Javey^{2,3}, Mark Lundstrom¹
¹Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, ²Electrical Engineering and Computer Sciences, University of California, Berkeley, CA, USA, ³Material Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA N/A
- 2:45 **(256) Photoluminescence Image Evaluation Based on an Alternative Equivalent Circuit, Not Assuming a Constant Short Circuit Current Density**
 Otwin Breitenstein¹, Höffler Halles², Haunschild Jonas²
¹Max Planck Institute of Microstructure Physics, Halle, Germany, ²Fraunhofer Institute of Solar Energy Systems (ISE), Freiburg, Germany N/A

Area 10 - Orals	
1:30 - 3:00 PM	Ballroom 1CD
System Performance Measurements and Validation	

Chair(s): Evan Riley, Lauren Ngan

- 1:30 **(257) PV System Energy Test**
 Sarah Kurtz¹, Janine Freeman¹, Evan Riley², Tim Dierauf³, Robert Flottemesch⁴, Pramod Krishnani⁵
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Black & Veatch, San Francisco, CA, USA, ³SunPower Corporation, San Jose, CA, USA, ⁴Constellation, Baltimore, MD, USA, ⁵Belectric, Newark, CA, USA 879
- 2:00 **(258) Measuring Soiling Losses at Utility-scale PV Power Plants**
 Michael Gostein¹, J. Riley Caron², Bodo Littmann²
¹Atonometrics, Austin, TX, USA, ²First Solar, San Francisco, CA, USA 885
- 2:15 **(259) Diffuse Shading Losses in Tracking Photovoltaic Systems**
 Owen W Westbrook, Mark Reusser, Forrest Collins
juwi solar Inc, Boulder, CO, USA 891

- 2:30 **(260) Sandia Inverter Performance Test Protocol Efficiency Weighting Alternatives**
 Jeffrey D Newmiller¹, William Erdman², Joshua S Stein³, Sigifredo Gonzalez³
¹DNV GL, San Ramon, CA, USA, ²Cinch, Lafayette, CA, USA, ³Sandia National Laboratories, Albuquerque, NM, USA 897
- 2:45 **(261) A Study of the Ability of Short Term Performance Tests to Reproduce the Results of a One-Year Adjusted Energy Test for Non-Concentrating Photovoltaic Systems**
 Martin Waters¹, Irina Berdnik¹, Evan Riley², Tejas Tirumalai², Sarah Kurtz³, Kevin Joyce²
¹Recurrent Energy, San Francisco, CA, USA, ²Black & Veatch, San Francisco, CA, USA, ³National Renewable Energy Laboratory, Golden, CO, USA 901

Area 11 - Orals	
1:30 - 3:00 PM	Ballroom 1AB
Government Policy Education and Standards	

Chair(s): John Benner, Elaine Ulrich

- 1:30 **(262) The Virtual Cell Factory: Teaching PV Manufacturing Science at QESST and Beyond**
 Jeffrey Cotter¹, Jenefer Husman¹, Stuart Bowden¹, Klaus Weber², Alison Lennon³, Tonio Buonassisi⁴, Timothy Kirkpatrick⁴
¹Arizona State University, Tempe, AZ, USA, ²The Australian National University, Canberra, Australia, ³The University of New South Wales, Sydney, Australia, ⁴Massachusetts Institute of Technology, Boston, MA, USA N/A
- 1:45 **(263) Growth in the US Market for Residential PV Systems and Buyer/Lessee Experience**
 Paula J Mints
 SPV Market Research, San Jose, CA, USA 907
- 2:00 **(264) Overview of Research and Development Projects for Solar Cells in Japan**
 Masafumi Yamaguchi¹, Hiroyuki Yamada²
¹Toyota Technological Institute, Nagoya, Japan, ²New Energy and Industrial Technology Development Organization, Kawasaki, Japan N/A
- 2:15 **(265) Effects of the Feed-in Tariff Program on the PV Market in Japan**
 Haruki Yamaya, Takashi Ohigashi, Hiroshi Matsukawa, Izumi Kaizuka, Osamu Ikki
 RTS Corporation, Tokyo, Japan 910
- 2:30 **(266) Ensuring the reliability of PV systems through the selection of International Standards for the IECRE Conformity Assessment System**
 George J Kelly¹, Ted Spooner², Guido Volberg³, Greg Ball⁴, Jonas Bruckner⁵
¹Sunset Technology Inc., Mount Airy, MD, USA, ²University of New South Wales, Sydney, Australia, ³TUV Rheinland, Koln, Germany, ⁴DNV GL, San Francisco, CA, USA, ⁵VDE, Offnebach am Main, Germany 914
- 2:45 **(267) Three-Prong Path to Comprehensive Technical Standards for PV Reliability**
 Sarah Kurtz¹, John Wohlgemuth¹, Tony Sample², Masaaki Yamamichi³, Michio Kondo³
¹National Renewable Energy Laboratory, Golden, CO, USA, ²European Commission, JRC, Ispra, Italy, ³National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan 919

Area 12 - Orals**1:30 - 3:00 PM****Ballroom 2B****PID****Chair(s): Mike Kempe, Carole Graas**

- 1:30 **(268) Thin Film PID Field Failures and Root Cause Determination**
Michelle L Propst, N.Anders Olsson
pearllaboratories, Fort Collins, CO, USA N/A
- 2:00 **(269) Theory and numerical simulation of the physical processes involved in the potential-induced degradation of conventional silicon solar cells**
Nitsa Kindyni, Constantinos Lazarou, George E. Georghiou
FOSS Research Center for Sustainable Energy, Photovoltaic Technology Group, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus N/A
- 2:15 **Best Student Presentation Award Finalist (270) Application of Reverse Bias Recovery Technique to Address PID Issue: Incompleteness of shunt resistance and quantum efficiency recovery**
Jaewon Oh¹, Stuart Bowden¹, GovindaSamy TamizhMani²
¹Solar Power Laboratory, Arizona State University, Tempe, AZ, USA, ²Photovoltaic Reliability Laboratory, Arizona State University, Mesa, AZ, USA 925
- 2:30 **(271) Application of the Terrestrial Photovoltaic Module Accelerated Test-to-Failure Protocol**
Peter Hacke¹, Kent Terwilliger¹, Stephen Glick¹, Ryan Smith², Greg Perrin¹, Sarah Kurtz¹, Nick Bosco¹, John Wohlgemuth¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Pordis, Austin, TX, USA 930
- 2:45 **(272) Investigation of c-Si Modules Degradation and Recovery Effect under High Potentials**
Bengt Jaeckel¹, Marijo Cosic², Jürgen Arp³
¹UL International GmbH, Neu-Isenburg, Germany, ²UL International GmbH, Neu-Isenburg, Germany, ³PV LAB Germany GmbH, Potsdam, Germany 937

3:00 - 3:30 PM**Exhibit Hall D****Coffee Break**

Joint Session: Areas 1,6 - Orals

3:30 - 5:00 PM

MR 505-507

Hybrid Organic / Inorganic and Perovskite Solar Cells

Chair(s): Annick Anctil, Shuzi Hayase, Dana Olson

- 3:30 **(273) Power from the Sun: Perovskite Solar Cells**
 Mohammad Nazeeruddin
EPFL, Lausanne, Switzerland 943
- 4:00 **Best Student Presentation Award Finalist**
(274) Double-Heterojunction Crystalline Silicon Solar Cell Fabricated at 250 °C with 12.9 % Efficiency
 Sushobhan Avasthi¹, Ken Nagamatsu^{1,2}, Janam Jhaveri^{1,2}, William E. McClain^{1,3}, Gabriel Man^{1,2}, Antoine Kahn^{1,2}, Jeffrey Schwartz^{1,3}, Sigurd Wagner^{1,2}, James C. Sturm^{1,2}
¹Princeton Institute for the Science and Technology of Materials (PRISM), Princeton, NJ, USA, ²Department of Electrical Engineering, Princeton University, Princeton, NJ, USA, ³Department of Chemistry, Princeton University, Princeton, NJ, USA 949
- 4:15 **(275) Ultrathin, Flexible, Hybrid Solar Cells in Sub-ten Micrometers Single Crystal Silicon Membrane**
 Pushpa Raj Pudasaini, Manisha Sharma, Francisco Ruiz-Zepeda, Arturo A Ayon
The University of Texas at San Antonio, San Antonio, TX, USA 953
- 4:30 **(276) Ultra-thin Doping-free Amorphous Silicon/Organic Hybrid Structure for Decorative Photovoltaic Applications**
 Jae Yong Lee, Kyu-Tae Lee, Sungyong Seo, L. Jay Guo
University of Michigan, Ann Arbor, MI, USA 956
- 4:45 **(277) Photoelectronic Responses in Solution-Processed Perovskite CH₃NH₃PbI₃ Solar Cell Studied by Photoluminescence and Photoabsorption Spectroscopy**
 Yasuhiro Yamada, Toru Nakamura, Masaru Endo, Atsushi Wakamiya, Yoshihiko Kanemitsu
Kyoto University, Kyoto, Japan N/A

Area 2 - Orals

3:30 - 5:00 PM

MR 502-504

Buffers and New Materials

Chair(s): Negar Naghavi, Takuya Kato

- 3:30 **(278) Sputtered Zn(O,S): A promising approach to dry in-line fabrication of Cd-free CIGS modules**
 Reiner Klenk¹, Alexander Steigert¹, Paul Gerhardt¹, Frank Hergert², Christian A. Kaufmann¹, Iver Lauermann¹, Mike Oertel³, Paul Pistor¹, Siegmund Zweigart⁴, Martha C. Lux-Steiner¹
¹Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, ²Bosch Solar CISTech, Brandenburg an der Havel, Germany, ³Manz CIGS Technology GmbH, Schwäbisch-Hall, Germany, ⁴Robert Bosch GmbH, Gerlingen-Schillerhöhe, Germany 959

- 4:00 **(279) Properties of Oxygenated Cadmium Sulfide (CdS:O) and Their Impact on CdTe Device Performance**
Daniel M Meysing¹, Michelle M Griffith¹, Matthew O Reese², James M Burst², William L Rance², Colin A Wolden¹, Teresa M Barnes²
¹Colorado School of Mines, Golden, CO, USA,
²National Renewable Energy Laboratory, Golden, CO, USA 964
- 4:15 **(280) Structural Order and Thermodynamic Stability of (Cu,Zn,Sn)S₄ Alloys**
Sin Cheng Siah¹, R. Jaramillo¹, Pete Erslev², Glenn Teeter², Tsu-Chien Weng³, Michael F. Toney³, Tonio Buonassisi¹
¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²National Renewable Energy Laboratory, Golden, CO, USA, ³Stanford Synchrotron Radiation Lightsource, Menlo Park, CA, USA N/A
- 4:30 **(281) Development of Cu Chalcogenide Photovoltaic Materials, CuInSe₂, Cu₂ZnSnS₄, Cu₂SnS₃ and Related Compounds**
Takahiro Wada, Tsuyoshi Tsuyoshi
Department of Materials Chemistry, Ryukoku University, Seta, Otsu, Japan N/A

Area 4 - Orals	
3:30 - 5:15 PM	Ballroom 1EF
Heterojunctions	

Chair(s): Richard Swanson, Bram Hoex

- 3:30 **(282) High-Efficiency Silicon Heterojunction Solar cells: Status and Perspectives**
Stefaan De Wolf, Bénédicte Demaurex, Jonas Geissbühler, Philipp Löper, Silvia Martin de Nicolas, Bertrand Paviet-Salomon, Johannes Seif, Andrea Tomasi, Christophe Ballif
PV-Lab, IMT, EPFL, Neuchatel, Switzerland N/A
- 4:00 **(283) Development of Hetero-Junction Back Contact Si Solar Cells**
Junichi Nakamura¹, Hiroyuki Katayama¹, Naoki Koide², Kyotaro Nakamura³
¹Solar Systems Division, SHARP Corporation, 282-1 Hajikami, Katsuragi-shi, Nara Prefecture 639-2198, Japan, ²Corporate Research & Development Division, SHARP Corporation, 2613-1 Ichinmoto-cho, Tenri-shi, Nara Prefecture 632-8567, Japan, ³Meiji University, 1-1-1 Higashimita, Tama-ku, Kawasaki, 214-8571, Japan N/A
- 4:15 **(284) Hole Selective MoO_x Contact for Silicon Heterojunction Solar Cells**
Corsin Battaglia^{1,2}, Silvia Martin de Nicolas³, Stefaan De Wolf³, Xingtian Yin^{1,2}, Maxwell Zheng^{1,2}, Christophe Ballif³, Ali Javey^{1,2}
¹University of California Berkeley, Berkeley, CA, USA, ²Lawrence Berkeley National Laboratory, Berkeley, CA, USA, ³Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland 968
- 4:30 **(285) Application of Thin Epitaxial Hydrogenated Si Layers to High Efficiency Heterojunction Solar Cells on N-Type Si Substrates**
Bahman Hekmatshoar, Davood Shahrjerdi, Devendra K. Sadana
IBM T.J. Watson Research Center, Yorktown Heights, NY, USA 971

- 4:45 **(286) 19.9% MWT silicon heterojunction solar cell – A novel concept embedding low Ag consumption and high module efficiency.** Gianluca Coletti¹, Yu Wu¹, Jochen Löffler¹, Bart J. Geerligs¹, Bas B. van Aken¹, Gaby Janssen¹, F. Li², Y. Shen², W. Yang², J. Shi², G. Li², Z. Hu², J. Xiong². ¹ECN Solar energy, Petten, Netherlands, ²Yingli Green Energy, Baoding, China N/A
- 5:00 **(Late News Result) Achievement of more than 25% conversion efficiency with crystalline silicon heterojunction solar cell.** Keichiro Masuko, Masato Shigematsu, Taiki Hashiguchi, Daisuke Fujishima, Motohide Kai, Naoki Yoshimura, Tsutomu Yamaguchi, Yoshinari Ichihashi, Tsutomu Yamanishi, Tsuyoshi Takahama, Mikio Taguchi, Eiji Maruyama, Shingo Okamoto. *Sanyo Electric Co., Ltd., Eco Solutions Company of Panasonic Group, Kaizuka, Japan.* N/A

Area 5 - Orals

3:30 - 5:00 PM

Ballroom 1CD

Thin Crystalline Silicon Films

Chair(s): Ivan Gordon, Sergey Varlamov

- 3:30 **(287) Intermediate Layer Development for Laser-Crystallized Thin-Film Silicon Solar Cells on Glass**
Jonathon Dore^{1,2}, Sergey Varlamov¹, Martin A. Green¹
¹University of New South Wales, Sydney, Australia,
²Suntech R&D Australia Pty Ltd, Sydney, Australia N/A
- 4:00 **(288) Liquid-Phase Crystallized PECVD a-Si:H Precursor Layers Applied in Thin-Film Silicon Solar Cells on Glass Substrates**
O Gabriel¹, S Calnan¹, S Ring¹, T Frijnts², J-H Zollondz², A Heidelberg², B Stannowski¹, R Schlatmann¹
¹PVcomB/ Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany, ²Masdar PV GmbH, Ictershausen, Germany N/A
- 4:15 **(289) Silicon thin film solar cells on glass with open circuit voltages above 620 mV formed by liquid phase crystallization**
Daniel Amkreutz, Jan Haschke, Lars Korte, Florian Ruske, Bernd Rech
Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany N/A
- 4:30 **Best Student Presentation Award Finalist (290) High Efficiency Screen Printed Silicon Solar Cell on Epitaxial Thin Active Layer with Porous Si Back Reflector using Standard Industrial Process**
Chi-Wei Chen¹, Ruiying Hao², Vijaykumar Upadhyaya¹, Ian B. Cooper¹, Ajay Upadhyaya¹, Alan Zhang¹, T.S. Ravi², Ajeet Rohatgi^{1,3}
¹University Center of Excellence for Photovoltaic Research and Education, School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA, ²Crystal Solar Inc., Santa Clara, CA, USA, ³Suniva Inc., Norcross, GA, USA N/A
- 4:45 **Best Student Presentation Award Finalist (291) Analysis of a 16.8% Efficient 18 um Silicon Solar Cell on Steel**
Lu Wang¹, Anthony Lochtefeld², Jianshu Han¹, Andrew Gerger², Mark Carroll², Jingjia Ji⁴, Hongzhao Li¹, Robert Opila³, Allen Barnett¹
¹University of New South Wales, Sydney, Australia, ²AmberWave Inc., Salem, NH, USA, ³University of Delaware, Newark, DE, USA, ⁴Sharesun Co. Ltd, Suzhou, China N/A

Area 8- Orals	
3:30 - 5:00 PM	Ballroom 2A
Optical Characterization	

Chair(s): Jim Sites, Robert Collins, Chris Fell

- 3:30 **(292) Analysis of Minority Carrier Lifetime and Surface Recombination Velocity in CdTe by Using Time-Resolved Photoluminescence with One-Photon and Two-Photon Excitation**
 Darius Kuciauskas¹, Ana Kanevce¹, Pat Dippo¹, Shahram Seyedmohammadi², Roger Malik²
¹NREL, Golden, CO, USA, ²First Solar, Santa Clara, CA, USA N/A
- 4:00 **(293) A novel optical method for mapping crystal orientations**
 S. Fu, Z. Xiong, Y. Zhang, Z. Ding, P. J. Verlinden, Z. Feng
 State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China N/A
- 4:15 **(294) Rapid quantitative analysis of elemental composition and depth profile of Cu(In,Ga)Se₂ thin film using laser-induced breakdown spectroscopy**
 Jung-Hwan In, Chan-Kyu Kim, Seok-Hee Lee, Jang-Hee Choi, Sungho Jeong
 Gwangju Institute of Science and Technology, Gwangju, Korea N/A
- 4:30 **(295) Quantitative Residual Stress Imaging of Multicrystalline, Quasi-Mono, and Kerfless Silicon Wafers by Infrared Birefringence and Sectioning**
 Sergio Castellanos, Tonio Buonassisi
 Massachusetts Institute of Technology, Cambridge, MA, USA 973
- 4:45 **(296) Differential Electroluminescence Imaging and the Current Transport Efficiency of Silicon Wafer Solar Cells**
 Johnson Wong¹, Ranjani Sridharan¹, Yu Chang Wang², Thomas Mueller¹
¹Solar Energy Research Institute of Singapore, Singapore, Singapore, ²IVT Solar Pte Ltd, Singapore, Singapore 975

TUESDAY PM

Area 9- Orals	
3:30 - 5:00 PM	Ballroom 2B
Module Power Electronics. Special Chinese Session: Module Materials	

Chair(s): Chris Deline, Yang Yang

- 3:30 **Best Student Presentation Award Finalist (297) Partial Shading Assessment of PV Installations via Module-Level Monitoring**
 Alex Hanson¹, Chris Deline², Christopher Schaeff¹, Jason Stauth¹, Charles Sullivan¹
¹Dartmouth College, Hanover, NH, USA, ²National Renewable Energy Laboratory, Golden, CO, USA N/A

- 3:45 **Best Student Presentation Award Finalist (298) Purely Inductive Ripple Power Storage for Improved Lifetime in Solar Photovoltaic Micro-inverter Topology**
 Ramprakash Kathiresan^{1,2}, Pritam Das^{1,2}, Thomas Reindl¹, Sanjib Kumar Panda^{1,2}
¹Solar Energy Research Institute of Singapore, Singapore, Singapore, ²Electrical and Computer Engineering Department, National University of Singapore, Singapore, Singapore 980
- 4:00 **(299) Evaluation of Maxim Module-Integrated Electronics at the DOE Regional Test Centers**
 Chris Deline¹, Bill Sekulic¹, Josh Stein², Stephen Barkaszi³, Jeff Yang⁴, Seth Kahn⁴
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Sandia National Laboratory, Albuquerque, NM, USA, ³Florida Solar Energy Center, Cocoa, FL, USA, ⁴Maxim Integrated, San Jose, CA, USA 986
- 4:15 **(300) Predictive Linear Regression Model for Microinverter Internal Temperature**
 Mohammad A. Hossain¹, Timothy J. Peshek², Yifan Xu³, Liang Ji⁴, Alexis R. Abramson¹, Roger H. French²
¹Department of Mechanical and Aerospace Engineering, Case Western Reserve University, Cleveland, OH, USA, ²Department of Materials Science and Engineering, Case Western Reserve University, Cleveland, OH, USA, ³Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, OH, USA, ⁴Underwriter's Laboratories, LLC, Northbrook, IL, USA 992
- 4:30 **(301) The influence of crosslinking agent on the properties of EVA resin**
 Shudong Zhou¹, Zhengdong Jin²
¹General Manager&Senior Engineer of Guangzhou Bothleader Electrical Materials Co., Ltd., Guangzhou, China, ²Chief Engineer of Guangzhou Bothleader Electrical Materials Co., Ltd., Guangzhou, China 997

Area 11- Orals	
3:30 - 5:00 PM	Ballroom 1AB
Interconnection and High PV Penetration	

Chair(s): Michael Coddington, Murali Baggu, Robert Broderick

- 3:30 **(302) GIS based multi-criteria decision analysis for photovoltaic panel deployment in the Southeast United States.** Kata Tisza, Scott Brames, Annick Anttil. *Clemson University, Clemson, SC, USA 1001*
- 3:45 **(303) Analysis of 100 Utility SGIP PV Interconnection Studies**
 Jimmy E Quiroz, Santiago S Sena, Robert J Broderick
Sandia National Laboratories, Albuquerque, NM, USA 1005
- 4:00 **(304) High Frequency Irradiance and Power Output for Grid Integration and Storage Evaluations**
 Jaclyn D Frank, Philip Beaucage, Michael C Brower
AWS Truepower, Albany, NY, USA 1011

- 4:15 **Best Student Presentation Award Finalist (305) Energy Storage Management in Residential Feeders with High PV Penetration for Overvoltage Prevention**
Seyedmostafa Hashemi, Jacob Østergaard
Center for Electric Power and Energy, Department of Electrical Engineering, Kongens Lyngby, Denmark N/A
- 4:30 **(306) Automating the Sandia Advanced Interoperability Test Protocols**
Jay T Johnson¹, Bob Fox²
¹*Sandia National Laboratories, Albuquerque, NM, USA,*
²*Loggerware, San Francisco, CA, USA N/A*
- 4:45 **(307) Testing Advanced Photovoltaic Inverters Conforming to IEEE Standard 1547 – Amendment 1**
Anderson Hoke, Sudipta Chakraborty, Thomas Basso
National Renewable Energy Laboratory, Golden, CO, USA 1014

5:30 - 7:00 PM Exhibit Hall D Pre-function & Terrace
Cherry Award Reception

7:00 - 9:00 PM Exhibit Hall D
PV Jobs Fair

7:00 - 9:30 PM Exhibit Hall D
Evening Poster Reception

Area 1 - Posters
7:00 - 8:15 PM Exhibit Hall D
Low-Dimensional Structures for Solar Cell Enhancement

TUESDAY PM

Chair(s): Rob Walters, Chaffra Affouda, Dave Forbes

(308-A2) **Improving mechanical stability and electrical properties of silver nanowire films with a zinc tin oxide overcoat.** Shruti Aggarwal^{1,2}, Maikel Hest¹, John Perkins¹, David Ginley¹. ¹*National Renewable Energy Laboratory, Golden, CO, USA,* ²*Guru Gobind Singh Indraprastha University, New Delhi, India. 1022*

(309-A5) **Dark Current Suppression in Quantum Dot Solar Cells through Interfacial Engineering.** Nauman Z Butt, Maham Masood Sadiq, Khurram Mazher. *Lahore unioversity of Managemnt Science, Lahore, Pakistan. 1027*

(310-A8) **α -Germanium Nano Disk Array Fabrication by Combination of Bio Template and Neutral Beam Etching for Solar Cell Application.** Takuya Fujii^{1,2}, Takeru Okada¹, Mohd Erman Syazwan¹, Taiga Isoda^{1,3}, Hirotaka Endo², Mohammad Maksudur Rahman^{1,3}, Kohei Itoh^{3,4}, Seiji Samukawa^{1,3,5}. ¹*IFS, Tohoku University, Sendai, Japan,* ²*Honda R&D Co., Ltd., Fundamental Technology Center, Wako, Japan,* ³*JST-CREST, Tokyo, Japan,* ⁴*Keio University, Tokyo, Japan,* ⁵*WPI-AIMR, Tohoku University, Sendai, Japan. 1033*

(311-A11) **Drift-diffusion simulations of InAs/AlAsSb quantum dot intermediate-band solar cells.** Staffan Hellstroem, Seth M Hubbard. *NanoPower Research Laboratory, Rochester Institute of Technology, Rochester, NY, USA. 1037*

(312-A14) **Bandgap Optimized III-V (GaAsP) Nanowire on Silicon Tandem Solar Cell, Device and Data.** Jeppe V Holm^{1,3}, Martin Aagesen¹, Yunyan Zhang², Jiang Wu², Sabina Hatch², Huiyun Liu². ¹*Gasp Solar ApS, Copenhagen, Denmark*, ²*Department of Electronic and Electrical Engineering, University College London, London, UK*, ³*Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark*. 1041

(313-A17) **Impact of Nanostructures and Radiation Environment on Defect Levels in III-V Solar Cells.** Seth M. Hubbard¹, Wyatt Strong¹, David V. Forbes¹, Christopher Bailey², Kenneth Schmieder², Raymond Hoheisel³, Robert Walters². ¹*Rochester Institute of Technology, Rochester, NY, USA*, ²*Naval Research Laboratory, Washington, DC, USA*, ³*George Washington University, Washington, DC, USA*. 1045

(314-A20) **Charge Carrier transfer investigation in quantum dot sensitized solar cells.** Bitu Janfeshan, Bahareh Sadeghimakki, Navid M.S. Jahed, Siva Sivonthaman. *Electrical and computer Engineering Department, University of Waterloo, Waterloo, ON, Canada*. 1051

(315-A23) **Structural and optical properties of multi-stack InAs/GaAsSb quantum dots with different Sb composition.** Yeongho Kim¹, Nikolai Faleev¹, Darius Kuciauskas², Pat Dippo², Christiana Honsberg¹. ¹*Department of Electrical Engineering, Arizona State University, Tempe, AZ, USA*, ²*National Renewable Energy Laboratory, Golden, CO, USA*. 1056

(316-A26) **TCAD Simulation and Modeling of Impact Ionization Effect on Thin Film c-Si HIT Solar Cells.** Vikas Kumar, Ammar Nayfeh. *Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates*. 1059

(317-A29) **MOCVD-Grown InGaN Nanowires for Photovoltaic Applications.** Hsun C. Kuo, Taesu Oh, S. J. Kim, Xiaoqing Pan, Pei-Cheng Ku. *University of Michigan, Ann Arbor, MI, USA*. 1064

(318-A32) **Limiting Efficiencies of Integrating Single Junction with Intermediate Band Solar Cells for Multiphysical Effects.** Jongwon Lee, Christiana Honsberg. *School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA*. 1068

(319-A35) **Hyperdoped Silicon Sub-Band Gap Photoresponse for an Intermediate Band Solar Cell in Silicon.** Jonathan P Mailoa¹, Austin J Akey¹, Christie B Simmons¹, David Hutchinson², Jay Mathews³, Joseph T Sullivan¹, Daniel Recht⁴, Mark T Winkler¹, James S Williams⁵, Jeffrey M Warrender³, Peter D Persans², Michael J Aziz⁴, Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA*, ²*Rensselaer Polytechnic Institute, Troy, NY, USA*, ³*US Army Benét Laboratories, Watervliet, NY, USA*, ⁴*Harvard School of Engineering and Applied Sciences, Cambridge, MA, USA*, ⁵*The Australian National University, Canberra, Australia*. 1073

(320-A38) **Multiple Exciton Generation Solar Cells: Effects of Nanocrystal Shape on Quantum Efficiency.** Ashley R. Marshall^{1,2}, Matthew C. Beard², Joseph M. Luther². ¹*University of Colorado, Boulder, CO, USA*, ²*National Renewable Energy Laboratory, Golden, CO, USA*. 1077

(321-A41) **Drift-Diffusion Modeling of a Superlattice p-i-n Device With Resonant Conduction-Band Assisted Photon Absorption and Carrier Extraction.** Akhil Mehrotra, Liberty A. Falcon, Gopi K. Vijaya, Alex Freundlich. *Photovoltaics and Nanostructures Laboratory, Center for Advanced Materials, University of Houston, Houston, TX, USA*. 1080

(322-A44) **Toward an efficient extremely thin absorber solar cell based on ZnO nanowire arrays.** Jérôme Michallon^{1,2}, Mehdi Daanouné¹, Davide Bucci¹, Jérôme Garnier², Estelle Appert², Quentin Raffhay¹, Vincent Consonni², Anne Kaminski-Cachopo¹. ¹IMEP-LAHC, Grenoble, France, ²LMGP, Grenoble, France. 1084

(323-A47) **Electron microscopy studies of III-Sb-based quantum dot solar cell structures.** Andrew G. Norman¹, Ramesh B. Laghumavarapu², Meng Sun², Paul J. Simmonds², Baolai Liang², Diana L. Huffaker². ¹National Renewable Energy Laboratory, Golden, CO, USA, ²Electrical Engineering Department University of California Los Angeles, Los Angeles, CA, USA. N/A

(324-B2) **Effects of Doping on Carrier Confinement in InAs QD Solar Cells.** Stephen J. Polly, Staffan Hellström, David V. Forbes, Seth M. Hubbard. Rochester Institute of Technology, Rochester, NY, USA. 1089

(325-B5) **Effect of Miniband Formation in a Quantum Dot Super Lattice Fabricated by Combination of Bio-Template and Neutral Beam Etching for High Efficiency Quantum Dot Solar Cells.** Mohammad Maksudur Rahman^{1,4}, Makoto Igarashi^{1,4}, Weiguo Hu^{1,4}, Mohd Erman Syazwan^{1,4}, Takeru Okada¹, Yasuke Hoshi², Noritaka Usami², Seiji Samukawa^{1,3,4}. ¹Institute of Fluid Science, Tohoku University, Sendai, Japan, ²Graduate School of Engineering, Nagoya University, Nagoya, Japan, ³WPI Advanced Institute for Materials Research, Tohoku University, Sendai, Japan, ⁴Japan Science and Technology Agency, CREST, Tokyo, Japan. 1092

(326-B8) **Effect of Hydrogen Passivation on Optical Properties of a-Si/SiNX Multilayered Films with Si-QDs and without Si-QDs.** Dharmendra kumar R. Rai¹, Bikas Rajan², Ashish K. Panchal³, K. R. Balasubramaniam¹, Chetan S. Solanki¹. ¹NCPRE, Department of Energy Science and Engineering, IIT Bombay, Powai, Mumbai - 400076, India, ²Department of Nuclear and Atomic Physics, TIFR, Mumbai - 400005, India, ³Electrical Engineering Department, S. V. NIT, Surat - 395007, India. 1096

(327-B11) **Effect of External Bias on Multi-stacked InAs/AlGaAs Quantum Dots Solar Cell.** Yasushi Shoji, Yoshitaka Okada. Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan. 1099

(328-B14) **Investigation of the Cause of Reduced Open Circuit Voltage in Ge/Si Quantum Dot Solar Cells.** Takeshi Tayagaki^{1,2}, Yusuke Hoshi³, Noritaka Usami³. ¹Kyoto University, Uji, Japan, ²PRESTO-JST, Kawaguchi, Japan, ³Nagoya University, Nagoya, Japan. 1103

(329-B17) **Surface Recombination Dependent Performance of A Nano-scale P-n Junction Solar Cell.** Hung-Ruei Tseng, Shun-Chieh Hsu, Shih-Li Lin, Yin-Han Chen, Chien-Chung Lin. Institute of Photonic System, National Chiao Tung University, Tainan, Taiwan. 1106

(330-B20) **Influence of the preparation conditions in the morphology and photoluminescence of CdS nanostructures.** Patricia Gutiérrez Zayas-Bazán¹, Karla Gutiérrez Z-B¹, Guillermo Santana², Jaime Santoyo-Salazar³, Josué Esaú Romero-Ibarra⁴, Gerardo Contreras-Puente⁵, Luis Carlos Hernández⁶, María Tamargo⁶, Osvaldo de Melo¹. ¹Facultad de Física, Universidad de La Habana, La Habana, Cuba, ²Instituto de Investigación en Materiales, UNAM, Mexico D.F., Mexico, ³Departamento de Física, CINVESTAV-IPN, Mexico D.F., Mexico, ⁴Laboratorio de nanoscopía electrónica, CINVESTAV-IPN, Mexico D.F., Mexico, ⁵Escuela Superior de Física y Matemáticas-IPN, Mexico D.F., Mexico, ⁶City College of New York, New York, NY, USA. 1110

(331-B22) **Capacitance-Voltage Characterization of In-situ Boron Doped Silicon Quantum Dot in Silicon Dioxide.** Tian Zhang, Ivan Perez Wurfl, Binesh Puthen Veetil, Lingfeng Wu, Xuguang Jia, Ziyun Lin, Chien Jen Yang, Gavin Conibeer. *The University of New South Wales, Sydney, Australia.* 1115

(332-B24) **Polarization Insensitive Perfect Absorber with Nanorods Arrays.** Fengyun Zhao, Guangyao Su, Zhaoyu Zhang. *Peking University, Shenzhen, China.* 1119

(333-B25) **Hierarchical modeling of electron and hole transport in nanoparticle thin films: from ab initio to monte carlo.** Gergely Zimanyi¹, Ian Carbone², Marton Voros¹. ¹University of California, Davis, CA, USA, ²University of California, Santa Cruz, CA, USA. 1124

Area 3 - Posters

7:00 - 8:15 PM

Exhibit Hall D

III-V on Silicon and III-V Materials for Solar Cells

Chair(s): John Geisz, Tyler Grassman

(334-E20) **Novel GaAs_{0.71}P_{0.29} / Si Tandem Step-Cell Design.** Sabina Abdul Hadi¹, Evelina Polyzoeva², Tim Milakovich², Mayank Bulsara², Judy L. Hoyt², Eugene A. Fitzgerald², Ammar Nayfeh¹. ¹Institute Center for Future Energy Systems (iFES) Department of Electrical Engineering and Computer Science (EECS) Masdar Institute of Science and Technology, P.O. Box 54224, Abu Dhabi, United Arab Emirates, ²MIT Microsystems Technology Laboratories, Cambridge, MA, USA. 1127

(335-E23) **Nonradiative recombination centers in GaAsN Grown by Chemical Beam Epitaxy.** Boussairi Bouzazi, Nobuaki Kojima, Yoshio Ohshita, Masafumi Yamaguchi. *Toyota Technological Institute, Nagoya, Japan.* 1132

(336-E26) **Optimization of Tellurium Doped InGaAs Grown by MOCVD for Solar Application.** Daniel P. Byrnes, Chris Ebert, Ziggy Pulwin, Aaron Krahnert. *Veeco Process Equipment, Inc., Somerset, NJ, USA.* 1135

(337-E29) **GaN/GaN - Ni/Au Transparent Conducting Oxide Schottky Barrier Solar Cells.** Kevin T. Chern¹, Louis J. Guido¹, Oleg A. Laboutin², Roger E. Welsch³, Victor C. Elarde⁴. ¹Virginia Tech, Blacksburg, VA, USA, ²Kopin Corporation, Taunton, MA, USA, ³Magnolia Solar, Woburn, MA, USA, ⁴Microlink Devices, Niles, IL, USA. 1139

(338-E32) **Double Layer Antireflection Coating and Window Optimization for GaAsP/SiGe Tandem on Si.** Brianna Conrad¹, Tian Zhang¹, Anthony Lochtefeld², Andrew Gerger², Chris Ebert³, Martin Diaz¹, Li Wang¹, Ivan Perez-Wurfl¹, Allen Barnett¹. ¹The University of New South Wales, Sydney, Australia, ²AmberWave Inc., Salem, NH, USA, ³Veeco MOCVD, Somerset, NJ, USA. 1143

(339-F3) **Doped and undoped GaAs thin films with single-crystalline-like properties on low-cost flexible metal substrates.** Pavel Dutta¹, Monika Rathi¹, Nan Zheng², Ying Gao¹, Yao Yao¹, Phil Ahrenkiel², Venkat Selvamani¹. ¹University of Houston, Houston, TX, USA, ²South Dakota School of Mines and Technology, Rapid City, SD, USA. N/A

(340-F6) **Microstructure of the Nitrogen-Induced Localized State in GaAsN Thin Films Grown by Chemical Beam Epitaxy.** Atsuhiko Fukuyama¹, Goshi Morioka¹, Ding Weng¹, Akio Suzuki¹, Hidetoshi Suzuki², Masafumi Yamaguchi³, Tetsuo Ikari¹. ¹Faculty of Engineering, University of Miyazaki, Miyazaki, Japan, ²Interdisciplinary Research Organization, University of Miyazaki, Miyazaki, Japan, ³Toyota Technological Institute, Nagoya, Japan. 1148

(341-F9) **Wafer Bonding for III-V -based Solar Cells: The Roles of Surface Preparation and Wafer Orientations.** Mark S Goorsky, Xiaolu Kuo, Jeffrey McKay, Mark Seal, Douglas Chen, Joseph Schlies, Brett Beekley. UCLA, Los Angeles, CA, USA. N/A

(342-F11) **Performance Evaluation of Monolithically Integrated 3J InGaP/GaAs/Si Tandem Solar Cells for Concentrated Photovoltaics.** Nikhil Jain, Yan Zhu, Michael Clavel, Patrick Goley, Mantu Hudait. Virginia Tech, Blacksburg, VA, USA. 1152

(343-F13) **Investigation of Heat Transfer through Germanium – AlN Ceramics Interface in Heterostructure Solar Cells by Laser Thermal Wave Method.** Vitali Stanislavovic Kalinovsky³. ¹Alexej Glazov, St.-Petersburg, Russia, ²Kirill Muratkov, St.-Petersburg, Russia, ³Viacheslav Andreev, St.-Petersburg, Russia. 1158

(344-F15) **Growth of Layered (In_xGa_{1-x})₂Se₃ Buffer Material for GaAs on Si System.** Nobuaki Kojima, Hiroya Nakamura, Yoshio Ohshita, Masafumi Yamaguchi. Toyota Technological Institute, Nagoya, Japan. 1164

(345-F17) **Reducing dislocations in GaAs on Si by a novel GaAs_{1-x}Sb_x buffer layer for multi-junction solar cells.** Osamu Morohara, Hirotsuka Geka, Yoshitaka Moriyasu, Naohiro Kuze. AsahiKASEI Corporation, Fuji, Japan. N/A

(346-F19) **Study of deep levels in InAlAsSb grown via MOCVD.** George T Nelson, Zac S Bittner, Brittany Smith, David F Forbes, Seth M Hubbard. Rochester Institute of Technology, Rochester, NY, USA. 1168

(347-F21) **Material Selection and Fabrication Parameters for the Integration of Antireflective Nanostructures with Multijunction Photovoltaics.** Emmett E Perl¹, William E McMahon², John E Bowers¹, Daniel J Friedman². ¹University of California at Santa Barbara, Santa Barbara, CA, USA, ²National Renewable Energy Laboratory, Golden, CO, USA. 1174

(348-F23) **Characterization of InAlAs Solar Cells Grown by OMVPE.** Brittany L. Smith, Staffan D. Hellstroem, George T. Nelson, Zachary S. Bittner, David V. Forbes, Seth M. Hubbard. Rochester Institute of Technology, Rochester, NY, USA. 1180

(349-F25) **GaAsP Hall Mobility Characterisation for GaAsP/SiGe Tandem Solar Cell on Si Substrate.** Anastasia H. Soeriyadi¹, Anthony Lochtefeld², Andrew Gerger², Chris Ebert³, Ivan Perez-Wurfl¹, Allen Barnett¹. ¹UNSW, Sydney, Australia, ²AmberWave Inc, Salem, NH, USA, ³Veeco MOCVD, Somerset, NJ, USA. 1186

(350-F27) **Effect of Material Choice on Spalling Fracture Parameters to Exfoliate Thin PV Devices.** Cassi Sweet¹, John Simon², David Young², Aaron Ptak², Corinne E. Packard^{1,2}. ¹Colorado School of Mines, Golden, CO, USA, ²National Renewable Energy Laboratory, Golden, CO, USA. 1189

(351-F29) **Self-Catalyzed High-Quality GaAsP Nanowires for High-Efficiency Solar Cells Grown by Solid-Source Molecular Beam Epitaxy on Silicon.** Yunyan Zhang¹, Jiang Wu¹, Sabina Hatch¹, Martin Agesen^{2,3}, Ana Sanchez⁵, Jeppe V. Holm^{3,4}, Henrik I. Jørgensen², Huiyun Liu¹. ¹*Department of Electronic and Electrical Engineering, University College London, London WC1E 7JE, UK, London, UK*, ²*SunFlake A/S, Universitetsparken 5, Copenhagen DK-2100, Denmark, Denmark, Denmark*, ³*Gasp Solar ApS, Gregersensvej 7, Taastrup DK-2630, Denmark, Denmark, Denmark*, ⁴*Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen O, Denmark, Denmark, Denmark*, ⁵*Department of Physics, University of Warwick, Coventry CV4 7AL, Warwick, UK.* N/A

(352-F31) **AlGaAs Solar Cells Grown by Liquid Phase Epitaxy for Dual Junction Solar Cells Based on c-Si Bottom Sub-cell.** Xin Zhao, Kyle H. Montgomery, Jerry M. Woodall. *University of California, Davis, CA, USA.* 1193

Area 4 - Posters	
7:00 - 8:15 PM	Exhibit Hall D
Surface Passivation II	

Chair(s): Jan Benick, David Young, Tobias Pletzer

(353-F40) **The Influence of Texturing Bath Conditions on the Morphology and Optical Properties of Crystalline Silicon.** Hamda A. Al-Thani, Abeer AlYafeai, Ahlam AlJaeedi, Sahar AlShaibani, Falah S. Hasoon. *National Energy and Water Research Center, Abu Dhabi, United Arab Emirates.* N/A

(354-G4) **Effect of Carbon Diffusion on Performance of Thin Film c-Si HIT Solar Cells with a-SiC Passivation Layer.** Aaasha Alnuaimi, Vikas Kumar, Farsad Chowdhury, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Department of Electrical Engineering and Computer Science (EECS), Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates.* 1197

(355-G8) **Substrate Dependent Growth of Nanocrystalline Silicon.** Mark S Bailly, Joe V Carpenter, Zachary Holman. *Arizona State University, Tempe, AZ, USA.* 1201

(356-G12) **Evaluation of Passivation Layers via Temperature-Dependent Lifetime Measurements.** Simone Bernardini¹, Adrienne L. Blum², Mariana I. Bertoni¹. ¹*Arizona State University, Tempe, AZ, USA*, ²*Sinton Instruments, Boulder, CO, USA.* 1206

(357-G16) **Improve the performance of silicon nano-textured solar cell via Al₂O₃ passivation.** Bingfei Dou, Rui Jia, Yun Sun, Haofeng Li, Chen Chen, Zhi Jin, Xinyu Liu. *IME, Beijing, China.* N/A

(358-G20) **Wafer Surface Preparation for High-Efficiency Solar Cells.** Ismail Kashkoush, Gim Chen, Dennis Nemeth, Jennifer Rieker. *Akrion Systems, Allentown, PA, USA.* 1211

(359-G24) **Role of Micro and Nanostructures in Enhancing Near IR Optical Absorption in Silicon.** Cheow Siu Leong¹, Ayu W. Azhari^{1,2}, K. Sopian¹, Saleem H. Zaidi¹. ¹*Universiti Kebangsaan Malaysia, Bangi, Malaysia*, ²*Universiti Malaysia Perlis, Kangar, Malaysia.* 1214

(360-G28) **High-Performance Hetero-Junction Crystalline Silicon Photovoltaic Technology.** Jacques Levrat¹, Christophe Allebé¹, Nicolas Badel¹, Loris Barraud¹, Jonathan Champlaud¹, Fabien Debrot¹, Antoine Descoeur¹, Antonin Faes¹, Agata Lachowicz¹, Sylvain Nicolay¹, Laurent Sansonnens¹, Stefaan De Wolf², Jonas Geissbühler², Matthieu Despeisse¹, Christophe Ballif¹. ¹CSEM PV-center SA, Neuchâtel, Switzerland, ²EPFL PV-LAB, Neuchâtel, Switzerland. 1218

(361-G32) **Optical Modelling for Multilayer and Geometric Light-Trapping Structures for Crystalline Silicon Solar Cells.** Yang Li, Zhongtian Li, Zhong Lu, Jie Cui, Zi Ouyang, Alison Lennon. *University of New South Wales, Kensington, Australia.* 1223

(362-G36) **Impact of Surface Treatments on the Passivation Effect for N-Type Crystalline Silicon in Heterojunction Solar Cells.** Zhengxin Liu¹, Dongliang Wang², Jieyu Bian¹, Jinning Liu¹, Fanying Meng¹, Liping Zhang¹, Jian Bao², Wanwu Guo², Zhiqiang Feng². ¹Research Center for New Energy Technology, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, Shanghai, China, ²State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China. 1227

(363-G40) **The effect of silicon surface area on bulk lifetime after annealing at different temperatures.** Pei Hsuan Doris Lu, Nitin Mampalli, Malcolm Abbott, Stuart Wenham, Alison Lennon. *UNSW, Sydney, Australia.* N/A

(364-H4) **Comparison of Microstructure and Surface Passivation Quality of Intrinsic a-Si:H Films Deposited by Remote Plasma Chemical Vapor Deposition using Argon and Helium Plasma.** Emmanuel U Onyegam¹, Karla F Weidmar¹, Sayan S Saha¹, Mohamed M Hilali¹, Rajesh Rao², Leo Mathew², William James¹, Sanjay K Banerjee¹. ¹The University of Texas at Austin, Austin, TX, USA, ²Applied Novel Device, Inc, Austin, TX, USA. 1230

(365-H8) **Structural Studies of Light-induced Anodic Aluminum Oxide.** Zi Ouyang, Jie Cui, Yang Li, Zhongtian Li, Alison Lennon. *School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia.* 1234

(366-H12) **Investigation of Effects of Rear Side Roughness Influencing the Effective Lifetime.** Maxi Richter, Yelena Fridekind, Andreas Fischer, Martin Zimmer, Jochen Rentsch. *Fraunhofer Institut für Solare Energiesysteme, Freiburg, Germany.* 1238

(367-H16) **Photolithography Free Inverted Pyramidal Texturing for Solar Cell Applications.** Sandeep S Saseendran^{1,2}, Anil Kottantharayil^{1,2}. ¹National Center for Photovoltaic Education and Research, IIT Bombay, Mumbai, India, ²Department of Electrical Engineering, IIT Bombay, Mumbai, India. 1244

(368-H20) **Evaluation of Hydrogen plasma effect in a-Si:H/c-Si interface by means of Surface Photovoltage measurement and FTIR spectroscopy.** Luca Serenelli¹, Massimo Izzi¹, Mario Tucci¹, Luca Martini², Rita Asquini², Domenico Caputo², Giampiero de Cesare². ¹ENEA Research Centre Casaccia, Rome, Italy, ²University "la Sapienza", Rome, Italy. 1248

(369-H24) **Improvement of n-type nc-3C-SiC:H Heterojunction Emitter for c-Si Solar Cells.** Kazuki Shimizu¹, Eric Omondi Ateto¹, Shinsuke Miyajima¹, Makoto Konagai^{1,2}. ¹Department of Physical Electronics, Tokyo Institute of Technology, Meguro, Tokyo, Japan, ²Photovoltaics Research Center (PVREC), Tokyo Institute of Technology, Meguro, Tokyo, Japan. 1253

(370-H28) **Light Trapping in Large-Scale Photonic Nanostructures Fabricated from Vertically Aligned Ge Quantum Dots on Crystalline Silicon.** Takeshi Tayagaki¹, Yusuke Hoshi², Yuko Kishimoto¹, Noritaka Usami². ¹Kyoto University, Uji, Japan, ²Nagoya University, Nagoya, Japan. 1257

(371-H32) **Simulation of Honeycomb-texture for optical and electrical characteristics of solar cells.** Anne-Kristin Volk¹, William Glover¹, Martin Zimmer¹, Jochen Rentsch¹, Holger Reinecke². ¹Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany, ²Department of Microsystems Engineering - IMTEK University, Freiburg, Germany. 1260

(372-H36) **Spray pyrolysis coating Al₂O₃:Cl/TiO₂ bilayer for PERC.** Hsing-Hua Wu¹, Sheng-Min Yu², Wan-Ying Chou², Sung-Yen Wei², Tai-Jui Wang², Wen-Ching Sun², Kuei-Bo Chen¹, Walt K. W. Huang¹, Nai-Tien Ou¹, Chung-Han Wu¹. ¹Gintech Energy Corporation, Miaoli, Taiwan, ²Material & Chemical Research Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan. 1265

(373-H40) **Industrially Rear Side Passivated Cz Mono-crystalline Cells with 19.5% Efficiency.** Zhuo Xu, Xueliang Yang, Gaofei Li, Wenchao Zhao, Decheng yang, Zhiyan Hu. Yingli Green Energy Holding Co., Ltd., Baoding, China. 1268

(374-14) **Passivated Contacts for Silicon Solar Cells Based on Transparent Conducting Oxides.** David L. Young, William Nemeth, Benjamin G. Lee, Pauls Stradins. National Renewable Energy Laboratory, Golden, CO, USA. 3725

(375-18) **Surface Passivation of c-Si by Atomic Layer Deposition TiO₂ Thin Films Deposited at Low Temperature.** Ing-Song Yu¹, I-Hsuan Chang², Hsyi-En Cheng², Yung-Sheng Lin³. ¹Department of Materials Science and Engineering, National Dong Hwa University, Hualien, Taiwan, ²Department of Electro-Optical Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan, ³R&D Department, E-Ton Solar Tech. Co., LTD., Tainan, Taiwan. 1271

(376-112) **Comparative study of silver nanoparticles embedded in dielectric layers hybrid plasmonic structures for solar cell application.** Xiaoxia Zhao, Hui Shen. School of Physics and Engineering, Institute for Solar Energy Systems, State Key Laboratory of Optoelectronic Materials and Technologies, Sun Yat-sen University,, Guangzhou, China. 1275

(377-116) **Design Guidelines for Using Si Nanocone Arrays as Antireflection Layer in Crystalline Silicon Solar Cells.** Keya Zhou¹, Shutian Liu¹, Jung-Ho Lee². ¹Department of Physics, Harbin Institute of Technology, Harbin, China, ²Department Chemical Engineering, Hanyang University, Ansan, South Korea. N/A

Area 5 - Posters**7:00 - 8:15 PM****Exhibit Hall D****Crystalline Si-Films and Novel Concepts****Chair(s): Sergey Varlamov, Ivan Gordon**

(378-I31) **Boron doped SRO/SiO₂ and SRN/SiN_x bilayers on Molybdenum substrates for vertical structured Si quantum dot solar cells.** Ziyun Lin, Lingfeng Wu, Xuguang Jia, Tian Zhang, Binesh Puthen-Veetil, Terry Chien-Jen Yang, Hongze Xia, Gavin Conibeer, Ivan Perez-Wurfl. *University of New South Wales, Sydney, Australia.* N/A

(379-I33) **Effect of Deposition Temperature of Electron Beam Evaporated Silicon Thin Films on Glass Crystallized by Line Focus Diode Laser.** Jae Sung Yun¹, Jialiang Huang¹, Kyung Kim^{1,2}, Sergey Varlamov¹, Martin Green¹. ¹*University of New South Wales, Sydney, Australia,* ²*Suntech R&D Australia, Sydney, Australia.* N/A

(380-I35) **Highly Controlled Crystalization of Silicon Thins Film on Low Cost Substrate by Pulsed Laser Annealing Process.** Munem Hossain, Mahbube Khoda Siddiki, Masud H Chowdhury. *University of Missouri – Kansas City, Kansas City, MO, USA.* 1279

(381-I37) **Novel Fabrication of Si Thin film for Solar Cell Applications.** Chien-Ting Liu¹, Thiyagu Subramani¹, Chen-Chih Hsueh¹, Hong-Jang Syu¹, Song-Ting Yang², Ching-Fuh Lin^{1,2,3}. ¹*Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan,* ²*Graduate Institute of Electronics Engineering, Nation Taiwan University, Taipei, Taiwan,* ³*Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan.* 1284

(382-I39) **Directional heating and cooling for controlled spalling.** Jan Hensen¹, Raphael Niepelt¹, Sarah Kajari-Schröder¹, Rolf Brendel^{1,2}. ¹*Institute for Solar Energy Research Hamelin, 31860 Emmerthal, Germany,* ²*Institute for Solid State Physics, Leibniz Universität Hannover, 30167 Hanover, Germany.* N/A

(383-J1) **Heteroepitaxial silicon thin films on flexible polycrystalline metal substrates for crystalline photovoltaic solar cells: A comparison between physical vapor deposition and plasma-enhanced chemical vapor deposition.** Ying Gao, Pavel Dutta, Monika Rathi, Yao Yao, Milko Iliev, Jae-Hyun Ryou, Venkat Selvamanickam. *Department of Mechanical Engineering & Texas Center for Superconductivity, University of Houston, Houston, TX, USA.* 1287

(384-J3) **Ion Energy Threshold in Low Temperature Silicon Epitaxy for Thin Film Crystalline Photovoltaic.** Bastien Bruneau¹, Romain Cariou^{1,2}, Jean-Christophe Dornstetter^{1,3}, Erik Johnson¹, Pere Roca i Cabarrocas¹. ¹*LPICM, Ecole Polytechnique, Palaiseau, France,* ²*III-V lab a joint laboratory between Alcatel-Lucent Bell Labs France, Thales Research and Technology and CEA-LETI, Marcoussis, France,* ³*Total, Paris la Defense, France.* N/A

(385-J5) **Structural characterization of oriented crystalline silicon film grown on SiO₂, Sapphire, TiO₂ and Nickel Substrate by Hot Wire Chemical Vapour Deposition.** Md Abul Hossion¹, Brij M. Arora². ¹*Applied Physics, Electronics and Communication Engineering, University of Dhaka, Dhaka, Bangladesh,* ²*Electrical Engineering, Indian Institute of Technology Bombay, Mumbai, India.* 1292

TECHNICAL PROGRAM**TUESDAY PM**

(386-J7) **Nanostructured Silicon Oxide Film for Enhanced Crystalline Solar Cell.** Abdulla Tahhan¹, Zahir Dehouche¹, Tony Anson², George Fern³. ¹*School of Engineering and Design, Brunel University, Uxbridge, UK*, ²*Experimental Techniques Centre, Brunel University, Uxbridge, UK*, ³*Wolfson Centre for Materials Processing, Brunel University, Uxbridge, UK.* 1296

(387-J9) **Titanium Dioxide Nanoparticles for Enhanced Monocrystalline Solar Cell.** Chiara Breda¹, Zahir Dehouche¹, Abdulla Tahhan¹, Tony Anson², George Fern³. ¹*School of Engineering and Design, Brunel University, Uxbridge, UK*, ²*School of Engineering and Design, Brunel University, Uxbridge, UK*, ³*School of Engineering and Design, Brunel University, Uxbridge, UK*, ⁴*Experimental Techniques Centre, Brunel University, Uxbridge, UK*, ⁵*Wolfson Centre for Materials Processing, Brunel University, Uxbridge, UK.* 1299

(388-J11) **Inteference Lithography for the Fabrication of Light-Trapping Structures on Ultra-thin Crystalline Silicon Solar Cells.** Kevin M.W. Boyd, Rafael N. Kleiman. *McMaster University, Hamilton, ON, Canada.* N/A

(389-J13) **Reliability Model Development for Microsystems-Enabled Photovoltaics.** Benjamin B. Yang, Jose Luis Cruz-Campa, Gaddi S. Haase, Paiboon Tangyonyong, Murat Okandan, Gregory N. Nielson. *Sandia National Laboratories, Albuquerque, NM, USA.* 1305

(390-J15) **Comparative Studies of Single-crystalline-like Ge Thin Film on Inexpensive Flexible Metallic Substrates.** Yao Yao¹, Pavel Dutta¹, Monika Rathi¹, Ying Gao¹, Yongkuan Li¹, Bernhard Holzapfel², Venkat Selvamanickam¹. ¹*University of Houston, Houston, TX, USA*, ²*Karlsruhe Institute of Technology, Karlsruhe, Germany.* 1310

(391-J17) **Analyzing Si-SiGe thin-film solar cell by simulation and calculation.** C.-F. Hsieh¹, Y.-T. Li¹, H.-S. Wu¹, T.-C. Wu¹, M. H. Liao². ¹*Industrial Technology Research Institute, Hsinchu, Taiwan*, ²*National Taiwan University, Taipei, Taiwan.* 1314

(392-J19) **PC1D Analysis of Thin-Film crystalline Si_{1-x}Gex/Si Solar Cells.** Adnan Ali¹, Ayu Wazira³, Kamaruzzaman Sopian², Saleem H Zaidi². ¹*Government College University, Faisalabad, Pakistan*, ²*Universiti Kebangsaan Malaysia, Bangi, Malaysia*, ³*Universiti Malaysia Perlis, Kangar, Malaysia.* 1317

(393-J21) **Numerical Analysis and Optimum Design of Efficient $\mu\text{-Si}/\mu\text{-Si}_{1-x}\text{Gex}$ Thin-film Solar Cells.** M. Amimul Ehsan, Mahbube Khoda Siddiki, Yang Yi. *University of Missouri-Kansas City, Kansas City, MO, USA.* 1321

(394-J23) **Synthesis of oriented and passivated polycrystalline silicon films on glass by hot wire chemical vapor deposition.** Brij M Arora¹, Gurleen Kaur², Abul Md. Hossion³, Kulasekaran M¹. ¹*Dept. of Electrical Engineering, IITBombay, Mumbai, India*, ²*Dept. of Electronics Technology, Guru Nanak Dev University, Amritsar, India*, ³*Department of Applied Physics, University of Dhaka, Dhaka, Bangladesh.* 1326

Area 9 - Posters**7:00 - 8:15 PM****Exhibit Hall D****Module Modeling & Integrated Electronics****Chair(s): Billy Hayes, Aron Dobos, Dragan Maksimovic****(395-M18) Active Optimal Optical Filtering of Wavelengths for Increasing the Efficiency of Photovoltaic Modules.**

Sharif Z Aljoaba, Aaron M Cramer, Bruce L Walcott.
Department of Electrical and Computer Engineering, University of Kentucky, Lexington, KY, USA. 1329

(396-M20) Modeling the Incidence Angle Dependence of Photovoltaic Modules in PVsyst. Junaid H. Fatehi, Kenneth J. Sauer. *Yingli Green Energy Americas, Inc., San Francisco, CA, USA. 1335*

(397-M22) Electrically Independent Subcircuits for a Seven-Junction Spectrum-Splitting Photovoltaic Module. Cristofer A Flowers, Harry A Atwater. *California Institute of Technology, Pasadena, CA, USA. 1339*

(398-M24) Thermal Modeling of PV Modules Using Computational Simulation. Davis R Hemenway^{1,2}, Walajabad Sampath², Hiroshi Sakurai², Kurt Barth^{1,2}. *¹Direct Solar, Fort Collins, CO, USA, ²Colorado State University, Fort Collins, CO, USA. 1344*

(399-M26) Energy-economic comparison of photovoltaic modules equipped with a layer of conventional and improved phase-change material. Ewald Japs, Stefan Krauter. *University of Paderborn, Paderborn, Germany. 1348*

(400-M28) A Comprehensive Method to Modeling and Simulation of Photovoltaic Module under Natural Environment. Zhou Jian, Li Hongfei, Qiao Yingshuo, Gao Qi, Liu Yucheng, Liu Zhengxin. *Shanghai Institute of micro-system and information technology, Shanghai, China. 1353*

(401-M30) Outdoor characterizations to evaluate the low-light effect on photovoltaic modules yield. Thomas Mambri¹, Anne Migan¹, Christophe Longeaud¹, Laurent Prieur², Vincent Radivoniuk². *¹LGEP (Laboratoire de Genie Electrique de Paris), Gif sur Yvette, France, ²Soleis technologie, Noisiel, France. 1358*

(402-M32) New Data Set for Validating PV Module Performance Models. Bill Marion¹, Allan Anderberg¹, Chris Deline¹, Joe del Cueto¹, Matt Muller¹, Greg Perrin¹, Jose Rodriguez¹, Steve Rummel¹, Timothy J Silverman¹, Frank Vignola², Rich Kessler², Josh Peterson², Steve Barkaszi³, Nick Riedel⁴, Larry Pratt⁴, Bruce King⁵. *¹National Renewable Energy Laboratory, Golden, CO, USA, ²University of Oregon, Eugene, OR, USA, ³Florida Solar Energy Center, Cocoa, FL, USA, ⁴CFV Solar Test Laboratory, Albuquerque, NM, USA, ⁵Sandia National Laboratories, Albuquerque, NM, USA. 1362*

(403-N2) Innovative AC photovoltaic module system using series connection and universal low-voltage micro inverters. Mika Nuotio¹, Pierre J. Verlinden², Milan Ilic¹, Jon Bonanno¹. *¹Empower Micro Systems Inc., San Francisco, CA, USA, ²Changzhou Trina Solar Energy Co. Ltd., Changzhou, China. 1367*

(404-N4) A Free and Open Source Finite-Difference Simulation tool for Solar Modules. Bart E. Pieters. *Forschungszentrum Juelich, Juelich, Germany. 1370*

(405-N6) **High Efficiency Flexible Triple Junction Solar Panels.** David A Scheiman¹, Phillip P Jenkins¹, Robert J Walters¹, Kelly Trautz², Raymond Hoheisel³, Rao Tatavarti⁴, Ray Chan⁴, Haruki Miyamoto⁴, Jessica Adams⁴, Victor Elarde⁴, Christopher Stender⁴, Alexander Hains⁴, Claiborne Mcpheeters⁴, Chris Youtsey⁴, Noren Pan⁴, Mark Osowski⁴. ¹Naval Research Laboratory, Washington, DC, USA, ²George Washington University, Washington, DC, USA, ³formerly Naval Research Laboratory, Washington, DC, USA, ⁴Microlink Devices Inc, Niles, IL, USA. 1376

(406-N8) **Performance Evaluation of Novel Photovoltaic/Thermal Module.** Huan-Liang Tsai, Chieh-Yen Hsu, Yung-Chou Chen. *Da-Yeh University, Chang-Hua, Taiwan.* N/A

(407-N10) **Relating Indoor and Outdoor Performance of Bifacial Modules.** Bas B. Van Aken, Anna J. Carr. *ECN - Solar Energy, Petten, Netherlands.* 1381

(408-N11) **Changes in the serial resistance of a-Si, a- μ c-Si and mono-crystalline PV modules during the year.** Johannes Arto Weicht, Frank U. Hamelmann, Alexander Domnik, Grit Behrens. *Fachhochschule Bielefeld - University of Applied Sciences Bielefeld, Minden, Germany.* 1384

(409-N12) **Reconfigurable Power Management Using Novel Monolithically Integrated CMOS-on-PV Switch.** Jonathan West, Somayeh Imani, Olga Lavrova, William Cavanaugh, Jing Ji, Kanamu Pupijhu, Smitha Keshavmurthy, Jim Aarestad, Payman Zarkesh-Ha. *University of New Mexico, Albuquerque, NM, USA.* 1389

(410-N13) **Relative Efficiency Revealed: Equations for k1-k6 of the PVGIS Model.** Georgi Hristov Yordanov. *University of Agder (UiA), Grimstad, Norway.* 1393

(411-N14) **Determining the Effect of Temperature on Microinverter Inversion Efficiency.** Daniel M. Riley, Armando Fresquez. *Sandia National Laboratories, Albuquerque, NM, USA.* 1399

TUESDAY PM

Area 11 - Posters	
7:00 - 8:15 PM	Exhibit Hall D
Interconnections	

Chair(s): Michael Coddington, Murali Baggu

(412-O25) **Evolution of the PV Industry in Argentina.** Julio A. Bragagnolo, Sebastian Kind, Andres Persello. *Universidad tecnologica Nacional, Buenos Aires, Argentina.* 1403

(413-O26) **Robust Current Controller Based Solar-Inverter System Used for Voltage Regulation at a Substation.** Mohit Chhabra, Frank Barnes. *University of Colorado - Boulder, Boulder, CO, USA.* 1407

(414-O27) **Robust Current Controller Design using Mu-Synthesis for Grid-Connected Three Phase Inverter.** Mohit Chhabra, Frank Barnes. *University of Colorado - Boulder, Boulder, CO, USA.* 1413

(415-O28) **Photovoltaic Waste Characterization with Environmental Considerations.** Mary Kayla Collins, Annick Antcil. *Clemson University, Anderson, SC, USA.* 1419

(416-O29) **Design and Performance of UNC-Charlotte Net-Zero Energy Solar House at the 2013 U.S. Department of Energy Solar Decathlon Competition.** Abasifreke Ebong^{1,2}, Valentina Cecchi^{1,2}, Mona Azarbayjani^{1,3}. ¹Energy Production and Infrastructure Center, Charlotte, NC, USA, ²Department of Electrical and Computer Engineering, Charlotte, NC, USA, ³College of Arts and Architecture, Charlotte, NC, USA. N/A

(417-O30) **Prospects for Photovoltaics in Sunny and Arid Regions: A Solar Grand Plan for Chile.** Vasilis Fthenakis^{1,2}, Alejandro Florenzano³, Mario Grageda⁴, Marco Lofat³, Svetlana Ushak⁴. ¹New York, NY, USA, ²Upton, NY, USA, ³Santiago, Chile, ⁴ntofagasta, Chile. 1424

(418-O31) **Analysis Methodology to Identify the Technical Potential of Some Colombian Cities for the Development of Grid Connected PV Systems.** Johann Hernández¹, Carlos Arredondo², William Vallejo³. ¹Universidad Distrital Francisco José de Caldas, Bogotá, Columbia, ²Universidad de Medellín, Medellín, Columbia, ³Universidad del Atlántico, Barranquilla, Columbia. 1430

(419-O32) **Criticality of Transparent Conductive Electrode Materials for PV Cells.** Ross J Jarrett¹, David A Dawson², Phillip Purnell². ¹Energy Research Institute, University of Leeds, Leeds, UK, ²Institute for Resilient Infrastructure, University of Leeds, Leeds, UK. 1436

(420-O33) **Growth Rates In Metals Production for Large-scale PV Deployment.** Goksin Kavlak, James Mc Nerney, Robert Jaffe, Jessika E. Trancik. *Massachusetts Institute of Technology, Cambridge, MA, USA.* 1442

(421-O34) **Linking Performance of PV Systems in India with Socio-Economic Aspects of Installation.** Vivek Kuthanazhi¹, Shashwata Chattopadhyay¹, Rajiv Dubey¹, Jim Joseph John¹, Chetan Singh Solanki¹, Anil Kottanthurayil¹, Brij M Arora¹, Narasimhan K.L. ¹, Juzer Vasi¹, Arun Kumar², Sastry O.S². ¹National Centre for Photovoltaic Research and Education, Indian Institute of Technology Bombay, Mumbai, India, ²Solar Energy Centre, Ministry of New and Renewable Energy, New Delhi, India. 1448

(422-O35) **Planning for Integration of Solar Photovoltaics into the Energy Needs of Villages through Local Self Governments: An experience in the state of Kerala, India.** Vivek Kuthanazhi, Anil Kottanthurayil, Narayanan N. C. *National Centre for Photovoltaic Research and Education, IIT Bombay, Mumbai, India.* 1452

(423-O36) **Life cycle water use for photovoltaic electricity generation: a review and harmonization of literature estimates.** Jordan Macknick¹, Meldrum James², Syndi Nettles-Anderson¹, Garvin Heath¹, Ariel Miara¹. ¹National Renewable Energy Laboratory (NREL), Golden, CO, USA, ²University of Colorado at Boulder, Boulder, CO, USA. 1458

(424-O37) **Photovoltaic Power Pattern Grouping Based on Bat Bio-Inspired Clustering.** Amr Abdullah A. Munshi, Yasser Abdel-Rady I. Mohamed. *University of Alberta, Edmonton, AB, Canada.* 1461

(425-O38) **HOMER: A Valuable Tool to Facilitate the Financing Process of Photovoltaic Systems in Puerto Rico.** Anthony Perez-Santiago¹, Randy Ortiz-Dejesus¹, Eduardo I. Ortiz-Rivera¹. ¹IEEE, Mayaguez, PR, Puerto Rico, ²IEEE, Mayaguez, PR, Puerto Rico, ³IEEE, Mayaguez, PR, Puerto Rico. 1467

(426-O39) **“High-Resolution Residential Feeder Load Characterization and Variability Modelling”**. Andrew Pohl, Jay Johnson, Santiago Sena, Robert Broderick, Jimmy Quiroz. *Sandia National Labs, Albuquerque, NM, USA. 1471*

(427-O40) **Why Decentralised Solar Deployment can be a Game-Changer in India**. Janani Rangarajan. *N/A*

(428-O41) **Kinesthetically Connecting Students to Power Produced by Photovoltaic Panels**. Steven S Robbins, Jeff L Alleman, Brent P Nelson. *NREL, Golden, CO, USA. 1476*

(429-O42) **Representation of Solar Capacity Value in the ReEDS Capacity Expansion Model**. Benjamin O Sigrin, Patrick Sullivan, Eduardo Ibanez, Robert Margolis. *National Renewable Energy Laboratory, Golden, CO, USA. 1480*

(430-O43) **Regional Atmosphere-Solar PV Interactions**. Parikhit Sinha¹, William Hayes², Lauren Ngan². ¹*First Solar, Tempe, AZ, USA, 2*²*First Solar, San Francisco, CA, USA. 1486*

(431-O44) **Profitability of PV electricity in Sweden**. Bengt Stridh^{1,2}, Stefan Yard³, David Larsson^{2,4}, Björn Karlsson². ¹*ABB Corporate Research, Västerås, Sweden, 2*²*Mälardalen University, Västerås, Sweden, 3*³*Lund University, Lund, Sweden, 4*⁴*Direct Energy, Örebro, Sweden 1492*

(432-O45) **Effect of Non-unity Power Factor Operation in Photovoltaic Inverters Employing Grid Support Functions** Sigifredo Gonzalez¹, Jason Neely¹, Michael Ropp²
¹*Sandia National Laboratories, Albuquerque, NM, USA, 2*²*Northern Plains Power Technologies, Brookings, SD, USA 1498*

(433-O46) **Matching A/C Loads to Solar Peak Production Using Thermal Energy Storage in Building Cooling Systems – A Case Study at Arizona State University**. Natasa Vulic, Yongjie Zou, Malvika Patil, Sri Harsha Amilineni, Christiana B. Honsberg, Stephen M. Goodnick. *School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA. 1504*

Joint Session: Areas 1,6 - Posters

8:15 - 9:30 PM

Exhibit Hall D

Hybrid Organic / Inorganic and Perovskites

Chair(s): Annick Anctil, Yasuhiro Yamada, Woojun Yoon

(434-P40) **ZnO Nanowire/N719 dye/Polypyrrole-SWNT nanocomposite Solid State Dye Sensitized Solar Cells**. S. AbdulAmohsin^{1,3}, M. Mohammed^{1,4}, Z. Li⁵, T. Chen². ¹*Department of Applied Science, University of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, 2*²*Department of Physics and Astronomy, University of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, 3*³*College of Science, Thi-Qar University, Thi-Qar, Iraq, 4*⁴*College of Science, University of Al-Qadisiyah, Al-Qadisiyah, Iraq, 5*⁵*Electron Microbeam Analysis Laboratory, Ann Arbor, MI, USA. 1510*

(435-P42) **Performance Optimization for Perovskite Based Solar Cells**. Sumanshu Agarwal¹, Pradeep R Nair². ¹*Department of Energy Science and Engineering, IIT Bombay, Mumbai, India, 2*²*Department of Electrical Engineering, IIT Bombay, Mumbai, India. 1515*

(436-P44) **Fabrication of Zinc Oxide Nanotube arrays for inverted solar cell**. Parvathy devi Balasubramaniam, Chi Cheng Yu, Yian Tai. *Department of Chemical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan. N/A*

(437-P46) **Photovoltaic Properties of Synthesized Nanocrystalline Semiconductor.** Sagar Bhardwaj¹, Aisha Malik¹, S Hameed¹, M.J Siddiqui², M Muneer³, M.M Haque³. ¹Department of Electrical Engineering, Aligarh Muslim University, Aligarh, India, ²Department of Electronics Engineering, Aligarh Muslim University, Aligarh, India, ³Department of Chemistry, Aligarh Muslim University, Aligarh, India. N/A

(438-P48) **10% Efficiency Hybrid GaAs/PEDOT:PSS Solar Cells with Monolayer Graphene.** Kai-Yuan Cheng¹, Huai-Te Pan¹, Shu-Cheng Yu¹, Wei-Sheng Weng¹, Yi-Chun Lai¹, Yi-Cheng Lin¹, Yu-Chen Chen¹, Ming-Chin Li², H. W. Hu¹, Peichen Yu¹, Hsin-Fei Meng². ¹National Chiao-Tung University, Hsinchu, Taiwan, ²National Chiao-Tung University, Hsinchu, Taiwan. 1519

(439-Q2) **Semi-transparent Perovskite Solar Cells for Hybrid Tandem Photovoltaics.** M. Greyson Christoforo¹, Colin D. Bailie², Jonathan P. Mailoa³, Andrea Bowring², Eva L. Unger², William H. Nguyen⁴, Julian Burschka⁵, Norman Pellet⁵, Jungwoo Z. Lee³, Michael Grätzel⁵, Rommel Nouff⁶, Tonio Buonassisi³, Alberto Salleo², Michael D. McGehee². ¹Department of Electrical Engineering, Stanford University, Stanford, CA, USA, ²Department of Materials Science and Engineering, Stanford University, Stanford, CA, USA, ³School of Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA, ⁴Department of Chemistry, Stanford University, Stanford, CA, USA, ⁵Laboratoire de Photoniques et Interfaces, Institut des Sciences et Ingénierie Chimiques, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, ⁶National Renewable Energy Laboratory, Golden, CO, USA. N/A

(440-Q4) **Characterization of Ion-Assisted, Coevaporated CH₃NH₃PbI₃ Thin Films.** Alexander J. Cimaroli, Yanfa Yan. University of Toledo, Toledo, OH, USA. 1522

(441-Q6) **Stable Low- Recombination at n-Si/TiO₂ Hole-blocking Interface and Its Effect on Silicon Heterojunction Photovoltaics.** Janam Jhaveri^{1,2}, Sushobhan Avasthi¹, Ken A. Nagamatsu^{1,2}, James C. Sturm^{1,2}. ¹Princeton Institute for the Science and Technology of Materials (PRISM), Princeton, NJ, USA, ²Department of Electrical Engineering, Princeton University, Princeton, NJ, USA. 1525

(442-Q8) **Time and Light-Dependence of Electrical Passivation of c-Si Surfaces with Quinhydrone Constituent Solutions.** Nicole A. Kotulak, Meixi Chen, Nikolas Schreiber, Robert L. Opila. University of Delaware, Newark, DE, USA. 1529

(443-Q10) **Highly Efficient Polymer Solar Cells with Inverted Structure by using KCl-Treated ZnO Nanorod Arrays.** Ching-Fuh Lin^{1,2}, Sheng Kai Chang¹, Chien Lee¹, Hsin-Che Lee¹. ¹Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, ²Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan. N/A

(444-Q12) **P-type Semiconducting Polymer as the Emitter Layer of hydrogenated Amorphous Silicon Solar cells for Higher Cell Efficiency.** Abdul R Middya, Eric A Schiff. Syracuse University, Syracuse, NY, USA. N/A

(445-Q14) **Fabrication of Low Cost Cu₂CdSnS₄ Based Counter Electrode for Dye Sensitized Solar Cells.** Krishnaiah Mokurula¹, Parag Bhargava¹, Sudhanshu Mallick¹. ¹Indian Institute of Technology Bombay, Mumbai, India, ²Indian Institute of Technology Bombay, Mumbai, India, ³Indian Institute of Technology Bombay, Mumbai, India. 1534

(446-Q16) **Transparent conductive oxide-less back contact dye-sensitized solar cell using Zinc porphyrin dye employing cobalt complex redox shuttle.** Md. Zaman Molla, Shyam S. Pandey, Yuhei Ogomi, Tingli Ma, Shuzi Hayase. *Kyushu Institute of Technology, Kitakyushu, Japan.* 1538

(447-Q18) **Synthesis of Highly Crystalline 'Particle in Tube' TiO₂ Nanostructures and its Application in Dye Sensitized Solar Cells.** Johns Naduvath¹, Parag Bhargava², Sudhanshu Mallick³. ¹*Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India,* ²*Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India,* ³*Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India.* 1543

(448-Q20) **The influence of molecular interface modification on the charge dynamics of polymeric semiconductor / ZnO heterojunctions.** Elham Rezasoltani¹, Mingqing Wang², Ian. G. Hill², Carlos Silva¹. ¹*Montreal University, Montreal, QC, Canada,* ²*Dalhousie University, Halifax, NS, Canada.* N/A

(449-Q22) **Non-toxic, Colloidal ZnS-AgInS₂ Nanoparticles for Organic-Inorganic Hybrid Photovoltaics.** Erin M. Sanehira¹, Christine K. Luscombe², Lih Y. Lin¹. ¹*Electrical Engineering Department, University of Washington, Seattle, WA, USA,* ²*Materials Science and Engineering Department, University of Washington, Seattle, WA, USA.* 1547

(450-Q23) **High Efficiency Hybrid Organic/Silicon-Nanohole Heterojunction Solar Cells.** Thiyagu Subramani¹, Chen-Chih Hsueh¹, Chien-Ting Liu¹, Hong-Jhang Syu¹, Song-Ting Yang², Ching-Fuh Lin^{1,2,3}. ¹*Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan,* ²*Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan,* ³*Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan.* 1553

(451-Q24) **SURFACE-ENGINEERED SILICON NANOCRYSTALS AS HIGH ENERGY PHOTONS DOWNSHIFTERS FOR ORGANIC AND HYBRID SOLAR CELLS.** Vladimir Svrcek¹, Toshihiro Yamanari¹, Davide Mariotti², Somak Mitra², Koiji Matsubara¹. ¹*AIST, Tsukuba, Japan,* ²*Ulster University, Belfast, UK.* 1556

(452-Q25) **Silicon Nanowire/Organic Hybrid Solar Cells with Zonyl Fluorosurfactant Treated PEDOT:PSS.** Hong-Jhang Syu¹, Thiyagu Subramani¹, Chien-Ting Liu¹, Shu-Chia Shiu¹, Ching-Fuh Lin^{1,2,3,4}. ¹*Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan,* ²*Graduate Institute of Electronic Engineering, National Taiwan University, Taipei, Taiwan,* ³*Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan,* ⁴*Innovative Photonics Advanced Research Center, National Taiwan University, Taipei, Taiwan.* 1560

(453-Q26) **The role of the hole-transport layer in perovskite solar cells – reducing recombination and increasing absorption.** Wolfgang Tress^{1,2}, Nevena Marinova¹, Olle Inganäs², Mohammad M Nazeeruddin¹, Shaik K Zakeeruddin¹, Michael Graetzel¹. ¹*EPFL, Lausanne, Switzerland,* ²*LiU, Linköping, Sweden.* 1563

(454-Q27) **CdTe Solar Cells with A PCBM Back Contact.** Curtis J Walkons, Brett W Guralnick, Brian E McCandless, Robert W Birkmire. *University of Delaware, Newark, DE, USA.* 1567

(455-Q28) **Low Temperature TiO_x Compact Layer by Chemical Bath Deposition Method for Vapor Deposited Perovskite Solar Cells.** Kouhei Yamamoto¹, Ying Zhou², Takayuki Kuwabara^{1,2}, Koshin Takahashi^{1,2}, Masaru Endo³, Atsushi Wakamiya^{3,4}, Yuhei Ogomi⁵, Shuzi Hayase⁵, Tetsuya

Taima^{1,2,4}. ¹Graduate School of Natural Science and Technology, Kanazawa University, Kanazawa, Japan, ²RSET, Kanazawa University, Kanazawa, Japan, ³Institute for Chemical Research, Kyoto University, Kyoto, Japan, ⁴JST-PRESTO, Japan Science and Technology Agency (JST), Saitama, Japan, ⁵Graduate School of Life Sciences and Systems Engineering, Kyushu Institute of Technology, Kitakyushu, Japan. 1573

(456-Q29) Vapor Deposition of Organic-Inorganic Hybrid Perovskite Thin-films for Photovoltaic Applications.

Woojun Yoon¹, Janice E Boercker¹, Matthew P Lumb^{1,2}, Joseph G Tischler¹, PhillPhillip.Jenkins Jenkins¹, Robert J Walters¹. ¹Naval Research Laboratory, Washington, DC, USA, ²The George Washington University, Washington, DC, USA. 1577

Area 2 - Posters	
8:15 - 9:30 PM	Exhibit Hall D
CIGS and CdTe	

Chair(s): Oana Cojocar-Mirédin, Reiner Klenk, Chris Ferekides

(457-B27) All-Sputtered CdTe/CdS Thin Film Solar Cells with Indium Doped Highly Resistive Absorber Layer.

Tursunjan Ablekim, Santosh K. Swain, Kelvin G. Lynn. *Center for Materials Research, Washington State University, Pullman, WA, USA.* 1581

(458-B30) Method for Electrical-Structural Correlation in Isolated CdTe/CdS Islands.

Brandon A. Aguirre^{1,2}, Jose L. Cruz-Campa², Douglas Pete³, Rafael Ordonez¹, Joseph Michael², David Zubia¹. ¹University of Texas at El Paso, El Paso, TX, USA, ²Sandia National Laboratories, Albuquerque, NM, USA, ³Center for Integrated Nanotechnologies, Albuquerque, NM, USA. 1585

(459-B33) Influence of Under-Laying Transparent Conducting Oxide on Properties of Cadmium Sulphide Layer Grown by RF Magnetron Sputtering.

Mohammed M. Aliyu¹, Muhammad A. Islam², Kammaruzzaman. Sopian³, Nowshad Amin⁴. ¹Kaduna Polytechnic, Kaduna, Nigeria, ²Universiti Kebangsaan, Bangi, Malaysia, ³King Saudi University, Riyadh, Saudi Arabia. N/A

(460-B36) Performance of transparent conductors on flexible glass and plastic substrates for thin film photovoltaics.

James M Burst¹, William L Rance¹, Daniel M Meysing², Colin A Wolden², Wyatt K Metzger¹, Sean M Garner³, Pat Cimo³, Timothy A Gessert¹, Teresa M Barnes¹, Matthew O Reese¹. ¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado School of Mines, Golden, CO, USA, ³Corning, Inc., Corning, NY, USA. 1589

(461-B39) A Molecular Dynamics Study on Defect Reduction in Thin Film Cd_{1-x}Zn_xTe/CdS Solar Cells.

Jose J. Chavez¹, Xiaowang Zhou², Donald K. Ward², Jose L. Cruz-Campa³, David Zubia¹. ¹University of Texas at El Paso, El Paso, TX, USA, ²Sandia National Laboratories, Livermore, CA, USA, ³Sandia National Laboratories, Albuquerque, NM, USA. 1593

(462-B42) Injection Dependent Minority Carrier Lifetime and Defect Configuration in Thin Film CdTe Solar Cells.

Zimeng Cheng, Alan E. Delahoy, Ken K. Chin. *Department of Physics and CNBM New Energy Materials Research Center, New Jersey Institute of Technology, Newark, NJ, USA.* 1596

(463-B45) **Electro-Optical Characterization Of n-CdS Nanowires/p-CdTe Heterojunction Solar Cell Devices.** Hongmei Dang¹, Sai Guduru¹, Vijay Singh¹. ¹University of Kentucky, Center for Nanoscale Science and Engineering, Department of Electrical and Computer Engineering, Lexington, KY, USA, ²University of Kentucky, Center for Nanoscale Science and Engineering, Department of Electrical and Computer Engineering, Lexington, KY, USA, ³University of Kentucky, Center for Nanoscale Science and Engineering, Department of Electrical and Computer Engineering, Lexington, KY, USA. 1601

(464-B48) **CIGS Absorber Layer by Single-step Non-vacuum Intense Pulsed Light Treatment of Inkjet-printed Film.** Sanjay R. Dhage, P.S. Chandrasekhar, S.B. Chandrasekhar, Shrikant V. Joshi. *International Advanced Research Center for Powder Metallurgy and New Materials, Hyderabad, India.* 1607

(465-C3) **Characterization and modeling of Schottky barrier electron reflector in CdS/CdTe solar cells.** Hamid Z. Fardi. *University of Colorado, Denver, CO, USA.* N/A

(466-C6) **Effect of Deposition Temperature on Reactively Sputtered CdS:O.** Corey R. Grice, Naba R. Paudel, Chuanxiao Xiao, Yanfa Yan. *The University of Toledo, Toledo, OH, USA.* 1611

(467-C9) **Strong Surface Effects in Low Energy Electron Beam Induced Current Experiments – Experiment and Theory.** Paul M Haney, Yeayoung Yoon, Nikolai Zhitenev. *National Institute for Standards and Technology, Gaithersburg, MD, USA.* 1616

(468-C12) **Design and Testing of Pilot-scale Cu and Mixed-vapor Ga-In Evaporation Sources.** Gregory M. Hanket, Shannon L. Fields, John R. Elliott. *Institute of Energy Conversion, University of Delaware, Newark, DE, USA.* 1621

(469-C15) **The Formation of the MOSe₂ Layer at CIGS/Mo interface and its Effect on the CIGS device Performance.** Falah S. Hasoon, Hamda A. Al-Thani. *National Energy and Water Research Center, Abu Dhabi, United Arab Emirates.* N/A

(470-C18) **Oxygenated CdS window layers for thin film CdTe Photovoltaics by pulsed DC magnetron sputtering.** Piotr M Kaminski, Fabiana Lisco, Jake W Bower, Gianfranco Claudio, John M Walls. *CREST (Centre for Renewable Energy Systems and Technology), School of Electronic, Electrical and Systems Engineering, Loughborough, UK.* 1626

(471-C21) **Challenges in deposition of wide band gap copper indium aluminum gallium selenide (CIAGS) thin films for tandem solar cells.** Sreejith Karthikeyan¹, Mandip Sibakoti¹, Richard Liptak^{1,3}, Sang Ho Song¹, Joel Abrahamson², Eray S Aydil², Stephen A Campbell¹. ¹Department of Electrical and Computer Engineering, University of Minnesota, Minneapolis, MN, USA, ²Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, MN, USA, ³Department of Physics and Optical Engineering, Rose-Hulman Institute of Technology, Terre Haute, IN, USA. 1632

(472-C24) **Multisource Close Space Sublimation Reactor for Deposition of Multilayer and Composite Films.** Damian Marrufo¹, Aldo Vidana², David Zubia¹, John McClure². ¹Electrical and Computer Engineering, University of Texas at El Paso, El Paso, TX, USA, ²Metallurgical and Materials Engineering, University of Texas at El Paso, El Paso, TX, USA. 1635

(473-C27) **Morphological and Compositional Analysis of Electrodeposited Indium (III) Sulfide (In₂S₃) Films.** Maqsood Ali Mughal, M. Jason Newell, Joshua Vangilder, Shyam Thapa, Robert Engelken, B. Ross Carroll, J. Bruce Johnson, Kayla Wood. *Arkansas State University, Jonesboro, AR, USA.* 1638

(474-C30) **Effect of Varying Process Parameters on CdTe Thin Film Device Performance and Its Relationship to Film Microstructure.** Amit H Munshi¹, Ali Abbas², John M Raguse¹, Kurt L Barth¹, Walajabad S Sampath¹, John M Walls². ¹Colorado State University, Fort Collins, CO, USA, ²University of Loughborough, Loughboough, UK. 1643

(475-C33) **The Effect of Ga Content on the Selenization of Co-evaporated CuGa/In Films and their Photovoltaic Performance.** Christopher P. Muzzillo^{1,2}, Lorelle M. Mansfield², Clay DeHart², Karen Bowers², Robert C. Reedy², Bobby To², Rommel Noufi³, Kannan Ramanathan², Timothy J. Anderson¹. ¹University of Florida, Gainesville, FL, USA, ²National Renewable Energy Laboratory, Golden, CO, USA, ³Retired, Golden, CO, USA. 1649

(476-C36) **Numerical Modeling of CdTe Cell Degradation.** Marco Nardone¹, David Albin². ¹Bowling Green State University, Bowling Green, OH, USA, ²National Renewable Energy Laboratory, Denver, CO, USA. 1655

(477-C39) **Stoichiometric Control via Periods of Open-circuit During Electrodeposition.** M. Jason Newell, Maqsood Ali Mughal, Joshua Vangilder, Shyam Thapa, Kayla Wood, Steven A. Hoke, Clay Kardas, J. Bruce Johnson, B. Ross Carroll, Robert Engelken. *Arkansas State University, Jonesboro, AR, USA.* 1661

(478-C42) **Optical Emission Spectroscopy of High Power Impulse Magnetron Sputtering (HiPIMS) of CIGS Thin Films.** Jiří Olejníček¹, Zdeněk Hubička¹, Michal Kohout¹, Petra Kšírová¹, Michaela Brunclíková¹, Štěpán Kment¹, Martin Čada¹, Scott A. Darveau², Christopher L. Exstrom². ¹Institute of Physics of ASCR, Department of Low-Temperature Plasma, Prague, Czech Republic, ²University of Nebraska at Kearney, Department of Chemistry, Kearney, NE, USA. 1666

(479-C45) **Band alignment of CBD deposited ZnOS/CIGS interface.** Joel W. Pankow, Glenn R. Teeter, K. Xerxes Steirer, Lorelle M. Mansfield, Rebekah L. Garris, Kannan Ramanathan. *National Renewable Energy Laboratory, Golden, CO, USA.* 1670

(480-C48) **XPS study of sodium in Bridgman-grown CuInSe₂+x.** Sunyoung Park, Clifford H. Champness, Ishiang Shih. *McGill University, Montreal, QC, Canada.* 1674

(481-D3) **Study of CdS/CdTe solar cells activated with N-O₂-CHClF₂ gas mixture.** Juan Luis Peña¹, Inés Riech², Victor Rejón¹. ¹Applied Physics Department, CINVESTAV-IPN, Mérida, Mexico, ²Materials Science Laboratory, Faculty of Engineering, University of Yucatán, Mérida, Mexico. 1679

(482-D6) **PbTe/CdTe Superlattices on ITO and a Solar Cell Made from CdTe/CdS.** Fei Qin, Pritpal Singh. *Department of Electrical and Computer Engineering, Villanova University, Villanova, PA, USA.* 1682

(483-D9) **Optical Enhancement of Ultra-thin CIGS Solar Cells using Multi-layered Antireflection Coatings.** Grace Rajan¹, Abdel-Rahman Ibdah², Krishna Aryal¹, Tasnuva Ashrafee¹, Vikash Ranjan¹, Robert W Collins², Sylvain Marsillac¹. ¹Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, ²Department of Physics and Astronomy, The University of Toledo,, Toledo, OH, USA. 1687

(484-D12) **Structure Evolution In CIGS Deposition: An X-ray Diffraction Analysis With Rietveld Whole-Pattern Refinement.** Thaddeus A. Reese, Sandra B. Schujman, Richard J. Matyi. *SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.* 1691

(485-D15) **The CdS/CdTe solar cell protected by ITO/Mo bilayer at improved back contact.** Victor Rejón¹, Inés Riech², Eric Hernández¹, Patricia Quintana¹, Juan Luis Peña¹. ¹*Applied Physics Department, CINVESTAV-IPN, Mérida, Mexico*, ²*Materials Science Laboratory, Faculty of Engineering, University of Yucatán, Mérida, Mexico.* 1696

(486-D18) **High lateral resolution of energy dispersive X-ray spectroscopy and cathodoluminescence on lamellae of CIGSe solar cells.** Sven Schönherr, Alexander Tille, Philipp Schöppe, Michael Oertel, Udo Reislöhner, Carsten Ronning. *Institut für Festkörperphysik, Friedrich Schiller Universität Jena, Max-Wien-Platz 1, Jena, Germany.* 1699

(487-D21) **Optimization of Electrical Performance of Cu(In,Ga)Se₂ Thin Film Solar Cells Sputtered from Quaternary Targets.** Grace H Shih¹, Sergey I Maximenko², Jesse Frantz², Jason Myers², Robel Bekele³, Jeff Mittereder², Jas S Sanghera², Vinh Q Nguyen², David Scheiman², Raymond Hoheisel⁴, Robert Walters². ¹*Naval Surface Warfare Center, Crane Division, Crane, IN, USA*, ²*Naval Research Laboratory, Washington, DC, USA*, ³*University Research Foundation, Greenbelt, MD, USA*, ⁴*The George Washington University, Washington, DC, USA* 1704

(488-D24) **Effect of sputtering sequence on the properties of Ag-Cu-In-Ga metal precursors and reacted (AgCu)(InGa)Se₂ films.** Sina Soltanmohammad^{1,2}, Dominik M. Berg¹, William N. Shafarman^{1,2}. ¹*Institute of Energy Conversion, University of Delaware, Newark, DE, USA*, ²*Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA.* 1707

(489-D27) **Spray Pyrolysis of Backwall Superstrate CuIn(S,Se)₂ Solar Cells.** Zhaoning Song, Adam B. Phillips, Patrick Krantz, Rajendra R. Khanal, Michael J. Heben. *Wright Center for Photovoltaics Innovation and Commercialization, School for Solar and Advanced Renewable Energy, Department of Physics and Astronomy, University of Toledo, Toledo, OH, 43606, USA, Toledo, OH, USA.* 1712

(490-D30) **Anomalous dark current ideality factor ($n > 2$) in thin-film solar cells: the role of grain-boundary defects.** GIOVANNA SOZZI¹, ROBERTO MOSCA², MARCO CALICCHIO², ROBERTO MENOZZI¹. ¹*Department of Information Engineering - University of Parma, PARMA, Italy*, ²*IMEM-CNR Institute, PARMA, Italy.* 1718

(491-E1) **A Combinatorial Approach to the Optimisation of Cd(1-x)ZnxS layers for CdTe Solar Cells.** Robert E Treharne¹, Andrew Clayton², Laurie, J Phillips¹, Jonathan D Major¹, Stuart J C Irvine², Ken Durose¹. ¹*Stephenson Institute for Renewable Energy, University of Liverpool, Liverpool, UK*, ²*Centre for Solar Energy Research, University of Glyndwr, St. Asaph, UK.* 1722

(492-E4) **The Comparisons of Na Incorporation Into Epitaxial Single-crystal CIS and CIGS Cells.** Po-Chuan Tsai^{1,2}, Han-Ping D. Shieh², Angus Rockett¹, Robert Forest³, Erten Eser³. ¹*University of Illinois, Urbana, IL, USA*, ²*Department of Photonics & Display Institute, National Chiao Tung University, Hsinchu, Taiwan*, ³*Institute of energy conversion, University of Delaware, Newark, DE, USA.* N/A

(493-E7) **Electrical and Compositional Characterization of Gallium Grading in Cu(In,Ga)Se₂ Solar Cells.** Bradley West¹, Harvey Guthrey², Lei Chen³, April Jeffries¹, Simone Bernardini¹, Barry Lai⁴, Jorg Maser⁴, William Shafarman³, Mowafak Al-Jassim², Mariana Bertoni¹. ¹Ira A. Fulton Schools of Engineering, Arizona State University, Tempe, AZ, USA, ²National Renewable Energy Laboratory, Golden, CO, USA, ³Institute of Energy Conversion, University of Delaware, Newark, DE, USA, ⁴Advanced Photon Source, Argonne National Laboratory, Lemont, IL, USA. 1726

(494-E10) **Identifying Parasitic Current Pathways in CIGS Solar Cells by Modelling Dark JV Response.** Ben L Williams¹, S Smit¹, B J Kniknie², N J Bakkers³, W M M Kessels¹, R E I Schropp³, M Creatore¹. ¹Eindhoven University of Technology, Eindhoven, Netherlands, ²TNO, Eindhoven, Netherlands, ³ECN, Eindhoven, Netherlands. 1729

(495-E13) **Transition Metal Nitride Contacts for CdTe Photovoltaics.** Zhengfeng Yang, P. Koirala, R.W. Collins, K. Aryal, S. Marsillac, Angus Rockett., 1735

(496-E16) **Application of CVD Graphene as Transparent Front Electrode in Cu(In,Ga)Se₂ Solar Cell.** Ling Yin^{1,2}, Chunlei Yang², Kang Zhang², Hailin Luo², Xieqiu Zhang^{1,2}, Zhuang Liu², Guanming Cheng², Zhiyu Xiong², Xudong Xiao^{1,2}. ¹Department of Physics, The Chinese University of Hong Kong, Hong Kong, Hong Kong, ²Center for Photovoltaic and Solar Energy, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China. 1740

Area 6- Posters	
8:15 - 9:30 PM	Exhibit Hall D
Organic PV Posters I: Organic Semiconductors	

Chair(s): Dana Olson, Matt Menke, Moritz Riede

(497-J27) **Organic PV Cell Using Genetic Engineering.** Ami Elazari. Millennium Solar, Tel Aviv, Israel. N/A

(498-J29) **Enhanced efficiency of inverted bulk heterojunction solar cells with embedded silica nanoparticles.** Sankara Rao Gollu¹, M S Murthy², Ramakant Sharma¹, Srinivas G¹, Swaroop Ganguly², Dipti Gupta^{1,2}. ¹Plastic Electronics and Energy Lab (PEEL), Department of Metallurgical Engineering and Material Science, Indian Institute of Technology Bombay, Mumbai, India, ²National Centre for Photovoltaic Research and Education (NCPRE), Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai, India. 1745

(499-J31) **The Application of a Magnetic Field to Improve Polymer:fullerence Solar Cell Performance.** Fang-Chi Hsu¹, Chiang-Ting Chen², Chia-Chun Chen³, Yang-Fang Chen². ¹Department of Materials Science and Engineering, National United University, Miaoli, Taiwan, ²Department of Physics, National Taiwan University, Taipei, Taiwan, ³Department of Chemistry, National Taiwan Normal University, Taipei, Taiwan. 1750

(500-J33) **Alternative Acceptors for Bulk Heterojunction Organic Photovoltaics.** Chaz Keiderling. Imperial College London, London, UK. N/A

(501-J35) **Influence of solvent on the molecular ordering of thin films of P3HT:PCBM blends and precursor solution.** Andres F Loaiza¹, Camilo A Otorola¹, Gerardo Gordillo². ¹Departamento de Química, Universidad Nacional de Colombia, Bogota, Columbia, ²Departamento de Física, Universidad Nacional de Colombia, Bogota, Columbia. 1754

(502-J37) **Charge Transport Kinetics in Organic Bulk Heterojunction Morphologies: Mesoscale Monte Carlo Simulation Analysis.** Ishtiaq Maqsood^{1,3}, Lance D Cundy², Matt Biesecker², Jung-Han Kimn², Elise Darlington³, Ethan P Hettwer³, Sabina Schill³, Venkat BommiSETTY¹. ¹*Department of Electrical Engineering and Computer Science, Brookings, SD, USA*, ²*Department of Mathematics and Statistics, Brookings, SD, USA*, ³*NSF-REU Participants, Brookings, SD, USA*. 1758

(503-J39) **New Generation of Biomorph Integrated with TCO and Thermoelectric to Enhance Efficiency in Wide Solar Spectrum Solar Cell.** Kathleen E. Martin¹, Matt Erdman¹, Hope Quintana², Julio Martinez², John Shelnut¹, Olga Lavrova¹, Tito Busani¹. ¹*University of New Mexico, Albuquerque, NM, USA*, ²*New Mexico State University, Las Cruces, NM, USA*. 1762

(504-K1) **Synthesis and Photovoltaic Properties of a New Donor-Acceptor Conjugated Polymer Based on Fluorinated Benzothiadiazole Units.** Hussein Medlej¹, Ali Nourdine¹, Hussein Awada², Mamatimin Abbas³, Christine Dagrón-Lartigau², Guillaume Wantz³, Lionel Flandin¹. ¹*Université de Savoie - LEPMI/LMOPS, Le Bourget du Lac, France*, ²*Université de Pau - IPREM/EPCP, Pau, France*, ³*Univeristé de Bordeaux 1 - IMS, Pessac, France*. 1766

(505-K3) **Influence of Valence band tail width on Performance of P3HT: PCBM Bulk-heterojunction Solar Cell: AMPS-1D simulation study.** BUSHRA MOHAMED OMER. *Taif University, Taif, Saudi Arabia*. 1770

(506-K5) **High Open Circuit Voltage Organic Photovoltaics: Minimizing Energetic Loss with a High Band Gap Donor Polymer and a Small-Molecule Acceptor.** David P. Ostrowski¹, Unsal Koldemir², Ryan Anderson², Alan Sellinger^{2,3}, Sean E. Shaheen^{1,4}. ¹*University of Colorado at Boulder, Boulder, CO, USA*, ²*Colorado School of Mines, Golden, CO, USA*, ³*National Renewable Energy Lab (NREL), Golden, CO, USA*, ⁴*Renewable and Sustainable Energy Institute (RASEI), Boulder, CO, USA*. 3730

(507-K7) **Synthesis, Electrochromic and Organic Photovoltaic Properties of a Benzotriazole and Triphenylamine Bearing Random Copolymer.** Serife Ozdemir Hacıoğlu¹, Gonul Hizalan¹, Ali Cirpan^{1,2,3,4}, Levent Toppare^{1,3,4,5}. ¹*Department of Chemistry, Middle East Technical University, 06800 Ankara, Turkey*, ²*Department of Micro and Nanotechnology, Middle East Technical University, Ankara 06800, Turkey*, ³*Department of Polymer Science and Technology, Middle East Technical University, 06800 Ankara, Turkey*, ⁴*The Center for Solar Energy Research and Application (GÜNAM), Middle East Technical University, 06800 Ankara, Turkey*, ⁵*Department of Biotechnology, Middle East Technical University, 06800 Ankara, Turkey*. N/A

(508-K9) **Explaining the Molecular Structure of the Bulk Heterojunction with Simple Electronic Measurements and Marcus-Hush Theory for Squaraine:PCBM Organic Photovoltaic Devices.** Susan Spencer¹, Patrick Heaphy¹, Cortney Bougher², Brad Conrad², John Andersen¹, Jeremy Cody¹, Scott Mixture³, Chris Collison¹. ¹*Rochester Institute of Technology, Rochester, NY, USA*, ²*Appalachian Institute of Technology, Boone, NC, USA*, ³*Alfred University, Alfred, NY, USA* 1776

(509-K11) **2D Conjugated Systems and Interfaces for Photovoltaic Devices.** Hsing-Lin Wang, Wanyi Nie, Aditya Mohite, Cheng-Yu Kuo, Hsinghan Hsai, Sergei Tretiak, Dmitry Yarotski, Gautam Gupta. *Los Alamos National Laboratory, Los Alamos, NM, USA*. N/A

(510-K13) **liner-shaped d(a-ar)₂ small molecule with enhanced π -system of arene-appended moiety for efficient solution-processed organic solar cells.** zhang youming, xiao manjun, tan hua, wang yafei, liu yu, zhu weiguo. *College of Chemistry, Xiangtan University, Key Lab of Environment-Friendly Chemistry and Application in Ministry of Education, xiangtan 411105, China. N/A*

Area 7- Posters

8:15 - 9:30 PM

Exhibit Hall D

Space PV Cells and Systems

Chair(s): Kazunori Shimazaki, David Scheiman

(511-K14) **Balance sheets of energy and carriers and subcell characteristics in a GaInP/GaAs/Ge tandem solar cell.** Shaoqiang Chen¹, Lin Zhu¹, Masahiro Yoshita¹, Toshimitsu Mochizuki¹, Changsu Kim¹, Hidefumi Akiyama¹, Mitsuru Imaizumi², Yoshihiko Kanemitsu³. ¹*Institute for Solid State Physics, University of Tokyo, and JST-CREST, Kashiwa, Japan,* ²*Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan,* ³*Institute for Chemical Research, Kyoto University, and JST-CREST, Kyoto, Japan. 1780*

(512-K15) **Modeling and Parametric Simulation of Triple Junction Solar Cell for Space Applications.** Simone Colasanti¹, Helmut Nesswetter^{1,2}, Claus G. Zimmermann², Paolo Lugli¹. ¹*Technical University Munich (TUM), Munich, Germany,* ²*Solar Array Center, EADS Astrium, Munich, Germany. 1784*

(513-K16) **An Electric Power Supply Design for the Space Plasma Ionic Charge Analyzer (SPICA) CubeSat.** Rachid Darbali-Zamora, Daniel A. Merced -Cirino, Cesar S. Gonzalez-Ortiz, Eduardo I. Ortiz-Rivera. *University of Puerto Rico, Mayagüez Campus, Mayagüez, PR, USA. 1790*

(514-K17) **Dry Epitaxial Lift-off for III-V solar cells.** John Farah¹, John Nicholson², Sekar Thirunavukkarasu², Kilian Wasmer³. ¹*OptiCOMP Networks, Attleboro, MA, USA,* ²*University of Massachusetts, Amherst, MA, USA,* ³*University of Massachusetts, Amherst, MA, USA,* ⁴*Swiss Federal Laboratory for Materials Science EMPA, Thun, Switzerland. 1796*

(515-K18) **Fast Ambient Pressure Thermal cycling of space solar array samples under equivalent AM0 illumination conditions.** Emilio Fernandez Lisbona. 1802

(516-K19) **Establishing Suitability of Standard Multijunction Solar Cells For MARS ORBITER MISSION.** Usha G, Vasudevan R, Krishnapriya G, Uma B R, Sankaran M. *Power Systems Group, ISRO Satellite Centre, Bangalore, India. 1805*

(517-K20) **AM0 Solar Cell Calibration Under Near Space Conditions.** Raymond Hoheisel¹, David Wilt², David Scheiman³, Phillip Jenkins³, Robert Walters³. ¹*George Washington University, Washington, DC, USA,* ²*Air Force Research Laboratory, Kirtland AFB, NM, USA,* ³*Naval Research Laboratory, Washington, DC, USA. 1811*

(518-K21) **Radiation Hardness Investigation of PECVD Silicon Carbide Layers for PV Applications.** Jozef Huran¹, Pavol Boháček¹, Sergey A. Kulikov², Eugeny P. Shabalin², Vlasta Sasinková³, Angela Kleinová⁴, Alexander P. Kobzev², Maria Sekáčová¹, Juraj Arbet¹. ¹*Institute of Electrical Engineering, Slovak Academy of Sciences, Bratislava, Slovakia,* ²*Joint Institute for Nuclear Research, Dubna, Russia,* ³*Institute of Chemistry, Slovak Academy of Sciences, Bratislava, Slovakia,* ⁴*Polymer Institute, Slovak Academy of Sciences, Bratislava, Slovakia. 1815*

(519-K22) **Properties of N-H Local Vibration Modes in GaAsN Grown by Chemical Beam Epitaxy.** Kazuma Ikeda, Akira Yamakata, Koushiro Demizu, Nobuaki Kojima, Yoshio Ohshita, Masafumi Yamaguchi. *Toyota Technological Institute, Nagoya, Japan.* 1821

(520-K23) **In-Flight I-V Results from the 2nd Forward Technology Solar Cell Experiment.** Phillip P. Jenkins¹, Maria Gonzalez², Justin Lorentzen¹, Joseph M. Flatico³, Michael J. Krasowski⁴, Lawrence Greer⁴, Kelly Trautz¹. ¹*Naval Research Laboratory, Washington, DC, USA*, ²*Soltera Defense Solutions, Annapolis Junction, MD, USA*, ³*Ohio Aerospace Institute, Cleveland, OH, USA*, ⁴*NASA Glenn Research Center, Cleveland, OH, USA.* N/A

(521-K24) **Radiation Resistance of Super-Straight Type Amorphous Silicon Germanium Alloy Solar Cells.** Shin-ichiro Sato¹, Tomomi Meguro², Takashi Suezaki², Kenji Yamamoto², Takeshi Ohshima¹. ¹*Japan Atomic Energy Agency, Takasaki, Japan*, ²*Kaneka Corporation, Settsu, Japan.* 1825

(522-K25) **The effects of Indium Pre-Evaporation on Rotational Twin Formation in GaAs films on Si(111).** Hidetoshi Suzuki¹, Daiki Ito², Akihiro Haga², Atsuhiko Fukuyama², Tetsuo Ikari². ¹*Interdisciplinary Research Organization, University of Miyazaki, Miyazaki, Japan*, ²*Faculty of Engineering, University of Miyazaki, Miyazaki, Japan.* 1830

(523-K26) **Structural Design of Laser-Photovoltaic Power Converter.** Hiroaki Suzuki¹, Hiroyuki Yoshida¹, Katsuto Kisara², Tetsuya Nakamura¹, Mitsuru Imaizumi¹. ¹*Japan Aerospace Exploration Agency, Tsukuba, Japan*, ²*Japan Aerospace Exploration Agency, Kakuda, Japan.* 1834

(524-K27) **Modeling of a Gallium Arsenide Solar Cell under Low Intensity and Low Temperature Conditions for Space Applications.** Paul von Allmen, Jonathan Grandier, Paul Stella. *Jet Propulsion Laboratory, Pasadena, CA, USA.* N/A

(525-K28) **Increased Radiation Hardness in Ultra-Thin GaAs Single-Junction Solar Cells.** Jacob J Becker, Ying-Shen Kuo, Yong-Hang Zhang. *Arizona State University, Tempe, AZ, USA.* 1839

Area 8- Posters

8:15 - 9:30 PM

Exhibit Hall D

Characterization II

Chair(s): Harvey Guthrey, Keith Emery

(526-K30) **Investigation of Low Injection Effects Using the Local Ideality Factor Obtained From Effective Lifetime Measurements.** Ziv Hameiri¹, Fa-Jun Ma¹, Keith R. McIntosh². ¹*Solar Energy Research Institute of Singapore, Singapore*, ²*PV Lighthouse, Coledale, Australia.* 1842

(527-K33) **Light-Beam-Induced-Current Characterization of CdTe Solar Cells.** Russell M. Geisthardt, James R. Sites. *Colorado State University, Fort Collins, CO, USA.* 1848

(528-K36) **Interfaces of Zinc Phosphide Magnesium Schottky Diodes.** Melissa Mushrush¹, Manish Sharma¹, Steve Rozeveld¹, Meaghan Woodward¹, Charlie Wood¹, Nick Shinkel¹, Phillip Small¹, Scott Sprague¹, Britt Vanchura¹, Alex Cimaroli², Naba Paudel², Yanfa Yan². ¹*The Dow Chemical Company, Midland, MI, USA*, ²*The University of Toledo, Toledo, OH, USA.* N/A

(529-K39) **Photoluminescence Spectroscopy as a Tool for Quality Control of GaN Thin Film to be Used in Solar Cell Devices.** Guillermo Santana Rodríguez¹, Adolfo Mejía-Montero¹, Marel Monroy¹, Gerardo Contreras-Puente², Máximo López-López³, Osvaldo De Melo⁴. ¹*Instituto de Investigaciones en Materiales-UNAM, Mexico City 04510, Mexico*, ²*Escuela Superior de Física y Matemáticas-IPN, Mexico City 07738, Mexico*, ³*Centro de Investigación y de Estudios Avanzados-IPN, Mexico City 07360, Mexico*, ⁴*Facultad de Física, Universidad de la Habana, San Lazaro y L., La Habana, 10400, Cuba*. 1852

(530-L2) **Numerical simulation of solar cell efficiencies in dependence of mc-Si brick materials lifetime and iron measurements.** Hannes Wagner¹, Bernhard Mitchell², Pietro Altermatt¹. ¹*University of Hannover, Hannover, Germany*, ²*University of New South Wales, Sydney, Australia*. 1855

(531-L5) **Quantitative Heterodyne Lock-in Carrierographic Imaging of Silicon Wafers and Solar Cells.** Qiming Sun¹, Alexander Melnikov², Andreas Mandelis^{1,2}. ¹*School of Optoelectronic Information, University of Electronic Science and Technology of China, Chengdu, China*, ²*Center for Advanced Diffusion-Wave Technologies (CADIFT), Mechanical and Industrial Engineering, University of Toronto, Toronto, ON, Canada*. 1860

(532-L8) **Induction of Internal Capacitance Effect of Organic Photovoltaic Device (OPV) by Real-Time One-Sweep Method (RTOSM) in I-V Measurement.** Yean-San Long, Shu-Tsung Hsu, Teng-Chun Wu, Yu-Tai Li. *Rm.213, Bldg.3, No. 321, Kuang Fu Road, Sec. 2, Hsinchu, Taiwan*. 1866

(533-L11) **Non-Intrusive Cell Quantum Efficiency Measurements of Accelerated Stress Tested Photovoltaic Modules.** Brett Knisely, Joseph Kuitche, Govindasamy TamizhMani, Aaron Korostyshevsky, Halden Field., 1870

(534-L14) **Challenges of Irradiance-mode Spectral Response Measurements.** Behrang H. Hamadani, John Roller, Brian Dougherty, Howard Yoon. *National Institute of Standards and Technology, Gaithersburg, MD, USA*. 1875

(535-L17) **I-V light and dark curves characterization of laser induced damage removal by alkaline etching for laser edge isolated crystalline solar cells.** Aloña Otaegi, Vanesa Fano, Muhammad Azam Rasool, Jose Ruben Gutierrez, Juan Carlos Jimeno. *Technological Institute of Microelectronics, Zamudio, Spain*. N/A

(536-L20) **Study of Al/a-SiC/c-Si(p)/Al structure prepared by PECVD.** Michal Váry¹, Jozef Huran², Milan Perný¹, Miroslav Mikolášek¹, Vladimír Šály¹, Juraj Packa¹, Alexander P. Kobzev³. ¹*Slovak University of Technology, Faculty of Electrical Engineering and Information Technology, Bratislava, Slovakia*, ²*Slovak Academy of Sciences, Institute of Electrical Engineering, Bratislava, Slovakia*, ³*Joint Institute for Nuclear Research, Dubna, Russia*. 1879

(537-L23) **Digital Noise Spectroscopy System and Its Application to Solar Cells.** Armin Mehrabian¹, Raymond Hoheisel¹, David J. Nagel¹, Scott R. Messenger², Sergey Maximenko³. ¹*The George Washington University, Washington, DC, USA*, ²*University of Maryland Baltimore County, Baltimore, MD, USA*, ³*Naval Research Laboratory, Washington, DC, USA*. 1884

(538-L26) **Spatially And Spectrally Resolved Temperature Dependence Of Defect Related Luminescence Using Hyperspectral Imaging.** Andreas Flø, Ingunn Burud, Espen Olsen. *Norwegian University of Life Sciences, Ås, Norway*. 1888

(539-L29) **In Situ PL Imaging Toward Real-Time Plating Process Control.** Jungwoo Z. Lee¹, Joseph T. Sullivan¹, Lynne Michaelson², Krystal Munoz², Tom Tyson², Anthony Gallegos², Tonio Buonassisi¹. ¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²Technic Inc., Cranston, RI, USA. 1893

(540-L32) **Accurate and Rapid Measurement of High-Capacitance PV Cells and Modules using a Single Short Pulse Light.** Hisashi Kojima¹, Kazutaka Iwamoto¹, Akio Shimono¹, Junichiro Abe¹, Yoshihiro Hishikawa². ¹Kyoshin Electric Co., Ltd., Kyoto, Japan, ²AIST, Ibaraki, Japan. 1896

(541-M3) **Afterpulse Background Suppression in Time-Correlated Single Photon Counting Lifetime Experiments using Optimized Gate Filter.** Martin W Gerber, Rafael N Kleiman. *McMaster University, Hamilton, ON, Canada.* 1899

(542-M6) **Nanoscale Photovoltaic Performance in Micro/Nanopatterned CdTe-CdS Thin Film Solar Cells.** Yasemin Kutes¹, James L Bosse¹, Brandon A Aguirre³, Jose L Cruz-Campa², Joseph Michael², David Zubia³, Erik D Spoerke², Bryan D Huey¹. ¹University of Connecticut, Storrs, CT, USA, ²Sandia National Laboratories, Albuquerque, NM, USA, ³University of Texas at El Paso, El Paso, TX, USA. 1903

(543-M9) **Induction of Internal Capacitance Effect of Organic Photovoltaic Device (OPV) by Real-Time One-Sweep Method (RTOSM) in I-V Measurement.** Yean-San Long, Shu-Tsung Hsu, Yu-Tai Li, Teng-Chun Wu. *Center for Measurement Standards, Industrial Technology Research Institute, Hsinchu, Taiwan.* N/A

(544-M12) **Direct Observation of Grain Boundary PN Junction Potentials in CIGS Using Photoemission and Low Energy Electron Microscopy (PELEEM).** Calvin K. Chan¹, Taisuke Ohta¹, Gary L. Kellogg¹, Douglas Pernik², Brian Korgel², Lorelle Mansfield³, Rommel Noufi³, Kannan Ramanathan³. ¹Sandia National Laboratories, Albuquerque, NM, USA, ²The University of Texas at Austin, Austin, TX, USA, ³National Renewable Energy Laboratory, Golden, CO, USA. 1908

Area 10- Posters

8:15 - 9:30 PM

Exhibit Hall D

Performance Modeling and Validation II

Chair(s): Billy Hayes, Martin Waters

(545-N16) **Critical Voltage Perturbation Size For An Open-loop Perturb-and-Observe (P&O) Maximum Power Point Tracking (MPPT) Grid-Connected Solar Photovoltaic (PV) System.** Emmanuel K. Anto, Philip Y. Okyere, Johnson A. Asumadu., 1912

(546-N20) **Effect of module temperature and seasonal variation analysis of the outdoor performance of CdTe at composite climate of India.** Birinchi Bora¹, O.S. Sastry¹, A Kumar¹, Y.K Singh¹, K. Yadav¹, R Singh¹, M Bangar¹. ¹Solar Energy centre, Gurgaon, India, ²Solar Energy centre, Gurgaon, India, ³Solar Energy centre, Gurgaon, India, ⁴Solar Energy centre, Gurgaon, India, ⁵Solar Energy centre, Gurgaon, India, ⁶Solar Energy centre, Gurgaon, India, ⁷Solar Energy centre, Gurgaon, India. N/A

(547-N24) **Complete PV Power Plant Certification: New Standards for Quality Assurance of Large Scale PV Power Plants.** Boris Farnung¹, Peter Bostock², Jonas Brückner³, Klaus Kiefer¹. ¹Fraunhofer ISE, Freiburg, Germany, ²VDE Americas, San Francisco, CA, USA, ³VDE Testing and Certification Institute, Offenbach, Germany. 1917

(548-N28) **Spatial Variations in Temperature Across a Photovoltaic Array.** Michaela Farr, Joshua S Stein. *Sandia National Laboratories, Albuquerque, NM, USA.* 1921

(549-N32) **Use of the Suns-Voc for Diagnosing Outdoor Arrays & Modules.** M. Keith Forsyth¹, Matthew Mahaffey², Adrienne L. Blum¹, Weston A. Dobson¹, Ronald A. Sinton¹. ¹*Sinton Instruments, Boulder, CO, USA,* ²*Colorado School of Mines, Golden, CO, USA.* 1928

(550-N36) **Validation of Multiple Flat Plate Photovoltaic Modeling Tools Against Measured Data.** Janine Freeman, Jonathan Whitmore, Nate Blair, Aron P. Dobos. *National Renewable Energy Laboratory, Golden, CO, USA.* 1932

(551-N40) **Inverter Induced Photovoltaic System Efficiency Losses.** Fan He, Liang Ji, Tim Zgonena, Christopher Flueckiger, Bengt Jaeckel, Paul Brazis. *UL LLC, Northbrook, IL, USA.* 1938

(552-N44) **An Advance Geometrical Maximum Power Point Trageting Technique for Solar Photovoltaics using Current-Voltage Characteristic.** Gaurav Kumar¹, Ashish Panchal². ¹*S V N I T, Surat, India,* ²*SVNIT, Surat, India.* 1944

(553-N48) **Seasonal quality factor; 60 kWp PV system at north Mexico City.** Yasuhiro Matsumoto¹, Jose Antonio Urbano¹, Oscar Iván Gómez¹, René Asomoza¹, Gabriela López¹, Ramón Peña¹, Claudia López². ¹*Research Center and Advanced Studies of the National Polytechnic Institute, Mexico, Mexico,* ²*Fronius SA de CV, Mexico, Mexico.* 1948

(554-O4) **Operational Performance of Grid-Connected PV Systems.** Panagiotis Moriartis, Wilfried G.J.H.M. Van Sark. *Utrecht University, Copernicus Institute, Utrecht, Netherlands.* 1953

(555-O8) **Performance Characterization of Cadmium Telluride Modules Validated by Utility Scale and Test Systems.** Lauren Ngan¹, Nicholas Strevel¹, Kendra Passow¹, Alex F. Panchula¹, D.C. Jordan². ¹*First Solar, San Francisco, CA, USA,* ²*National Renewable Energy Lab, Golden, CO, USA.* 1957

(556-O12) **Self-Reported Field Efficiency of Utility-Scale Inverters.** Kendra Passow, Lauren Ngan, Alex Panchula. *First Solar, San Francisco, CA, USA.* 1963

(557-O16) **A Practical Perspective on Grid-tied PV Systems in Low Reliability Grids.** Saad Pervaiz², Hassan A Khan¹, Muhammad Ali Qureshi¹. ¹*Dept of Electrical Engineering, LUMS, Lahore, Pakistan,* ²*University of Colorado at Boulder, Denver, CO, USA.* 1969

(558-O19) **Ambient Temperature Correction of Photovoltaic System Performance Data.** Bryson Rupnik, Owen Westbrook. *juwi solar Inc, Boulder, CO, USA.* 1973

(559-O22) **Performance of a 34 kWp Grid-Connected PV System in Indonesia – A Comparison of Tropical and European PV Systems.** Anton J. Veldhuis, Angele H.M.E. Reinders. *University of Twente, Enschede, Netherlands.* 1978

(560-O24) **Uniform and Partial Shading Conditions.** Antony Xenophontos, Ali Bazzi. *University of Connecticut, Storrs, CT, USA.* 1982

Area 12- Posters

8:15 - 9:30 PM

Exhibit Hall D

Reliability 1

Chair(s): Michelle Propst, Allan Ward, Shubhra Bansal

(561-O47) **Properties of encapsulation materials and their relevance for recent field failures.** Juliane Berghold, Benjamin Frohmann, Simon Koch, Paul Grunow. *PI Berlin AG, Berlin, Germany.* 1987

(562-P1) **Supplemental Methods to Analyze Ageing of PV Modules on Module Level.** Nicolas Bogdanski, Gerhard Mathiak. *TÜV Rheinland Energie und Umwelt, Cologne, Germany.* N/A

(563-P3) **PID Results at low irradiances.** Benoit Braisaz¹, Khalid Radouane². ¹*EDF R&D, Ecuelles, France,* ²*EDF EN, La Défense, France.* 1993

(564-P5) **Water Cooking for Backsheet and PV Module Endurance Evaluation.** Maoyi Chang, Haomin Chen, Chienyu Chen, C. H. Hsueh, W. J. Hsieh. *AU Optronics, Taichuang, Taiwan.* 1997

(565-P7) **Optimize Silicon Solar Cell Micro-Structure for Lowering PV Module Power Loss by Thermal Cycling Induced.** Wen-Tai Chung, Chien-Wen Chen. *Motech Industries, Inc., Tainan, Taiwan.* 2001

(566-P9) **A Modeling of Soldering Adhesion Forecast for the Crystalline Silicon Solar Cell.** Wen-Tai Chung, Wei-Cyun Lee, Chi-Kun Wu, Yu-Ting Hung, Chien-Wen Chen. *Motech Industries, Inc., Tainan, Taiwan.* 2004

(567-P11) **Device for Comprehensive Analysis of Leakage Current Paths in Photovoltaic Module Packaging Materials.** Neelkanth G. Dhere, Narendra S. Shiradkar, Eric Schneller. *Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA.* 2007

(568-P13) **Recovery after potential induced degradation of $\text{CuIn}_{1-x}\text{Ga}_x\text{Se}_2$ solar cells with CdS and Zn(O,S) buffer layers.** Viktor Fjällström, Bart Vermang, Pedro Salomé, Piotr Szaniawski, Fredrik Rostvall, Uwe Zimmermann, Marika Edoff. *Ångström Solar Center, Solid State Electronics, Uppsala University, Ångström Laboratory, PO Box 534, SE-75121, Uppsala, Sweden.* N/A

(569-P15) **One-Dimensional Reaction-Diffusion Simulation of Cu Migration in Polycrystalline CdTe Solar Cells.** Da Guo¹, Richard Akis¹, Daniel Brinkman², Igor Sankin³, Tian Fang³, Dragica Vasileska¹, Christian Ringhofer². ¹*School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA,* ²*School of Mathematical and Statistical Science, Arizona State University, Tempe, AZ, USA,* ³*First Solar, Perrysburg, OH, USA.* 2011

(570-P17) **Establishing the long term moisture barrier performance of the edge seal from accelerated testing.** Kedar Y Hardikar, Dan Vitkavage, Ajay Saproo, Todd Krajewski. 2016

(571-P19) **Solder joint failure modes in crystalline Si PV modules operated in the field for 10 years.** uichi itoh¹, Tetsuro Nishimura², Takuro Fukami², Kenji Takamura², Akira Kita², Ryosuke Miyabayashi³, Hideo Ohkuma⁴. ¹AIST, Tsukuba, Japan, ²Nihon Superior Co. LTD, Suita, Japan, ³Nihon Superior Co. LTD, Suita, Japan, ⁴Nihon Superior Co. LTD, Suita, Japan, ⁵Nihon Superior Co. LTD, Suita, Japan, ⁶NPC Incorporated, Tokyo, Japan, ⁷HTO Inc., Yasu, Japan. 2021

(572-P21) **Prevention of Potential Induced Degradation with Thin Ionomer Film.** Jane Kapur, Katherine M Stika, Craig Westphal, Jennifer L Norwood, Babak Hamzavatehrany, Alison MA Bennett. *E. I. DuPont de Nemours & Co., Inc., Wilmington, DE, USA.* N/A

(573-P23) **Study on the lifetime prediction of multilayer encapsulated organic solar cell under continuously varying environment.** Namsu Kim¹, Samuel Graham², Sung Hyun Kim³, Kyung-Jun Hwang¹, Dajung Kim¹. ¹Components & Materials Physics Research Center, Korea Electronics Technology Institute, Seongnam, South Korea, ²Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA, ³Energy Nano Materials Research Center, Korea Electronics Technology Institute, Seongnam, South Korea. N/A

(574-P25) **Laboratory testing and long term performance assessment of various solar lighting systems.** Parimita Mohanty, Arvind Sharma, Richie Brian Stephen. *TERI, India Habitat Centre, Lodhi Road, New Delhi, India.* N/A

(575-P27) **Stability of CZTS Thin Film Solar Cells upon Accelerated Thermal Cycling and Damp Heat Exposure.** Chien-Yi Peng^{1,2}, Tara P. Dhakal^{2,3}, Amin Emrani^{2,3}, Susan Lu¹, Charles R. Westgate^{2,3}. ¹Department of Systems Science and Industrial Engineering, State University of New York at Binghamton, Binghamton, NY, USA, ²Center for Autonomous Solar Power (CASP), Binghamton University, Binghamton, NY, USA, ³Department of Electrical and Computer Engineering, State University of New York at Binghamton, Binghamton, NY, USA. 2022

(576-P29) **Mirror Augmented Photovoltaics and Time Series Analytics of the I-V Curve Parameters.** Timothy J Peshek, Shay Mathews, Yang Hu, Roger H French. *Case Western Reserve University, Cleveland, OH, USA.* 2027

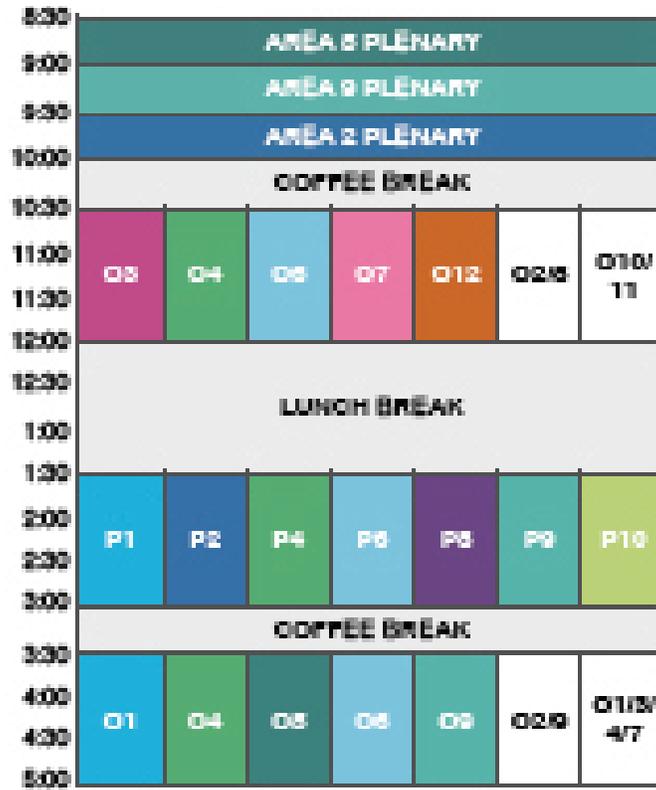
(577-P31) **Measuring PV System Series Resistance Without IV Curves.** Joshua S Stein¹, Shawn McCaslin², Clifford W Hansen¹, William E Boyson¹, Charles D Robinson¹. ¹Sandia National Laboratories, Albuquerque, NM, USA, ²Draker, Burlington, VT, USA. 2032

(578-P33) **CIGS PV Reliability - Current practices, Challenges and Approaches.** Rajalakshmi Sundaramoorthy, David Metacarpa, Jim R Lloyd, Pradeep Haldar. *US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.* 2037

(579-P35) **Desert Applications of PV Modules.** Karl-Anders Weiss, Michael Koehl, Elisabeth Klimm, Karolina Slamova, Timo Lorenz, Jan Herrmann. *Fraunhofer ISE, Freiburg, Germany.* 2043

WEDNESDAY PROGRAM SUMMARY

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	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 5 - Plenary	
8:30 - 9:00 AM	Ballroom 3-4
Thin Film Silicon Based PV Technologies	

Chair(s): Franz-Josef Haug

- 8:30 **(580) Blazing New Paths to High Efficiency Amorphous Silicon Based Solar Modules**
 Jun Lin¹, Julian Cashmore², Takashi Iwahashi¹, Junpei Sakurai¹, Paolo Losio², Jean Baptiste Orhan³, Jochen Hoetzel², Sergej Ristau², Yukimasa Saito¹, Akihiro Tsuji¹, Tobias Roschek², Johannes Meier³, Ivan Sinicco², Arno Zindel², Hiroaki Hayashi¹, Daisuke Matsunaga¹
¹Tokyo Electron Ltd., Tokyo, Japan, ²TEL Solar AG, Trubbach, Switzerland, ³TEL Solar-Lab SA, Neuchatel, Switzerland N/A

Area 9 - Plenary	
9:00 - 9:30 AM	Ballroom 3-4
PV Modules and Manufacturing	

Chair(s): Pierre Verlinden, Joshua Stein

- 9:00 **(581) Energy Modelling and Rating**
 Steve Ransome
 SRCL, Kingston upon thames, UK 2047

Area 2 - Plenary	
9:30 - 10:00 AM	Ballroom 3-4
Chalcogenide Thin Film Solar Cells	

Chair(s): Susanne Siebentritt

- 9:30 **(582) Thin Film Chalcogenide PV: Progress in Research Breakthroughs and Industrial Developments**
 Ayodhya N. Tiwari^{1,2}
¹Empa, Swiss Federal Laboratories for Materials Science and Technology, Duebendorf, Switzerland, ²Flisom, Duebendorf, Switzerland N/A

10:00 - 10:30 AM	Exhibit Hall D
Coffee Break	

Joint Session: Areas 2,8 - Orals

10:30 - 12:00 PM

MR 502-504

Characterisation Methods for CIGS Solar Cells

Chair(s): Wyatt Metzger, Alex Redinger

- 10:30 **(583) Characterization of internal interfaces in Cu(In,Ga)Se₂ thin-film solar cells using correlative microscopies (special invited speaker)**
 Oana Cojocaru-Mlrédin¹, Daniel Abou-Ras², Roland Wuerz³, Rodrigo Saez-Araoz², Christian-Herbert Fischer², Dierk Raabe¹
¹Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany, ²Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, ³Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Stuttgart, Germany N/A
- 11:00 **(584) Quantitative micrometric imaging of thin films solar cells properties using Cu(In,Ga)Se₂ microcells**
 Laurent Lombez^{1,2,3}, Myriam Paire^{1,2,3}, Amaury Delamarre^{1,2,3}, Gilbert El-Hajje^{1,2,3}, Daniel Ory^{1,2,3}, Daniel Lincot^{1,2,3}, jean-françois Guillemoles^{1,2,3}
¹Institute for Research and Development on Photovoltaic Energy (IRDEP), EDF R&D, chatou, France, ²IRDEP, CNRS, Chatou, France, ³IRDEP-Chimie Paristech, Paris, France 2053
- 11:15 **(585) Electroluminescence intensity analysis of neutral bulk and space charge region collection effects on large area CIGS module performance**
 Guozhen Yue, Dingyuan Lu, Bernie Cheng, Baosheng Sang, B.J. Stanbery
 HelioVolt Corporation, 6301-8 Stassney Lane, Austin, TX, USA 2056
- 11:30 **(586) Real Time Spectroscopic Ellipsometry Analysis of the Three-Stages of CuIn_{1-x}Ga_xSe₂ co-Evaporation**
 Puja Pradhan¹, Puruswottam Aryal¹, Abdel R Ibdah¹, Krishna Aryal², Jian Li¹, Nikolas J Podraza¹, Sylvain Marsillac², Robert W Collins¹
¹The University of Toledo, Toledo, OH, USA, ²Old Dominion University, Norfolk, VA, USA 2060
- 11:45 **(587) Charge Carrier Mobilities and Dynamics in Thin Film Compound Semiconductor Materials from Transient Thz Absorption**
 Hannes Hempel, Christian Strothkämper, Christian Kaufmann, Justus Just, Rainer Eichberger, Thomas Unold
 Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany 2066

Joint Session: Areas 10,11 - Orals

10:30 - 12:00 PM

MR 505-507

System Grid Integration

Chair(s): Michael Coddington, Chris Barker

- 10:30 **(588) The Economic Value of Forecasts for Optimal Curtailment Strategies to Comply with Ramp Rate Rules**
Daniel Cormode, Antonio Lorenzo, William Holmgren, Sophia Chen, Alex Cronin
University of Arizona, Tucson, AZ, USA 2070
- 10:45 **(589) Clustering Distribution Feeders in the Arizona Public Service Territory**
James Cale¹, Bryan Palmintier¹, Dave Narang², Kevin Carroll²
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Arizona Public Service, Phoenix, AZ, USA 2076
- 11:00 **(590) Examining System-Wide Impacts of Solar PV Control Systems with a Power Hardware-in-the-Loop Platform**
Tess Williams¹, Jason Fuller¹, Kevin Schneider¹, Bryan Palmintier², Blake Lundstrom², Sudipta Chakraborty²
¹Pacific Northwest National Laboratory, Richland, WA, USA, ²National Renewable Energy Laboratory, Golden, CO, USA 2082
- 11:15 **(591) Feeder Model Validation and Simulation for High-Penetration PV Deployment in the Arizona Public Service System**
Murali Baggu¹, Raja Ayyanar², David Narang³
¹National Renewable Energy Laboratory, Golden, CA, USA, ²Arizona State University, Phoenix, AZ, USA, ³Arizona Public Service, Phoenix, AZ, USA 2088
- 11:30 **(592) Evaluation of Reactive Power Control Capabilities of Residential PV in an Unbalanced Distribution Feeder**
John Seuss¹, Matthew J Reno^{1,2}, Ronald G Harley¹, Robert J Broderick²
¹Georgia Institute of Technology, Atlanta, GA, USA, ²Sandia National Laboratories, Albuquerque, NM, USA 2094
- 11:45 **(593) Verification of Protective Device Coordination in Distribution Systems with Photovoltaic Generation**
Yingying Tang, Raja Ayyanar
Arizona State University, Tempe, AZ, USA 2100

Area 3 - Orals

10:30 - 12:00 PM

Ballroom 1CD

Low Concentration Solar Cells and Receivers

Chair(s): Adam Plesniak, Pablo Garcia-Linares

- 10:30 **(594) Industrially Feasible All-Purpose Metal-Wrap-Through Concentrator Solar Cells**
Tobias Fellmeth¹, Raphael Efinger¹, Matthieu Ebert¹, Ingrid Hädrich¹, Florian Clement¹, Daniel Biro¹, Pablo Noriega², sebastian Caparros², Fernando Castano²
¹Fraunhofer ISE, Heidenhofstr. 2, 79110 Freiburg im Breisgau, Germany, ²Abengoa Solar New Technologies, Soland Center, Sanlucar la Mayor, 41800 Sevilla, Spain 2106
- 10:45 **(595) A Low Concentration Receiver Concept for Cost Effective Crystalline Back Contact Cells**
Matthieu Ebert¹, Tobias Dörsam¹, Tobias Fellmeth¹, Ingrid Hädrich¹, Ulrich Eitner¹, Daniel Biro¹, Maik Wiesenfarth¹, Pablo Noriega², Sebastian Caparros², Fernando Castano²
¹Fraunhofer ISE, Freiburg, Germany, ² Abengoa Solar New Technologies, Sevilla, Spain 2111
- 11:00 **(596) Ultra-Thin Defect-Tolerant High Efficiency III-V Tandems for Development of Low-Cost Photovoltaics.**
Alex Freundlich, Akhil Mehrotra, Manori V. Gunasekera, Gopi K. Vijaya
University of Houston, Houston, TX, USA 2117
- 11:15 **(597) Hybrid Micro-scale CPV/PV Architecture**
Michael W. Haney, Tian Gu, Gautam Agrawal
University of Delaware, Newark, DE, USA 2122
- 11:30 **Best Student Presentation Award Finalist (598) Epitaxial lift-off processed GaAs thin-film solar cells integrated with low-cost plastic mini-compound parabolic concentrators**
Kysang Lee¹, Jaesang Lee¹, Bryan A. Mazor², Stephen R. Forrest^{1,2,3}
¹Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA, ²Department of Physics, University of Michigan, Ann Arbor, MI, USA, ³Department of Material Science and Engineering, University of Michigan, Ann Arbor, MI, USA 2127
- 11:45 **(599) Analysis of GaAs Solar Cells at High MOCVD Growth Rates**
Kenneth J Schmieder¹, Michael K Yakes¹, Christopher G Bailey¹, Ziggy Pulwin², Louise C Hirst¹, Matthew P Lumb³, Maria Gonzalez⁴, Seth M Hubbard⁵, Chris Ebert², Robert J Walters¹
¹U.S. Naval Research Laboratory, Washington, DC, USA, ²Veeco MOCVD, Somerset, NJ, USA, ³George Washington University, Washington, DC, USA, ⁴Sotera Defense Solutions, Annapolis Junction, MD, USA, ⁵Nanopower Research Labs, Rochester Institute of Technology, Rochester, NY, USA 2130

Area 4 - Orals	
10:30 - 12:00 PM	Ballroom 1EF
Advanced Cell Structures	

Chair(s): James Gee, Rolf Brendel

- 10:30 **(600) Understanding Manufacturing Cost Influence on Future Trends in Silicon Photovoltaics**
Paul A Basore
pvspecialist@gmail.com, San Mateo, CA, USA N/A
- 11:00 **(601) Towards the Practical Limits of Silicon Solar Cells**
David D. Smith, Peter Cousins, Staffan Westerberg, Russelle De Jesus-Tabajonda, Gerly Aniero, Yu-Chen Shen
SunPower Corp., San Jose, CA, USA N?A
- 11:30 **(602) 20.63 % nPERT Cells and 20% PR Gain Bifacial Module**
Shu-Hung Yu, Chih-Jeng Huang, Po-Tsung Hsieh, Hung-Chih Chang, Wei-Cheng Mo, Chi-Chun Li
Motech Industries, Inc, Tainan, Taiwan, Taiwan 2134
- 11:45 **(603) The BSK cell concept - bifacial operation with double-sided collection**
Fabian Fertig, Karin Krauß, Johannes Greulich, Florian Clement, Daniel Biro, Ralf Preu, Stefan Rein
Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany 2138

Area 6 - Orals	
10:30 - 12:00 PM	Ballroom 2A
OPV Stability	

Chair(s): Jan Gilot, Moritz Riede

- 10:30 **(604) Degradation Mechanisms of Polymer-Based Organic Solar Cells**
Hans-Joachim Egelhaaf
Belectric OPV GmbH, Nuremberg, Germany N/A
- 11:00 **(605) The Effect of Side-Chains on Polymer Solar Cell Stability**
Graham E. Morse¹, Aurélien Tournebize², Agnès Rivaton², Nicolas Blouin¹, Steven Tierney¹
¹Merck Chemicals Ltd., Southampton, UK, ²ICCF, Equipe Photochimie, CNRS, Aubière, France N/A
- 11:15 **(606) Polaron stability in semiconducting polymer neat films**
Daniel S Beatrup¹, James R Durrant¹, Iain McCulloch¹, Hugo Bronstein², Bob Schroeder¹
¹Imperial College London, London, UK, ²University College London, London, UK N/A
- 11:30 **(607) The Stability of Organic Solar Cells Under Highly Damp Conditions – Normal vs. Inverted Cells**
Seunghyup Yoo, Donggeon Han
KAIST, Daejeon, Korea N/A

Area 7 - Orals

10:30 - 12:00 PM

Ballroom 1AB

Space PV Systems

Chair(s): Claus Zimmermann, Justin Likar

- 10:30 **(608) Effect of irradiation on Gallium Arsenide solar cells with multi quantum well structures**
Sergey maximenko¹, Matt Lumb², Raymond Hoheisel², Maria Gonzalez³, David Scheiman¹, Scott Messenger⁴, Tom Tibbits⁵, M Imaizumi⁶, T Ohshima⁷, S.-i. Sato⁷, Philip Jenkins¹, Robert Walters¹
¹Naval Research Laboratory, Washington, DC, USA, ²The George Washington University, Washington, DC, USA, ³Sotera Defense Solutions, Annapolis Junction, MD, USA, ⁴University of Maryland Baltimore County, Baltimore, MD, USA, ⁵formerly QuantaSol Ltd, Kingston-upon-Thames, UK, ⁶Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan, ⁷Japan Atomic Energy Agency (JAEA), Takasaki, Japan 2144
- 10:45 **(609) First Flight Demonstration of Glass-Type Space Solar Sheet**
Kazunori Shimazaki¹, Yuki Kobayashi¹, Masato Takahashi¹, Mitsuru Imaizumi¹, Mio Murashima², Yu Takahashi², Hiroyuki Toyota², Akio Kukita², Takeshi Ohshima³, Shin-ichiro Sato³, Tatsuya Takamoto⁴, Hiroaki Kusawake¹
¹Japan Aerospace Exploration Agency (JAXA), Tsukuba Space Center, Tsukuba, Japan, ²Japan Aerospace Exploration Agency (JAXA), ISAS, Sagamihara, Japan, ³Japan Atomic Energy Agency (JAEA), Takasaki, Japan, ⁴SHARP Corporation, Yamatokoriyama, Japan 2149
- 11:00 **(610) Predicting the Solar Probe Plus Solar Array Output**
Edward M Gaddy¹, Michael H Butler¹, Mary Kae Lockwood¹, Gayle K Martin², Cristina T Vigil², Andreea Boca², Benjamin Richards²
¹Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA, ²Emcore Corporation, Albuquerque, NM, USA 2155
- 11:15 **(611) Realisation of Mars Orbiter Mission (MOM) Solar Array**
Uma B R, Nukaraju R, Krishnapriya G, Sankaran M Power Systems Group, ISRO Satellite Centre, Bangalore, India N/A
- 11:30 **(612) On-orbit Performance Analysis on Solar Array Paddle of X-ray Astronomy Satellite "Suzaku"**
Takanobu Shimada, Hiroyuki Toyota, Kazuyuki Hirose, Yoshitomo Maeda, Kazuhisa Mitsuda Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA), Sagamihara, Japan 2161
- 11:45 **(613) Low Cost Automated Manufacture of High Specific Power Photovoltaic Solar Arrays for Space**
Nicholas Walmsley, Matthew Wrosch, Theodore Stern
Vanguard Space Technologies, Inc., San Diego, CA, USA 2166

Area 12 - Orals

10:30 - 12:00 PM

Ballroom 2B

Correlation of Accelerated Testing with Field Experience

Chair(s): Jeff Newmiller, Bengt Jaeckel

- 10:30 **(614) Evaluation of the Uncertainty in Accelerated Stress Testing**
Michael D. Kempe
National Renewable Energy Laboratory, Golden, CO, USA 2170
- 10:45 **Best Student Presentation Award Finalist (615) Data Science Study Protocols for Investigating Lifetime and Degradation of PV Technology Systems**
Nicholas R Wheeler¹, Abdulkerim Gok², Yifan Xu³, Ian Kidd², Laura S Bruckman², Jiayang Sun³, Roger H French^{1,2}
¹Department of Macromolecular Science and Engineering, Case Western Reserve University, Cleveland, OH, USA, ²Department of Material Science, Case Western Reserve University, Cleveland, OH, USA, ³Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, OH, USA N/A
- 11:00 **(616) Assessment of PV Module Durability Using Accelerated and Outdoor Performance Analysis and Comparisons**
William J. Gambogi¹, Yushi Heta², James G. Kopchick¹, Thomas Felder¹, Steven W. MacMaster¹, Alexander Z. Bradley¹, Babak Hamzavytehrany¹, Bao-Ling Yu¹, Katherine M. Stika¹, T. John Trout¹, Lucie Garreau-Iles³, Oakland Fu⁴, Hongjie Hu⁴
¹DuPont, Wilmington, DE, USA, ²DuPont K. K., Utsunomiya, Japan, ³Du Pont de Nemours International S.A., Meyrin, Switzerland, ⁴DuPont (China) R&D Center, Shanghai, China 2176
- 11:15 **(617) Trial Run of a Junction-Box Attachment Test for Use in Photovoltaic Module Qualification**
David M Miller, Scott L Deibert, John H Wohlgemuth
National Renewable Energy Laboratory, Golden, CO, USA 2182
- 11:30 **(618) A Comparison of Accelerated Degradation Test by a UV Pulse Laser and Fluorescence Tubes for EVA Films**
Yu-Tai Li¹, Bo-Fang Wang², Yu-Hsien Lee¹, Cho-Fan Hsieh¹, Hung-Sen Wu¹, Der-ray Huang²
¹Industrial Technology Research Institute, HsinChu, Taiwan, ²Department of Opto-Electronic Engineering, National Dong Hwa University, Hualien, Taiwan 2188
- 11:45 **(619) Development of Comparative Tests of PV Modules by the International PV Module QA Task Force**
John H Wohlgemuth¹, Sarah R. Kurtz¹, Tony Sample², Masaaki Yamamichi³, Michio Kondo³
¹NREL, Golden, CO, USA, ²JRC, Ispra, Italy, ³AIST, Tsukuba, Japan 2191

TECHNICAL PROGRAM

WEDNESDAY AM

Area 1 - Posters

1:30 - 3:00 PM

Exhibit Hall D

Light Management for Enhanced Solar Cell Performance

Chair(s): Albert Polman, Jacob J. Krich, Gregory Nielson

(620-A3) **Broad Band Absorption Silicon Nanowire Array Using Diverse Radii for Photovoltaic Applications.** OMAR AL Zoubi¹, Hameed Naseem^{1,2}. ¹*Department of Electrical Engineering, Fayetteville, AR, USA,* ²*Arkansas GREEN Research Center for Solar Cells, Fayetteville, AR, USA.* 2197

(621-A6) **Nanostructured Window Layer – A New Approach to Design Nanostructured Solar Cells.** Yusi Chen¹, Yangsen Kang¹, Yijie Huo¹, Dong Liang², Li Zhao³, Jieyang Jia¹, Jeremy Kim¹, Leon Yao¹, Jeremy Bregman¹, James S. Harris^{1,3,4}. ¹*Department of Electrical Engineering, Stanford University, Stanford, CA, USA,* ²*Department of Physics, Stanford University, Stanford, CA, USA,* ³*Department of Material Science and Engineering, Stanford University, Stanford, CA, USA,* ⁴*Department of Applied Physics, Stanford University, Stanford, CA, USA.* 2202

(622-A9) **Silicon nano-fabrication by using silica nanosphere lithography technique for enhanced light management.** Jeayoung Choi, Christiana. B. Honsberg. *Arizona State University, Tempe, AZ, USA* 2206.

(623-A12) **Efficiency Enhancement in Thin-Film c-Si HIT Cells using Luminescent 2.85 nm Silicon Nanoparticles.** Farsad I. Chowdhury, Aasha Alnuaimi, Kazi Islam, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Masdar Institute of Science and Technology, P.O. Box 54224, Abu Dhabi, United Arab Emirates.* 2209

(624-A15) **Spectrum Splitting Double-Cell Scheme for Solar Photovoltaics.** Alexander Dorodnyy¹, Valery Shklover², Leonid Braginsky^{2,3}, Christian Hafner¹, Juerg Leuthold¹. ¹*Institute of Electromagnetic Fields, ETH, Zurich, Switzerland,* ²*Laboratory of Crystallography, ETH, Zurich, Switzerland,* ³*Institute of Semiconductor Physics, Novosibirsk State University, Novosibirsk, Russia.* 2214

(625-A18) **Hybrid Approach Simulations for Light Propagation Problems.** Alexander Dorodnyy¹, Valery Shklover², Christian Hafner¹, Juerg Leuthold¹. ¹*Institute of Electromagnetic Fields, ETH, Zurich, Switzerland,* ²*Laboratory of Crystallography, ETH, Zurich, Switzerland.* 2220

(626-A21) **Design Improvements for Polyhedral Specular Reflector Spectrum-Splitting Module for Ultra-High Efficiency (>50%).** Carissa N. Eisler, Emily D. Kosten, Emily C. Warmann, Harry A. Atwater. *Caltech, Pasadena, CA, USA.* 2224

(627-A24) **A Study into Sensitizing Cerium with Silicon Nanocrystals for Down Shifting Applications.** Daniel R Frisina¹, Ahmed M Gabr², Justin Sacks¹, Karen Hinzer², Peter Mascher¹, Rafael, N Kleiman¹. ¹*McMaster University, HAMILTON, ON, Canada,* ²*SUNLAB, OTTAWA, ON, Canada.* N/A

(628-A27) **Optimization of Bifacial Cells for Upconversion Applications.** Ahmed M Gabr¹, Anna H. Trojnar¹, Matthew Wilkins¹, Trevor J Hall¹, Rafael N. Kleiman², Karin Hinzer¹. ¹*University of Ottawa, Ottawa, ON, Canada,* ²*McMaster University, Hamilton, ON, Canada.* 2230

(629-A30) **Texturing Low Reflecting Surface of Random Double Inverted Pyramids Using N-fluoropyridinium Salt.** Tatsuya Kumada¹, Kentaro Kawai¹, Masaki Otani¹, Toshinori Hirano¹, Takabumi Nagai², Kenji Adachi², Kenta Arima¹, Mizuho Morita¹. ¹Osaka University, Osaka, Japan, ²Daikin Industries, Ltd., Osaka, Japan. 2234

(630-A33) **Integrated Optical Nanostructures for Wide-angle Antireflection and Light Trapping in III/V Solar Cells.** Xiaohan Li¹, Ping-Chun Li¹, Dongzhi Hu², Daniel Schaad², Chris Stender³, Clay McPheeters³, Rao Tatavarti³, Kimberly Sablon⁴, Edward T Yu¹. ¹University of Texas at Austin, Austin, TX, USA, ²Technische Universität Clausthal, Clausthal-Zellerfeld, Germany, ³Microlink Devices, Inc., Niles, IL, USA, ⁴U. S. Army Research Laboratory, Adelphi, MD, USA. 2238

(631-A36) **Theoretical Modeling on Luminescent Down-Shifting Process: A Discussion on Luminescent Molecule Design.** Yilin Li, Wen-Ji Dong. School of Chemical Engineering and Bioengineering, Washington State University, Pullman, WA, USA. 2243

(632-A39) **Ray Trace Optimization of Light Trapping Filtered Concentrator.** John V. Lloyd, Emily D. Kosten, Emily C. Warmann, Cristofer A. Flowers, Harry A. Atwater. California Institute of Technology, Pasadena, CA, USA. 2249

(633-A42) **Irregular Metal Nanocavity for Efficient Near Band-edge Light-trapping in Organic and Inorganic Photovoltaic Materials.** Zingway Pei^{1,2,3}, B. Parvathy Devi¹, Subramani Thiyagu¹. ¹Department of Electrical Engineering, National Chung Hsing University, Taichung, Taiwan, ²Graduate Institute of Optoelectronic Engineering, National Chung Hsing University, Taichung, Taiwan, ³Nanoscience and Nanotechnology Research Center, National Chung Hsing University, Taichung, Taiwan. 2253

(634-A45) **Comparison of Dispersive and Non-Dispersive Spectrum Splitting Techniques for Photovoltaic Systems.** Juan M Russo¹, Shelby D Vorndran², Yuechen Wu¹, Raymond K Kostuk^{1,2}. ¹University of Arizona Dept. of Electrical Computer Engineering, Tucson, AZ, USA, ²University of Arizona College of Optical Sciences, Tucson, AZ, USA. 2257

(635-A48) **Proof of Down-Conversion by CdSe/ZnS Quantum Dots on Silicon Solar Cells.** Bahareh Sadeghimakki^{1,2}, Siva Sivorththaman^{1,2}. ¹Centre for Advanced Photovoltaic Devices and Systems, Waterloo, ON, Canada, ²Electrical and Computer Engineering Department, Waterloo, ON, Canada. 2262

(636-B3) **Plasmonic Light Trapping in Ultrathin Single Crystal Silicon Membrane for Solar Cells Application.** Manisha Sharma, Pushpa Raj Pudasaini, Arturo A Ayon. The University of Texas at San Antonio, San Antonio, TX, USA. 2267

(637-B6) **Surface Plasmon Polariton Enhanced Upconversion in Rare Earth Doped Nano Crystals on Plasmonic Substrates.** Steve Smith. South Dakota School of Mines and Technology, Rapid City, SD, USA. 2270

(638-B9) **Investigation of Moth-Eye Antireflection Coatings for Photovoltaic Cover Glass Using FDTD Modeling Method.** Corey S. Thompson, Min Zou. University of Arkansas, Fayetteville, AR, USA. 2273

(639-B12) **Luminescent Solar Concentrators: the route to 10% efficiency.** Wilfried G.J.H.M. van Sark¹, Zachar Krumer², Celso de Mello Donegá², Ruud E.I. Schropp^{3,4}. ¹*Utrecht University, Copernicus Institute, Utrecht, Netherlands*, ²*Condensed Matter and Interfaces, Debye Institute, Utrecht, Netherlands*, ³*Solar Energy, Energy Research Center of the Netherlands, Eindhoven, Netherlands*, ⁴*Plasma & Materials Processing, Department of Applied Physics, Eindhoven University of Technology, Eindhoven, Netherlands*. 2276

(640-B15) **Cylindrical and Square Fibre Luminescent Solar Concentrators: Experimental and Simulation Comparisons.** Jose J.H. Videira¹, Amanda J. Chatten¹, Emiliano Bilotti². ¹*Imperial College London, London, UK*, ²*Queen Mary University of London, London, UK*. 2280

(641-B18) **Buried PN Junction Nanopillar Solar Cell: A Novel Approach to Suppress Recombination Loss in Surface Nanostructure.** Keiji Watanabe, Mieko Matsumura, Takashi Hattori, Taro Osabe, Yasuhiro Shimamoto. *Central Research Laboratory, Hitachi Ltd., Tokyo, Japan*. 2286

Area 2 - Posters	
1:30 - 3:00 PM	Exhibit Hall D
CdTe and CZTS	

Chair(s): Hugh Hillhouse, Edgardo Saucedo, Sylvain Marsillac

(642-B28) **High Efficiency Flexible CdTe Superstrate Devices.** Teresa M. Barnes¹, Will L. Rance¹, James M. Burst¹, Matthew O. Reese¹, Daniel M. Meysing², Colin A. Wolden², Timothy A. Gessert¹, Sean M. Garner³, Pat Cimo³, Wyatt K. Metzger¹. ¹*NREL, Golden, CO, USA*, ²*Colorado School of Mines, Golden, CO, USA*, ³*Corning, Inc., Corning, NY, USA*. 2289

(643-B31) **Performance of Nanocrystalline Iron Pyrite as the Back Contact to CdS/CdTe Solar Cells.** Khagendra P. Bhandari, Rajendra R. Khanal, Naba R. Paudel, Prakash Koirala, Tyler Kinner, Yanfa Yan, Robert W. Collins, Michael J. Heben, Randy J. Ellingson. *Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, The University of Toledo, Toledo, OH, USA*. 2293

(644-B34) **Junction Formation and Interface Studies in CZTSe Solar Cells.** Brion Bob¹, Jian V. Li², Carolyn Beall², Jeff Carapella², Clay DeHart², Yang Yang¹, Ingrid L. Repins². ¹*University of California, Los Angeles, Los Angeles, CA, USA*, ²*National Renewable Energy Laboratory, Golden, CO, USA*. 2299

(645-B37) **Congruent Evaporation of Tin (II) Sulfide for Solar Cell Applications.** Rupak Chakraborty¹, Vera Steinmann¹, Rafael Jaramillo¹, Katy Hartman¹, Riley E. Brandt¹, Helen Hejin Park², Jeremy Poindexter¹, Yun Seog Lee¹, Roy G. Gordon², Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA*, ²*Harvard University, Cambridge, MA, USA*. 2304

(646-B40) **Two Ideal Compositions for Kesterite-Based Solar Cell Devices: Maximizing Independently VOC and JSC.** Mirjana Dimitrievska¹, Andrew Fairbrother¹, Alejandro Perez-Rodriguez^{1,2}, Victor Izquierdo-Roca¹, Edgardo Saucedo¹. ¹*IREC, Barcelona, Spain*, ²*IN2UB, Barcelona, Spain*. 2307

(647-B43) **CdTe Single-Crystal Wafer Heterojunction Photovoltaic Cells.** Joel N. Duenow, James M. Burst, David S. Albin, Anna Duda, Clay M. DeHart, Wyatt K. Metzger. *National Renewable Energy Laboratory, Golden, CO, USA*. 2310

(648-B46) **CZTS solar cells fabricated by fast sulfurization of sputtered Sn/Zn/Cu precursors under H₂S atmosphere.** Amin Emrani, Tara P. Dhakal, Charles R. Westgate. *Center for Autonomous Solar Power (CASP), SUNY-Binghamton, Binghamton, NY, USA.* 2314

(649-C1) **Rapid thermal processing of Cu₂ZnSnSe₄ thin films.** Andrew Fairbrother¹, Lionel Fourdrinier², Xavier Fontané¹, Victor Izquierdo-Roca¹, Mirjana Dimitrievska¹, Fabrizio Maseri², Alejandro Pérez-Rodríguez^{1,3}, Edgardo Saucedo¹. ¹*Catalonia Institute for Energy Research (IREC), Sant Adrià del Besòs-Barcelona, Spain,* ²*AC&CS – CRM Group, Liege, Belgium,* ³*IN2UB, Universitat de Barcelona, Barcelona, Spain.* 2317

(650-C4) **ZnTe:Cu Film Properties and Their Impact on CdS/CdTe Devices.** Brooke R Faulkner¹, James M Burst², Timothy R Ohno¹, Craig L Perkins², Bobby To², Timothy A Gessert². ¹*Colorado School of Mines, Golden, CO, USA,* ²*National Renewable Energy Laboratory, Golden, CO, USA.* 2321

(651-C7) **Study of RF sputtered Cu₃SbS₄ Thin-film Solar Cells.** Nicholas D. Franzer, Naba R. Paudel, Chuanxiao Xiao, Yanfa Yan. *University of Toledo, Toledo, OH, USA.* 2326

(652-C10) **Analysis of ZnTe:Cu/Ti Contacts for Crystalline CdTe.** Timothy A. Gessert, Joel N. Duenow, Scott Ward, Bobby To. *National Renewable Energy Laboratory, Golden, CO, USA.* 2329

(653-C13) **Study of recombination process in Cu₂ZnSnS₄ thin film using two-wavelength excited photoluminescence.** Mohammad Abdul Halim¹, Muhammad Monirul Islam¹, Xianjia Luo¹, Chong Xu¹, Takeaki Sakurai¹, Noriyuki Sakai², Takuya Katou², Hiroki Sugimoto², Hitoshi Tampo³, Hajime Shibata³, Shigeru Niki³, Katsuhiro Akimoto¹. ¹*Tsukuba University, Tsukuba, Japan,* ²*Showa Shell Sekiyu KK, Minato, Japan,* ³*National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan.* 2334

(654-C16) **Heteroepitaxial Growth of CZTS.** Steven P Harvey¹, Craig Perkins¹, Matthew Young¹, helio moutinho¹, Andrew Norman¹, Samuel Wilson², Glenn Teeter¹. ¹*National Renewable Energy Laboratory, Golden, CO, USA,* ²*University of Florida, Gainesville, FL, USA.* 2338

(655-C19) **Controlled electrodeposition of Cu-Zn-Sn thin films for highly efficient CZTS_{Se} thin films solar cells.** Jong-Ok Jeon^{1,2}, Jin Young Kim^{1,2,3}. ¹*Photo-electronic Hybrids Research Center, Korea Institute of Science and Technology (KIST), Seoul, South Korea,* ²*Department of Nanomaterials Science and Engineering, University of Science and Technology (UST), Daejeon, South Korea,* ³*Green School, Korea University, Seoul, South Korea.* N/A

(656-C22) **Stoichiometric Effects in Polycrystalline CdTe.** Md Imran Khan¹, Vamsi Evani¹, Shamara Collins¹, Prasad Bane¹, Sara Bakhshi¹, Vishal Kendre¹, Vasilis Palekis¹, Sergiu Vatavu², Don Morel¹, Chris Ferekides¹. ¹*University of South Florida, Tampa, FL, USA,* ²*Moldova State University, Chisinau, Moldova.* 2343

(657-C25) **Semiconducting Carbon Single-walled Nanotubes as a Cu-Free, Barrier-Free Back Contact for CdTe Solar Cell.** Rajendra R Khanal¹, Adam B Phillips¹, Zhaoning Song¹, Victor V Plotnikov², Chad W Carter², John M Stayancho², Michael J Heben¹. ¹*Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, School of Solar and Advanced Renewable Energy, University of Toledo, Toledo, OH, USA,* ²*Lucintech Incorporated, Toledo, OH, USA.* 2348

(658-C28) **Investigation of Passivation Treatment of Cd_{1-x}Mg_xTe Thin Films for Possible Application in High Efficiency Cells.** Pavel S. Kobayakov¹, Drew E. Swanson¹, Carey Reich¹, Jennifer Drayton², W.S. Sampath¹. ¹*Department of Mechanical Engineering, Colorado State University, Fort Collins, CO, USA*, ²*Department of Physics, Colorado State University, Fort Collins, CO, USA*. N/A

(659-C31) **Doped a-Si_{1-x}C_x:H as a Novel Back Contact Material for CdTe Solar Cells.** Prakash Koirala¹, Zhiquan Huang¹, Xinxuan Tan¹, Maxwell Junda¹, Nikolas J Podraza¹, Sylvain Marsillac², Anjus A Rockett³, Robert W Collins¹. ¹*The University of Toledo, Toledo, OH, USA*, ²*Old Dominion University, Norfolk, VA, USA*, ³*University of Illinois Urbana-Champaign, Urbana, IL, USA*. 2354

(660-C34) **Rapid thermal processing of ZnTe:Cu contacted CdTe solar cells.** Jiaojiao Li, Colin Wolden. *Colorado School of Mines, Golden, CO, USA*. 2360

(661-C37) **Photocapacitance Measurements and Photocarrier Mobilities in CdTe Thin Film Solar Cells.** Qi Long¹, Daniel A. Goldman¹, Steluta A. Dinca¹, Eric A. Schiff¹, Jeremy Theil², Ming Yu². ¹*Syracuse University, Syracuse, NY, USA*, ²*First Solar Inc., Santa Clara, CA, USA*. N/A

(662-C40) **Defect Studies of Cu₂ZnSn(S,Se)₄ Thin Film Solar Cells with Different Cu/Sn Ratios by Admittance Spectroscopy.** Xianjia Luo¹, Muhammad Monirul Islam¹, Mohammad Abdul Halim¹, Chong Xu¹, Takeaki Sakurai¹, Noriyuki Sakai², Takuya Kato², Hiroki Sugimoto², Hitoshi Tampo³, Hajime Shibata³, Shigeru Niki³, Katsuhiko Akimoto¹. ¹*Institute of Applied Physics, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki, 305-8573, Japan*, ²*Energy Solution Business Center, Showa Shell Sekiyu K.K., 2-3-2 Daiba, Minato-ku, Tokyo 135-8074, Japan*, ³*National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan*. 2366

(663-C43) **Impact of Humidity Exposure during Device Fabrication on CZTSSe Solar Cell Performance.** Irina Malajovich, Yanyan Cao, Jonathan V. Caspar, Qijie Guo, Lynda K. Johnson, Boheng Ma, Kaushik Roy Choudhury, Dennis J. Walls, Wei Wu. *E. I. DuPont de Nemours, Wilmington, DE, USA*. 2370

(664-C46) **A Path to 10 % Efficiency in Tin Sulfide Solar Cells.** Niall Mangan¹, Riley E. Brandt¹, Vera Steinmann¹, Rafael Jaramillo¹, Jian V. Li², Helen Hejin Park³, Leizhi Sun³, Roy G. Gordon³, Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA*, ²*National Renewable Energy Laboratory, Golden, CO, USA*, ³*Harvard University, Cambridge, MA, USA*. 2373

(665-D1) **Epitaxial Growth of CZTS on Si Substrates Investigated with Electron Backscattered Diffraction.** Helio Moutinho, Matthew Young, Steve Harvey, Chun-Sheng Jiang, Craig Perkins, Samuel Wilson, Mowafak Al-Jassim, Ingrid Repins, Glenn Teeter. *National Renewable Energy Laboratory, Golden, CO, USA*. 2379

(666-D4) **Calculation of Defect Concentrations in Cu₂ZnSnS₄ from Stoichiometry.** Daniel Mutter, Scott T. Dunham. *University of Washington, Department of Electrical Engineering, Seattle, WA, USA*. 2384

(667-D7) **Formation Energies of Carbon related Defects in Cu₂ZnSnS₄.** Daniel Mutter, Scott T. Dunham. *University of Washington, Department of Electrical Engineering, Seattle, WA, USA*. 2390

(668-D10) **Effect of band gap grading on the performance characteristics of Cu₂ZnSnS₄ solar cell.** Muteeu A. Olopade, Adeyinka D. Adewoyin, Deborah O. Olorode, Michael A. Chendo. *Department of Physics, University of Lagos, Akoka, Lagos, Nigeria.* 2394

(669-D13) **High Throughput Laser Processing for the Formation of Ohmic Contacts to CdTe Solar Cells.** Vasilios Palekis¹, Brian J. Simonds², Md Khan¹, Vamsi Evani¹, Michael A. Scarpulla², Chris Ferekides¹. ¹*University of South Florida, Tampa, FL, USA,* ²*University of Utah, Salt Lake City, UT, USA.* N/A

(670-D16) **Valence Band Offset at MoO₃/CdTe Interface Probed by X-ray Photoelectron Spectroscopy.** Naba R Paudel, Yanfa Yan. *Department of Physics & Astronomy, University of Toledo, Toledo, OH, USA.* 2397

(671-D19) **Thin Film Iron Pyrite Synthesized by Sulfurization of Iron Oxide for Application in Photovoltaics.** Pravakar P Rajbhandari^{1,3}, Tara P Dhakal^{1,3}, Anju Sharma^{2,3}, Charles R Westgate^{1,3}. ¹*Center for Autonomous Solar Power, Binghamton, NY, USA,* ²*Small Scale Systems Integration and Packaging (S3IP) Center, Binghamton, NY, USA,* ³*Binghamton University, State University of New York, Binghamton, NY, USA.* 2400

(672-D22) **Nitrogen Doped Chalcopyrites as Contacts to CdTe Photovoltaics.** Angus Rockett¹, Thomas Erickson¹, Zhengfeng Wang¹, Krishna Aryal², Sylvain Marsillac², Prakash Koirala³, Robert Collins³. ¹*University of Illinois Urbana-Champaign, Urbana, IL, USA,* ²*Dept. of Electrical & Computer Engineering, Old Dominion Univ., Norfolk, VA, USA,* ³*Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA.* 2404

(673-D25) **Te-rich CdTe Surface by Pulsed UV Laser Treatment for Ohmic Back Contact Formation.** Brian J. Simonds¹, Vasilios Palekis², Brian Van Devener³, Christos Ferekides², Michael A. Scarpulla¹. ¹*Materials Science and Engineering, University of Utah, Salt Lake City, UT, USA,* ²*Electrical Engineering, University of South Florida, Tampa, FL, USA,* ³*University of Utah, Salt Lake City, UT, USA.* 2407

(674-D28) **Exploring the Potential for High-quality Epitaxial CdTe Solar Cells.** Tao Song^{1,2}, Ana Kanevce², James R. Sites¹. ¹*Department of Physics, Colorado State University, Fort Collins, CO, USA,* ²*National Renewable Energy Laboratory, Golden, CO, USA.* 2412

(675-D31) **Epitaxial Growth of Cu₂ZnSnS₄ by Radio Frequency Magnetron Sputtering.** Ning Song¹, Xiaojing Hao², Martin Green³. ¹*SPREE, UNSW, Sydney, Australia,* ²*SPREE, UNSW, Sydney, Australia,* ³*SPREE, UNSW, Sydney, Australia.* N/A

(676-E2) **Characterization of Nanocrystal-Ink based CZTSSe and CIGSSe Solar Cells using Voltage-dependent Admittance Spectroscopy.** Xingshu Sun¹, Charles J. Hages², Nathaniel J. Carter², James E. Moore¹, Rakesh Agrawal², Mark Lundstrom¹. ¹*Purdue University School of Electrical and Computer Engineering, West Lafayette, IN, USA,* ²*Purdue University School of Chemical Engineering, West Lafayette, IN, USA.* 2416

(677-E5) **Study of defects in CdTe heterostructures using imaging confocal photoluminescence and photoluminescence intensity measurements.** Craig H. Swartz¹, Odille C. Noriega¹, Pathiraja A Jayathilaka¹, Madhavie Edirisooriya¹, Xin-Hao Zhao², Michael J. DiNezza², Shi Liu², Yong-Hang Zhang², Thomas H. Myers¹. ¹*Texas State University, San Marcos, TX, USA,* ²*Arizona State University, Tempe, AZ, USA.* 2419

(678-E8) **Crystallization behavior of Cu₂ZnSn(S_xSe_{1-x})₄ absorbers processed from sputtered Cu₂ZnSnS₄ precursors under different selenization conditions.** Solange Temgoua, Romain Bodeux, Sebastien Delbos, Negar Naghavi. *Institute of Research and Development on Photovoltaic Energy, Chatou, France.* 2425

(679-E11) **CdTe solar cells using combined ZnS/CdS window layers.** Chuanxiao Xiao, Naba. R Paudel, Corey. R Grice, Yue Yu, Yanfa Yan. *The University of Toledo, Toledo, OH, USA.* 2428

(680-E14) **The Effect of Secondary phases on Cu₂ZnSn(S,Se)₄ based Solar Cell.** Hyesun Yoo¹, Robert Lechner², Stefan Jost², Jörg Palm², Arnaud Verger³, Anne Lelarge³, Virginie Moreau³, Corinne Papret³, Rainer Hock¹. ¹University of Erlangen-Nürnberg, Erlangen, Germany, ²AVANCIS GmbH, München, Germany, ³Saint-Gobain Recherche, Aubervilliers, France. 2431

(681-E17) **Comparison of Cu-Sn-S and Cu-Sb-S as potential solar cell absorbers.** Andriy Zakutayev¹, Lauryn L. Baranowski^{1,2}, Adam W. Welch^{1,2}, Colin A. Wolden², Eric S. Toberer^{1,2}. ¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado School of Mines, Golden, CO, USA. 2436

(682-E18) **Towards Model-Guided Defect Reduction in Cd_{1-x}Zn_xTe/CdS Solar Cells: Development of Molecular Dynamics Models.** Xiaowang Zhou¹, Jose Juan Chavez², Jose Luis Cruz-Campa¹, David Zubia². ¹Sandia National Laboratories, Livermore, CA, USA, ²University of Texas at El Paso, El Paso, NM, USA. 2439

Area 4 - Posters

1:30 - 3:00 PM

Exhibit Hall D

Contacts and Analysis

Chair(s): Keith Mcintosh, Kyumin Lee, Kirsten Cabanas-Holmen

(683-G1) **A simplified expression for optical absorbance in Si solar cells.** Luigi Abenante. *ENEA, ROMA, Italy.* 2443

(684-G5) **Enhanced performance core-shell Si/CdS nanowires heterojunction solar cell device.** Alaa A. AL-Hilo^{1,2}, Muatez Z. Mohammed¹, Johnathan C. Armstrong¹, Tar-Pin Chen¹. ¹University of Arkansas at Little Rock and Green Solar cell Research Center, Little Rock, AR, USA, ²University of Basrah, Basrah, Iraq. 2447

(685-G9) **Fine Texture for Front Surface Fine Lines with Screen Printing.** Mari Aoki¹, Kyotaro Nakamura², Isao Sumita¹, Tomihisa Tachibana¹, Yasushi Kawata³, Hironori Sato³, Yoshio Ohshita¹. ¹Toyota Technological Institute, Nagoya, Japan, ²Meiji University, Kawasaki, Japan, ³Y.A.C. Co., Ltd., Akishima, Japan. 2452

(686-G13) **A Critical Analysis on the Role of Back Surface Passivation for a-Si/c-Si Heterojunction Solar Cells.** Nithin Chatterji¹, Sanchit Khatavkar¹, Cristobal Voz², A. Morales Vilches², J. Puigdollers², B. M. Arora¹, Aldrin Antony³, Pradeep R Nair¹. ¹Dept. of Electrical Engineering, IIT Bombay, Mumbai, India, ²Grup de Recerca en Micro i Nanotecnologies, Dept d'Enginyeria Electronica, Universitat Politecnica De Catalunya, Barcelona, Spain, ³Dept. of Energy Science and Engineering, IIT Bombay, Mumbai, India. 2456

(687-G17) **Investigation of Rear SiOx/SiNx Passivated Solar Cells Under Low Irradiance Intensities.** Wei-Chih Cheng, Jun-Rui Huang, Kuo-Yi Yen, Chi-Yu Hsieh, Chih-Ming Kang, Sean Huai Chung Chen, Li-Wei Cheng. *Topcell Solar International Co., Ltd., Taoyuan County, Taiwan.* 2459

(688-G21) **Impact of the bias on the temperature of silicon solar cells under operating conditions.** Romain Couderc^{1,2}, Mustapha Lemiti², Mohamed Amara¹. ¹*Centre de thermique CETHIL-UMR5008 CNRS, Villeurbanne, France,* ²*Institut de Nanotechnologies INL-UMR5270 CNRS, Villeurbanne, France.* 2463

(689-G25) **“Thin Silicon Solar Cells: A Path to 35% Shockley-Queisser Limits”, a DOE funded FPACE II project.** Laura Ding, Mathieu Boccard, Joshua Williams, April Jeffries, Srikanth Gangam, Kunal Ghosh, Christiana Honsberg, Mariana Bertoni, Zachary Holman, Stuart Bowden. *School of Electrical, Computer & Energy Engineering, Arizona State University, Tempe, AZ, USA.* 2467

(690-G29) **Evaluation of Recombination Losses in Bifacial n⁺-p-p⁺ and p⁺-n-n⁺ Si Solar Cells Fabricated Using B Ion Implantation.** Ygal Eisenberg¹, Iev Kreinin¹, Ninel Bordin¹, Galina Grigorieva², Marlen Kagan², Kira Zviagina², Naftali Eisenberg¹, Shlomo Hava³. ¹*Jerusalem College of Technology, Jerusalem, Israel,* ²*KVANT Research and Production Enterprise, Moscow, Russia,* ³*Ben-Gurion University of the Negev, Beer Sheva, Israel.* N/A

(691-G33) **Role of the Interfacial Inversion Layer with Reduced Bandgap Narrowing in the Improvement of the Open Circuit Voltage of Amorphous Silicon/Crystalline Silicon Heterojunction [HIT] Solar Cell.** Moustafa Y Ghannam¹, Ghadah Shehadah¹, Yaser Abdulraheem¹, Jef Poortmans². ¹*EE Department, College of Engineering and Petroleum, Kuwait University, Kuwait, Kuwait,* ²*IMEC, Kapeldreef 75, 3001, Leuven, Belgium.* N/A

(692-G37) **Topology Optimization: An effective method for designing front metallization patterns of solar cells.** Deepak K. Gupta¹, Matthijs Langelaar¹, Marco Barink², Fred van Keulen¹. ¹*Precision and Microsystems Engineering, Delft University of Technology, Delft, Netherlands,* ²*TNO, Eindhoven, Netherlands.* 2471

(693-H1) **Hydrogen Passivation of Laser-Induced Defects for Silicon Solar Cells.** Brett J Hallam^{1,2}, Adeline Sugianto¹, Ly Mai¹, GuangQi Xu¹, Catherine E Chan¹, Malcolm D Abbott¹, Stuart R Wenham¹, Angel Uruena³, Monica Aleman³, Jef Poortmans^{2,3,4}. ¹*School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Kensington, Australia,* ²*KU Leuven, Leuven, Belgium,* ³*imec, Leuven, Belgium,* ⁴*UHasselt, Hasselt, Belgium.* 2476

(694-H5) **Zn as the Protective Layer for Cu Electrode in Wafer-Si Solar Cells.** Xiaofei Han¹, Bin Zhou¹, Deren Yang², Meng Tao¹. ¹*Arizona State University, Tempe, AZ, USA,* ²*Zhejiang University, Hangzhou, China.* 2481

(695-H9) **A simplified process flow for silicon heterojunction interdigitated back contact solar cells: using shadow masks and tunnel junctions.** Stanislau Y Herasimenka, Clarence J Tracy, Jongwon Lee, William J Dauksher, Christiana B Honsberg, Stuart Bowden. *Arizona State University, Tempe, AZ, USA.* 2486

(696-H13) **Micro Cold Spray Printed Top Metallization Layer for Solar Cells.** Justin M Hoey, Michael J Robinson, Robert A Sailer. *North Dakota State University, Fargo, ND, USA.* 2491

(697-H17) **a-Si:H/TCO Contact Resistance Measurement Using a Kelvin Cross Bridge Resistor.** Priyaranga L Koswatta, Zachary C Holman. *Arizona State University, Tempe, AZ, USA.* 2495

(698-H21) **Patterning and Metallization of Silicon Solar Cells by Inkjet-Printed Functional Ink on a Photoresist Layer.** Zhongtian Li, Ran Chen, Yu Yao, Aliosn Lennon. *The University of New South Wales, Sydney, Australia.* 2499

(699-H25) **Process optimization of localized BSF formation for solar cells with over 20% energy conversion efficiency.** Dong Lin, Malcolm Abbott, Pei Hsuan Lu, Bo Xiao, Stuart Wenham. *University of New South Wales, Sydney, Australia.* 2502

(700-H29) **Analysis of Small Area Interdigitated Back Contact Silicon Solar Cells: The Influence of Boron Diffusion Process on Cell Performances.** Shu Yen Liu, Yun Kuo Tsao, Zong Liang Yao, Bo Shen Lee, Kuang Chieh Lai, Yu Pan Pai. *Motech Industries, Tainan, Taiwan.* 2507

(701-H33) **Novel High-Efficiency c-Si Compound Heterojunction Solar Cells: HCT (Heterojunction with Compound Thin-layer).** Yiming Liu^{1,2}, Yun Sun¹, Wei Liu¹, Zhiqiang Zhou¹, Jiangong Yao². ¹*Institute of Photo-electronic Thin Film Devices and Technology, Nankai University, Tianjin, China,* ²*Department of Physics, Nankai University, Tianjin, China.* 2510

(702-H37) **HELICS Cell, Laser-cut grooves to create a high-efficiency, low-cost IBC solar cell.** Wassim J. Mughal¹, Humayun A. Mughal², Alan G. Laffoley², Antulio Tarazona³, Sergei Simdyankin⁴, Darren M. Bagnall⁵, Stuart A. Boden¹, Nick E. B. Cowern⁴. ¹*University of Southampton, Southampton, UK,* ²*Silicon CPV plc, Harlow, UK,* ³*EcherKon Technologies Ltd, Crawley, UK,* ⁴*Newcastle University, Newcastle, UK,* ⁵*University of New South Wales, Sydney, Australia.* 2514

(703-I1) **Hot Hole Transport in a-Si/c-Si Heterojunction Solar Cells.** Pradyumna Muralidharan, Kunal Ghosh, Dragica Vasileksa, Stephen M Goodnick. *Arizona State University, Tempe, AZ, USA.* 2519

(704-I5) **New Cu paste with high bonding strength---nano composite alloy particles synthesized by nanomized method.** Shigenobu Sekine¹, Uichi Itoh², Ryuji Kimura¹, Keiji Okada¹, Hiroaki Shindo¹, Tatsuya Ooi¹, Manabu Yoshida², Hideo Tokuhisa². ¹*Napra Corporation, Katsushika-ku, Japan,* ²*AIST, Tsukuba, Japan.* 2524

(705-I9) **Advances in screen printing metallization for a-Si:H/c-Si heterojunction solar cells.** Luca Serenelli¹, Michele Miliciani², Massimo Izzì¹, Rosa Chierchia¹, Mario Tucci¹. ¹*ENEA, Rome, Italy,* ²*CHIMET SpA, Arezzo, Italy.* 2528

(706-I13) **Non-Vacuum Electroplated Al for n-Side Electrode in Si Solar Cells.** Wen-Cheng Sun, Xiaofei Han, Meng Tao. *Arizona State University, Tempe, AZ, USA.* 2533

(707-I17) **Optimization of Local Contact Formation on Screen-printed Al₂O₃ passivated Solar Cells.** Xusheng Wang^{1,2}, Jian Wu^{1,2}, Lingjun Zhang^{1,2}. ¹*Canadian Solar Inc, Suzhou, China,* ²*Photovoltaic Research Center of Soochow University, Suzhou, China.* 2538

(708-I19) **Field-Effect Ferroelectric-Semiconductor Solar Cells.** Wentao Wang¹, Fude Liu¹, Chor Man Lau¹, Lei Wang¹, Guandong Yang¹, Dawei Zheng¹, Zhigang Li². ¹*The University of Hong Kong, Hong Kong, Hong Kong,* ²*The Hong Kong University of Science and Technology, Hong Kong, Hong Kong.* 2542

(709-I21) **Metallization of Crystalline Silicon Solar Cells with Very Narrow Gridlines and Multi-Busbars.** Baomin Xu, Scott Solberg, Scott Limb, Sean Garner. *Palo Alto Research Center Inc., 3333 Coyote Hill Road, Palo Alto, CA, USA. N/A*

(710-I23) **Development of a Self-aligned Etch-back Process for Selectively Doped Silicon Solar Cells.** Di Yan, James Bullock, Yimao Wan, Andres Cuevas. *Australian National University, canberra, Australia. 2545*

(711-I25) **Design and Characterization of an Adhesion Strength Tester for Evaluating Metal Contacts on Silicon Solar Cells.** Trevor L. Young¹, Kenneth Hee¹, Alison J. Lennon², Renate J. Egan¹, Oscar Wilkie², Yu Yao². ¹*Suntech R&D Australia Pty Ltd, Sydney, Australia,* ²*School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia. 2550*

Area 6 - Posters	
1:30 - 3:00 PM	Exhibit Hall D
Organic PV II: Interfaces, Stability and Fabrication	

Chair(s): Jan Gilot, Graham Morse, Dana Olson

(712-J28) **Surface Plasmon Enhanced Infrared Absorption in the Sensitized Polymer Solar Cell.** Sungmo Ahn¹, Devin Rourke², Alexandre M. Nardes³, Jao van de Lagemaat³, Nikos Kopidakis³, Wounghang Park¹. ¹*Department of Electrical, Computer and Energy Engineering, University of Colorado, Boulder, CO, USA,* ²*Department of Physics, University of Colorado, Boulder, CO, USA,* ³*National Renewable Energy Laboratory, Golden, CO, USA. 2554*

(713-J30) **Improving P3HT:PCBM Based Polymer Solar Cell: Role of Doped PEDOT:PSS Hole Extracting Layer Towards Degradation.** Swati Arora¹, Vinamrita Singh², Manoj Arora³, Ram Pal Tandon². ¹*Department of Physics, Zakir Husain College, University of Delhi, Delhi, India,* ²*Department of Physics & Astrophysics, University of Delhi, Delhi, India,* ³*Department of Physics, Ramjas College, University of Delhi, Delhi, India. 2557*

(714-J32) **PBDTPD-based polymer solar cells fabricated under up-scalable conditions.** Anna Calabrese, Riccardo Po, Gianni Corso, Riccardo Barbieri. *Centro Ricerche per le Energie non Convenzionali – Istituto eni Donegani, eni SpA, Novara, Italy. N/A*

(715-J34) **Plasmonic-electrical Effect and Carrier Accumulation Effects of Metal Nanomaterials for High Performance Organic Solar Cells.** Wallace Choy. *Department of Electrical and Electronic Engineering, the University of Hong Kong, Hong Kong, Hong Kong. N/A*

(716-J36) **Reversing Degradation of Organic Solar cells.** Virkam Dalal, Joydeep Bhattacharya, Pranav Joshi, Robert Mayer. *Iowa State University, Ames, IA, USA. N/A*

(717-J38) **The role of temperature in the triplet-fusion induced low-energy photon up-converted delayed luminescence of a solid state composite.** Hossein Goudarzi, Panagiotis E. Keivanidis. *Centre for Nano Science and Technology @Polimi, Istituto Italiano di Tecnologia, Milan, Italy. 2561*

(718-J40) **Micro-Scale Textures for Enhanced Performance of Organic Solar Cells.** Benjamin Lipovsek, Janez Krc, Marko Topic. *University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia. 2566*

(719-K2) **Current Voltage Analysis of Silver Nanoparticle Doped Organic Photovoltaic Devices.** Roy Murray, Nopporn Rujisamphan, Hailey Cramer, S. Ismat Shah. *University of Delaware, Newark, DE, USA.* 2570

(720-K4) **Thermal annealing affects vertical morphology, doping and defect density in BHJ OPV devices.** Alexandre M Nardes. *NREL, Golden, CO, USA.* 2575

(721-K6) **Extrusion as Plausible Processing Method for Production of Organic PhotoVoltaic Solar Cells.** Ali Nourdine, Lara Perrin, Nicole Albérola, Lionel Flandin. *LEPMI, UMR 5279, CNRS-Grenoble INP-Université de Savoie-Université J. Fourier LMOPS-INES Bâtiment Hélios, Campus de Savoie-Technolac, F-73376 Le Bourget-du-Lac Cedex, France.* 2581

(722-K8) **Fabrication and encapsulation of perovskites sensitized solid state solar cells.** F. Javier Ramos¹, David Cortes², Aranzazu Aguirre², Fernando J. Castano^{1,2}, Shahzada Ahmad¹. ¹*Abengoa Research, Campus palmas altas, Spain,* ²*Abergoa Solar, Soland center, Spain.* 2584

(724-K12) **Oxygen Diffusion in Organic Polymers.** Safa Sahoe^{1,2}, Ying Soon¹, Fernando Castro², James R. Durrant¹. ¹*Imperial College London and National Physical Laboratory, London, UK,* ²*National Physical Laboratory, London, UK.* N/A

Area 8 - Posters	
1:30 - 3:00 PM	Exhibit Hall D
Characterization III	

Chair(s): Chris Fell, Keith Emery

(725-K31) **SunsPZ© : Real Time Spatially Resolved Solar Cell Parameter Visualizer.** Pooja Chaturvedi, Ziv Hameiri, Bram Hoex. *Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore.* 2588

(726-K34) **Characterization of Solar Cells in Transportation.** Shu-Tsung Hsu¹, Yean-San Long², Yu-Tai Li³. ¹*HsinChu, Taiwan,* ²*HsinChu, Taiwan,* ³*HsinChu, Taiwan.* 2592

(727-K37) **Influence of Soiling Layer on Quantum Efficiency and Spectral Reflectance on Crystalline Silicon PV Modules.** Jim Joseph John^{1,2}, Sai Tatapudi², Govindasamy Tamizhmani². ¹*Indian Institute of Technology, Mumbai, India,* ²*Arizona State University, Mesa, AZ, USA.* 2595

(728-K40) **An Experimental Procedure to Check the Performance Degradation On-Site in Grid-Connected Photovoltaic Systems.** Filippo Spertino, Fabio Corona, Paolo Di Leo, Fabio Papandrea. *Politecnico di Torino, Torino, Italy.* 2600

(729-L3) **Reliability evaluation of anti-reflection coated glass for photovoltaic modules.** Tony Tang, Ruirui Lv, Jing Tang, Lixia Peng, Albert Fu, Lingjun Zhang. *Canadian Solar Inc., Suzhou, China.* N/A

(730-L6) **The study of dependency of external quantum efficiency of triplejunction solar cells on measurement condition.** Mitusnobu Sugai¹, Jiro Harada¹, Tetsuya Nakamura², Mitusru Imaizumi², Takeshi Ohshima³. ¹*Advanced Engineering Services Co., Ltd., Tsukuba, Japan*, ²*Japan Aerospace Exploration Agency, Tsukuba, Japan*, ³*Japan Atomic Energy Agency, Takasaki, Japan*. 2605

(731-L9) **High-Speed Multi-Channel System for Solar Simulator Irradiance Non-Uniformity Measurement.** Davide Rivola, Sebastian Dittmann, Mauro Pravettoni, Gabi Friesen, Domenico Chianese. *University of Applied Sciences and Arts of Southern Switzerland, Institute for Applied Sustainability to the Built Environment, Canobbio, Switzerland*. 2611

(732-L12) **Empirical Procedure to Correct Concentrator Cell Efficiency Measurement Errors Caused by Unfiltered Xenon Flash Solar Simulators.** Carl R Osterwald¹, Mark W Wanlass², Tom Moriarty¹, Myles A Steiner¹, Keith A Emery¹. ¹*National Renewable Energy Laboratory, Golden, CO, USA*, ²*Wanlass Consulting, Golden, CO, USA*. 2616

(733-L15) **Fast Electrical Modeling for Spatially-Resolved Characterization of Amorphous Silicon Photovoltaic Cells.** Xiaofeng Wu, Martin Bliss, Jiang Zhu, Thomas R Betts, Ralph Gottschalg. *CREST, Loughborough University, Loughborough, UK*. 2620

(734-L18) **Effects of light-soaking and temperature on different PV technologies.** Sandra B. Schujman, Jonathan R. Mann, Christopher Hull, John Wax, Linda M. LaQue, Gary Dufresne, Crispin Rice, David Taylor, Milo Tallon, Alex Bialy, Alex Novicki, David J. Metacarpa, Pradeep Haldar. *US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA*. 2626

(735-L21) **Influence of Spectral Composition on the Temperature Coefficients of Solar Cells from Elkem Solar.** Muhammad Tayyib¹, Jan Ove Odden², Tor Oskar saetre³. ¹*Teknova AS Gimlemoen 19, 4630, Krisitiansand S, Norway*, ²*Elkem Solar AS. P.O. Box 8040 Vaagsbygd. NO-4675, Krisitiansand S, Norway*, ³*University of Agder. Postboks 509. NO-4898, Grimstad, Norway*. 2630

(736-L24) **Scaling Error of Quantum Efficiency Measurements for Heavily Shunted Cells in Reliability Research.** Jaewon Oh¹, GovindaSamy TamizhMani², Stuart Bowden¹. ¹*Solar Power Laboratory, Arizona State University, Tempe, AZ, USA*, ²*Photovoltaic Reliability Laboratory, Arizona State University, Mesa, AZ, USA*. 2635

(737-L27) **Current-Soaking and Dark Storage Effects of Polycrystalline Thin Film Solar Modules.** Sebastian Dittmann, Alessandro Virtuani, Gabi Friesen, Flavio Serrano. *University of Applied Sciences and Art of Southern Switzerland, Canobbio, Switzerland*. 2639

(738-L30) **Compact Accelerated Life Testing with Expanded Measurement Suite.** John M. Raguse, Russell Geisthardt, Jennifer Drayton, James R. Sites. *Colorado State University, Fort Collins, CO, USA*. 2644

(739-M1) **Mapping Chemical and Mechanical Property Degradation in Photovoltaic Modules.** Katherine M Stika, Craig S Westphal, Jane Kapur, Gail Raty, Jing Li, James G Kopchick, William J Gambogi, Babak Hamzavytehrany, Alexander Z Bradley, James R Marsh, Benjamin W Foltz. *E.I. DuPont de Nemours & Co, Wilmington, DE, USA*. 2647

(740-M4) **Correcting Bias in Measured Module Temperature Coefficients.** Clifford W Hansen¹, Michaela Farr¹, Larry Pratt². ¹Sandia National Laboratories, Albuquerque, NM, USA, ²CFV Solar Test Lab, Albuquerque, NM, USA. 2651

(741-M7) **Stochastic Analysis of Advanced Photovoltaic Devices.** Daniel P Heinzl, Hongyi M Wu, Angus Rockett. *Department of Material Sciences and Engineering, University of Illinois, Urbana, IL, USA.* 2656

(742-M10) **Impact of Incidence-Angle Dependence on Solar Radiometric Calibration.** Mike Dooraghi, Aron Habte, Ibrahim Reda, Manajit Sengupta, Peter Gotseff, Afshin Andreas. *National Renewable Energy Laboratory, Golden, CO, USA.* 2662

(743-M13) **Data Acquisition System for PV System Outdoor Performance Evaluation.** Severine Busquet. *UH-HNEI, Honolulu, HI, USA.* N/A

(744-M15) **Outdoor Calibration System for Solar Cell/Module.** Chen Jiangong, Li Jie. *Fujian Metrology Institute/National PV Industry Measurement and Testing Center, Fuzhou, China.* N/A

(745-M16) **Assessing Solar PV Inverters' Anti-Islanding Protection.** Richard J Bravo¹, Steven A Robles¹, Eduard Muljadi². ¹Southern California Edison, Westminster, CA, USA, ²National Renewable Energy Laboratory, Golden, CO, USA. 2668

(746-M17) **VAR Support from Solar PV Inverters.** Richard J Bravo¹, Steven A Robles¹, Tom Bialek². ¹Southern California Edison, Westminster, CA, USA, ²San Diego Gas and Electric, San Diego, CA, USA. 2672

Area 9 - Posters

1:30 - 3:00 PM

Exhibit Hall D

Module Technology and Manufacturing

Chair(s): Keith McIntosh, Michael Kempe, Yifeng Chen

(747-M19) **Metal Wrap-Through Cell and Module Design Optimization.** Ian J Bennett, Evert E Bende, Wilma Eerenstein. *Energy Research Centre of the Netherlands, Solar Energy, Petten, Netherlands.* 2677

(748-M21) **The Effect of soldering process on performance of crystalline silicon solar module.** dingyue cao, hong yang, he wang. *xi'an jiaotong university, xi'an, China.* 2681

(749-M23) **A High Voltage MWT Module with Improved Shadow Performance.** Anna J. Carr, Mark J. Jansen, Maarten de Bruijne, Lars A. G. Okel, Mario J. H. Kloos, Wilma Eerenstein. *ECN Solar Energy, Petten, Netherlands.* 2685

(750-M25) **Light Capturing Film for Power Gain of Crystalline Silicon PV modules.** Indeok Chung, Won-jae Lee, Eun-Chel Cho, In-Sik Moon. *Hyundai heavy industries, Yongin-si, South Korea.* 2689

(751-M27) **Statistical Methods and Experiment Designs for Bulk Factor Screening in Manufacturing – In the Style of Evolutionary Operations.** Jeffrey Cotter. *Arizona State University, Tempe, AZ, USA.* 2693

(752-M29) **Data mining photovoltaic cell manufacturing data.** Rhett Evans^{1,3}, Eric Van Voorthuysen², Jingbing Zhu⁴, Martin Green¹. ¹Australian Centre for Advanced Photovoltaics, UNSW, Sydney, Australia, ²School of Mechanical and Manufacturing Engineering, UNSW, Sydney, Australia, ³Suntech R&D Australia, Sydney, Australia, ⁴Wuxi Suntech Power Co, Wuxi, China. 2699

(753-M31) **Proposed Photovoltaic Module Form Factor to Reduce Levelized Cost of Energy.** Kurt Lyell¹, John Hoffner¹, David Krick², Frank McIntire³, Scott Stibrich⁴, Craig Brooker⁴, Jaya Jackson⁵, Jack Whittier⁴, Richard Campbell⁴, Beth Dart⁶. ¹CH2M Hill, Austin, TX, USA, ²CH2M Hill, Pittsburgh, PA, USA, ³CH2M Hill, Spartanburg, SC, USA, ⁴CH2M Hill, Englewood, CO, USA, ⁵CH2M Hill, Dallas, TX, USA, ⁶CH2M Hill, Oakland, CA, USA. 2705

(754-N1) **Integrated Approach for Economic PV Waste Recycling.** Jens Wolfram Palitzsch, Ulrich Maria Loser, Petra Schönherr. Loser Chemie GmbH, Langenweißbach, Germany. 2709

(755-N3) **From Grey Glass to Green Glass – an Offbeat Recycling Idea for Photovoltaic Production Waste.** Jens Wolfram Palitzsch¹, Ulrich Maria Loser¹, Petra Schönherr¹, Dirk Herfurth². ¹Loser Chemie GmbH, Langenweißbach, Germany, ²Mounting Systems, Inc, Sacramento, CA, USA. 2712

(756-N5) **A Highly Abrasive-Resistant, Long-Lasting Anti-Reflective Coating for PV Module Glass.** Sergiu C. Pop¹, Venkata Abbaraju¹, Brenor Brophy², Y. Sam Yang², Sina Magshoodi², Peter Gonsalvez². ¹Yingli Green Energy Americas, San Francisco, CA, USA, ²Enki Technology, San Jose, CA, USA. 2715

(757-N7) **HCPV Modules of SMALFOC Design in Versions for PV and PV/T Operation.** Valery D. Romyantsev¹, Viacheslav M. Andreev¹, Alexander V. Chekalin¹, Nikolai Yu. Davidyuk², Nikolai A. Sadchikov¹. ¹Ioffe Physical Technical Institute, St.-Petersburg, Russia, ²St Petersburg Academic University, St.-Petersburg, Russia. 2720

(758-N9) **The research on a new type of BIPV modules constructed by Thin-film Photovoltaic Panel(or Module)/ PU/Color organic-coated Steel Plate.** Huacong Yu^{1,2}, Qi Wang², Chuanda Lu², Chenggang Wei². ¹Hanergy PV Science & Technology Co., Ltd, Beijing, China, ²Nanjing Hanergy Solar PV Co.,Ltd, Nanjing, China. 2724

Area 10 - Posters

1:30 - 3:00 PM

Exhibit Hall D

PV System Design and Protection

Chair(s): Adrian Haering

(759-N17) **Development of a Grid-Connected Photovoltaic-Storage System using Novel Bidirectional Intelligent Conversion and Connection.** Antonia Sonia A. C. Diniz¹, Lauro V. B. Machado Neto¹, Suellen C. S. Costa¹, Marcio E. M. Souza², Wilton de C. Padrão³, Delly Oliveira Filho⁴. ¹Pontifical Catholic University of Minas Gerais, Belo Horizonte, Minas Gerais,, Brazil, ²Energetic Company of Minas Gerais, Belo Horizonte, Minas Gerais,, Brazil, ³Engetron Ltda., Belo Horizonte, Minas Gerais,, Brazil, ⁴Federal University of Viçosa, Vicosá, Minas Gerais,, Brazil. 2728

(760-N21) **Design and Implementation of a Management System of Surplus Energy Generated By a Distributed Generation System, Case Study GCPVS.** Johann Hernández, Carolina Korez, David Avila, Jose Antonio Murillo. Universidad Distrital Francisco José de Caldas, Bogotá, Columbia. 2734

(761-N25) **Cost and Market Analysis of Integrative Lightweight PV Systems for Low-Slope Commercial Rooftops.** Eric Holton, Ankush Halbe, Adam Garney, Jake Whitbeck, Kevin Sharpe, David Metacarpa, Pradeep Haldar. SUNY College of Nanoscale Science and Engineering, Albany, NY, USA. 2740

(762-N29) **Design and Implementation of 59 kWp Solar Hybrid Mini-Grid in Solab, Ras Al Khaimah.** Zaki Iqbal¹, Gorkem Soyumer², Waqarullah Kazim¹. ¹CSEM UAE Innovation Center LLC, Ras Al Khaimah, United Arab Emirates, ²École polytechnique fédérale de Lausanne (Middle East), Ras Al Khaimah, United Arab Emirates. 2743

(763-N33) **A New Real Time Reconfiguration Approach Based on Neural Network in Partial Shading for PV Arrays.** Mehmet KARAKOSE¹, Mehmet BAYGIN¹, Koray Sener PARLAK². ¹Firat University Computer Engineering, Elazig, Turkey, ²Firat University Vocational School of Technical Sciences, Elazig, Turkey. N/A

(764-N37) **Stand-Alone Solar Generator with LED Floodlights for Outdoor Sign Illumination.** Daniel L. Meier. *Lightdrop Harvest, LLC, St. Marys, PA, USA.* 2748

(765-N41) **Integrating Rule Base-Disturbance Estimation based fault diagnosis with Graphical User Interface for Grid Connected PV System.** MANIKANDAN PANDIYAN¹, JOVITHA JEROME². ¹Student Scholar, Dept. of Instrumentation and Control Systems Engg, PSG College of Technology, Coimbatore, India, ²Professor, Dept. of Instrumentation and Control Systems Engg, PSG College of Technology, Coimbatore, India. N/A

(766-N45) **An Efficient Reconfiguration Method based on Standard Deviation for Series and Parallel Connected PV Arrays.** Koray Sener Parlak¹, Mehmet Karakose². ¹Firat University, Elazig, Turkey, ²Firat University, Elazig, Turkey. N/A

(767-O1) **A Novel Strategy for Connecting Battery in Standalone Solar Photovoltaic Converter System.** Sachin Parsekar, Kishore Chatterjee. *Indian Institute of Technology Bombay, Mumbai, India.* 2751

(768-O5) **Fire at a PV Installation.** Finley R. Shapiro. *Finley Shapiro Consulting, Inc., Philadelphia, PA, USA.* 2757

(769-O9) **A Power Generation Estimate of Cylindrically-shaped Flexible PV Cell Systems for Off-grid Use.** Mamoru Shibasaki, Toshiaki Yachi. *Tokyo University of Science, Tokyo, Japan.* 2759

(770-O13) **The expansion opportunity for off-grid PV to go mainstream: multiple case studies for village electrification and telecom power-up in India.** Andrew Skumanich², Prabhakar Loka¹, Karthik Polsani¹, Shekar Reddy². ¹Premier Solar, Hyderabad, India, ²SolarVision Co, Los Gatos - Silicon Valley, CA, USA. 2765

WEDNESDAY PM

3:00 - 3:30 PM	Exhibit Hall D
Coffee Break	

Joint Session: Areas 2,9 - Orals	
3:30 - 5:00 PM	MR 502-504
Manufacturing of Thin Film Chalcogenide Modules	

Chair(s): Eray Aydil, Shogo Ishizuka

3:30 **(771) High efficiency and large volume production of CIS-based modules**
 Hiroki Sugimoto^{1,2}
¹Showa Shell Sekiyu K.K., Atsugi, Japan, ²Solar Frontier K.K., Atsugi, Japan 2767

- 4:00 **(772) Evaluation of Micro- and Nanoscale Uniformity in All-PVD Cu(In,Ga)Se₂ Solar Cells**
Gregory M Kimball, Neil Mackie, Magdalena Parker, Atiye Bayman
MiaSole Hi-Tech Corp, Santa Clara, CA, USA 2771
- 4:15 **(773) CIGS Module Manufacturing with High Deposition Rates and Efficiencies**
Dirk Herrmann¹, Philipp Kratzert¹, Stefan Weeke¹, Martin Zimmer¹, Jovana Djordjevic-Reiss¹, Ralf Hunger¹, Lars Bach¹, Peter Lindberg², Erik Wallin², Olle Lundberg², Lars Stolt^{1,2}
¹*Solibro GmbH, Bitterfeld-Wolfen, Germany, ²Solibro Research AB, Uppsala, Sweden 2775*
- 4:30 **(774) Broadband Anti-Reflection coatings for Thin Film Photovoltaics**
Piotr M Kaminski, Gerald Womack, John M Walls
CREST (Centre for Renewable Energy Systems and Technology), School of Electronic, Electrical and Systems Engineering, Loughborough University, Loughborough, UK 2778
- 4:45 **(775) Recent developments toward a one step thin-film PV interconnection process using laser scribing and inkjet printing.**
Mickey L. Crozier^{1,2}, Phillip Adamson¹, Adam Brunton¹, Simon Henley¹, Meng Jiang¹, Piotr M. Kaminski³, Jonathan D. Shephard², John M. Walls²
¹*M-Solv, Oxford, UK, ²Heriot-Watt, Edinburgh, UK, ³CREST, Loughborough, UK 2784*

Joint Session: Areas 1,3,4,7 - Orals	
3:30 - 5:00 PM	MR 505-507
III-V on Silicon Solar Cells	

Chair(s): Mitsuru Imaizumi, Steven Ringel

- 3:30 **(776) Progress Toward a Si-Plus Architecture: Epitaxially-Integrable Si Sub-Cells for III-V/Si Multijunction Photovoltaics**
Tyler J Grassman^{1,2}, John A Carlin³, Santino D Carnevale², Ibraheem Al Mansouri⁴, Hamid Mehrvarz⁴, Stephen Bremner⁴, Anita Ho-Baillie⁴, Elisa García-Tabarés⁵, Ignacio Rey-Stolle⁵, Martin A Green⁴, Steven A Ringel^{2,3}
¹*Dept. of Materials Science and Engineering, The Ohio State University, Columbus, OH, USA, ²Dept. of Electrical and Computer Engineering, The Ohio State University, Columbus, OH, USA, ³Institute for Materials Research, The Ohio State University, Columbus, OH, USA, ⁴School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia, ⁵Instituto de Energía Solar, Universidad Politécnica de Madrid, Madrid, Spain N/A*
- 4:00 **(777) Direct Epitaxial Growth of Silicon on GaAs by Low Temperature Epitaxy**
Romain Cariou^{1,2}, Jean-Luc Maurice², Jean Decobert¹, Pere Roca i Cabarrocas²
¹*III-V Lab, joint laboratory between Alcatel-Lucent Bell Labs France, Thales Research and Technology and CEA-LETI, Marcoussis, France, ²LPICM-CNRS, Ecole Polytechnique, Palaiseau, France 2789*

- 4:15 **(778) III-V-N/Si heteroepitaxy for multijunction solar cells**
 Akihiro Wakahara, Noriyuki Urakami, Hiroto Sekiguchi, Keisuke Yamane
Toyohashi University of Technology, Toyohashi, Japan 2792
- 4:30 **(779) An Experimental-Theoretical Atomic-Scale Study - In Situ Analysis of III-V on Si(100) Growth for Hybrid Solar Cells**
 Oliver Supplie^{1,2}, Sebastian Brueckner^{1,2}, Oleksandr Romanyuk³, Matthias M. May², Henning Doescher⁴, Peter Kleinschmidt^{1,2}, Helena Stange², Anja Dobrich^{1,2}, Christian Hoehn², Hans-Joachim Lewerenz⁵, Frank Grosse⁶, Thomas Hannappel^{1,2}
¹Ilmenau University of Technology Technical, Ilmenau, Germany, ²Helmholtz-Zentrum Berlin, Berlin, Germany, ³Academy of Sciences of the Czech Republic, Prague, Czech Republic, ⁴National Renewable Energy Laboratory, Golden, CO, USA, ⁵California Institute of Technology, Pasadena, CA, USA, ⁶Paul-Drude Institute, Berlin, Germany 2797
- 4:45 **(780) Rapid Characterization of Extended Defects in III-V/Si by Electron Channeling Contrast Imaging**
 Santino D. Carnevale¹, Julia I. Deitz², Tyler J. Grassman^{1,2}, John A. Carlin³, Yoosuf N. Picard⁴, Marc De Graef⁴, Steven A. Ringel^{1,3}
¹Department of Electrical and Computer Engineering, The Ohio State University, Columbus, OH, USA, ²Department of Materials Science and Engineering, The Ohio State University, Columbus, OH, USA, ³Institute for Materials Research, The Ohio State University, Columbus, OH, USA, ⁴Department of Materials Science and Engineering, Carnegie Mellon University, Pittsburgh, PA, USA 2800

Area 1 - Orals

3:30 - 5:00 PM

Ballroom 1AB

Light Management 2: Light Trapping and Advanced ARCs

Chair(s): Jonathan Granddier, Pei-chen Yu

- 3:30 **(781) High-Efficiency Solar Cells by Nanophotonic Design**
 Albert Polman
FOM Institute AMOLF, Amsterdam, Netherlands N/A
- 4:00 **Best Student Presentation Award Finalist (782) Plasmonic Nanocavity Organic Solar Cells with Highly Enhanced Power Conversion Efficiency, Broad-Band, and Omni-Acceptance**
 Wei Ding, Stephen Y. Chou
Princeton University, Princeton, NJ, USA 2804
- 4:30 **(783) Advanced Broadband Antireflection Coatings Based on Cellulose Micro-fiber Paper**
 Dongheon Ha^{1,2}, Zhiqiang Fang³, Liangbing Hu³, Jeremy N. Munday^{1,2}
¹Department of Electrical and Computer Engineering, University of Maryland, College Park, MD, USA, ²Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD, USA, ³Department of Materials Science and Engineering, University of Maryland, College Park, MD, USA N/A

- 4:45 **(784) Metal nanogrids for efficient light harvesting in ultrathin GaAs solar cells**
 Nicolas VANDAMME¹, Ines MASSIOT¹, Clement COLIN^{1,2}, Aristide LEMAITRE¹, Andrea CATTONI¹, Jean-Francois GUILLEMOLES², Stephane COLLIN¹
¹LPN-CNRS, MARCOUSSIS, France, ²IRDEP-EDF/CNRS/Chimie ParisTech, CHATOU, France N/A

Area 4 - Orals	
3:30 - 5:00 PM	Ballroom 1EF
Contacts	

Chair(s): Giso Hahn, David Smith

- 3:30 **Best Student Presentation Award Finalist (785) Transparent electrodes for silicon heterojunction solar cells fabricated by atomic layer deposition**
 Benedicte Demaurex¹, Johannes Peter Seif¹, Sjoerd Smit², Bart Macco², W.M.M. Kessels², Stefaan De Wolf¹, Christophe Ballif¹
¹Ecole Polytechnique Fédérale de Lausanne (EPFL) Institute of Microengineering (IMT) / Photovoltaics and thin-film electronics laboratory, Neuchatel, Switzerland, ²Eindhoven University of Technology, Department of Applied Physics, Eindhoven, Netherlands N/A
- 3:45 **(786) Emitter Recombination Current Densities of Boron Emitters with Silver/Aluminum Pastes**
 Fabian Kiefer¹, Robby Peibst¹, Tobias Ohrdes¹, Jan Krügener², H. Jörg Osten², Rolf Brendel^{1,3}
¹Institute for Solar Energy Research Hamelin, Emmerthal, Germany, ²Institute of Electronic Materials and Devices, Leibniz Universität Hannover, Hanover, Germany, ³Institute of Solid State Physics, Leibniz Universität Hannover, Hanover, Germany 2808
- 4:00 **(787) Point-contacting by Localised Dielectric Breakdown: a robust approach to contacting silicon for solar applications**
 Ned J Western, Stephen P Bremner
 School of Photovoltaic and Renewable Energy Engineering, Sydney, Australia 2813
- 4:15 **(788) Selective Anodisation**
 Pei Hsuan Doris Lu, Stuart Wenham, Alison Lennon
 UNSW, Sydney, Australia 2818
- 4:30 **(789) Copper Metallization of Silicon PERL Solar Cells: 21% Cell Efficiency and Module Assembly Using Conductive Film**
 Kyumin LEE, Dohyeon KYEONG, Moonseok KIM, Won-jae LEE, Eun-Chel CHO
 Hyundai Heavy Industries, Co., Ltd., Yongin, South Korea 2823
- 4:45 **(790) Understanding Peel Force Variation during Ag Grid Line Adhesion Measurements**
 Liang Liang, Zhigang Li, Nick Glassmaker, Lapkin Cheng
 DuPont CR&D, Wilmington, DE, USA 2828

Area 5 - Orals

3:30 - 5:00 PM

Ballroom 1CD

Amorphous, Nano- and Micro-Crystalline Silicon

Chair(s): Hitoshi Sai, Franz-Josef Haug

- 3:30 **(791) Development and Progress in Thin Film Si Photovoltaic Technologies by Photovoltaic Power Generation Technology Research Association**
Isao Yoshida¹, Takuya Matsui², Hitoshi Sai², Takashi Suezaki³, Hirotaka Katayama⁴, Mitsuhiro Matsumoto⁴, Shuichiro Sugiyama⁵, Takuro Masuda⁶, Mitsuru Ushijima⁷, Shuichi Nonomura⁹, Masaharu Shiratani¹⁰, Makoto Konagai¹¹, Kimihiko Saito^{1,8}, Michio Kondo², Makoto Tanaka⁴, Shigeru Niki²
¹PVTEC, Tsukuba, Japan, ²AIST, Tsukuba, Japan, ³Kaneka Corp., Settsu, Japan, ⁴Panasonic Corp., Moriguchi, Japan, ⁵Sharp Corp., Katsuragi, Japan, ⁶Mitsubishi Heavy Industries Ltd., Isahaya, Japan, ⁷Tokyo Electron Ltd., Tsukuba, Japan, ⁸Fukushima University, Tsukuba, Japan, ⁹Gifu University, Gifu, Japan, ¹⁰Kyushu University, Fukuoka, Japan, ¹¹Tokyo Institute of Technology, Meguro-ku, Japan 2832
- 4:00 **(792) Nano-imprint lithography for advanced light management concepts in multi-junction solar cells**
Matthias Meier¹, Ulrich Wilhelm Paetzold¹, Michael Ghosh¹, Rob van Erven²
¹Forschungszentrum Juelich GmbH, Juelich, Germany, ²OM&T B.V. - Moser Baer Technologies, Eindhoven, Netherlands 2836
- 4:15 **(793) High efficiency thin film solar cells deposited at the amorphous-to-microcrystalline transition using SiF₄/H₂/Ar gas mixtures**
Jean-Christophe Dornstetter^{1,2}, Bastien Bruneau², Pavel Bulkin², Erik V. Johnson², Pere Roca i Cabarrocas²
¹TOTAL New Energies, Paris La Defense, France, ²LPICM CNRS - Ecole Polytechnique, Palaiseau, France 2839
- 4:30 **Best Student Presentation Award Finalist**
(794) Effect of ion energy on microcrystalline silicon material and devices: a study using Tailored Voltage Waveforms
Bastien Bruneau¹, Junkang Wang¹, Jean-Christophe Dornstetter^{1,2}, Erik Johnson¹
¹LPICM, Ecole Polytechnique, Palaiseau, France, ²Total, Paris La Defense, France N/A
- 4:45 **Best Student Presentation Award Finalist**
(795) The nature and the kinetics of light-induced defect creation in hydrogenated amorphous silicon films and solar cells.
Jimmy Melskens¹, Marc Schouten¹, Awital Mannheim², Albert S. Vullers¹, Yalda Mohammadian¹, Stephan W.H. Eijt², Henk Schut³, Takuya Matsui^{4,5}, Miro Zeman¹, Arno H.M. Smets¹. ¹Photovoltaic Materials and Devices, Faculty of Electrical Engineering, Mathematics and Computer Science, Delft University of Technology, Delft, Netherlands. ²Fundamental Aspects of Materials and Energy, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands. ³Neutron and Positron Methods in Materials, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands. ⁴Research Center for Photovoltaic Technologies, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan. ⁵Thin Film Silicon Lab, Photovoltaic Power Generation Technology Research Association (PVTEC), Tsukuba, Japan N/A

Area 6 - Orals

3:30 - 5:00 PM

Ballroom 2A

OPV Fabrication and Reliability

Chair(s): Wolfgang Tress, Yang Yang, Gang Li

- 3:30 **(796) High Specific Power Plastic Solar Cells**
Yue Wu
Solarmer, El Monte, CA, USA N/A
- 4:00 **(797) Ultrasonic Spray Coating of 6.4% Efficient Diketopyrrolopyrrole Based Organic Photovoltaics**
Jeffrey G. Tait^{1,2}, Cindy Wong^{2,3}, David Cheyns², Mathieu Turbiez⁴, Barry P. Rand⁵, Paul Heremans^{1,2}
¹KU Leuven, Leuven, Belgium, ²IMEC, Leuven, Belgium, ³The Cooper Union, New York, NY, USA, ⁴BASF, Basel, Switzerland, ⁵Princeton University, Princeton, NJ, USA N/A
- 4:30 **(798) Organic Photovoltaic Cells with All Inkjet Printed Layers and Freedom of Form**
Tamara Eggenhuisen¹, Yulia Galagan¹, Anne Biezemans², Michiel Coenen¹, Jan Gilot¹, Pim Groen^{1,3}, Ronn Andriessen¹
¹Holst Centre, Eindhoven, Netherlands, ²ECN Solar Energy, Eindhoven, Netherlands, ³Delft University, Delft, Netherlands 2842
- 4:45 **(799) Controlling the Reliability of Polymer Solar Cells**
Stephanie R Dupont, Chris Bruner, Reinhold H Dauskardt
Stanford University, Stanford, CA, USA N/A

TECHNICAL PROGRAM

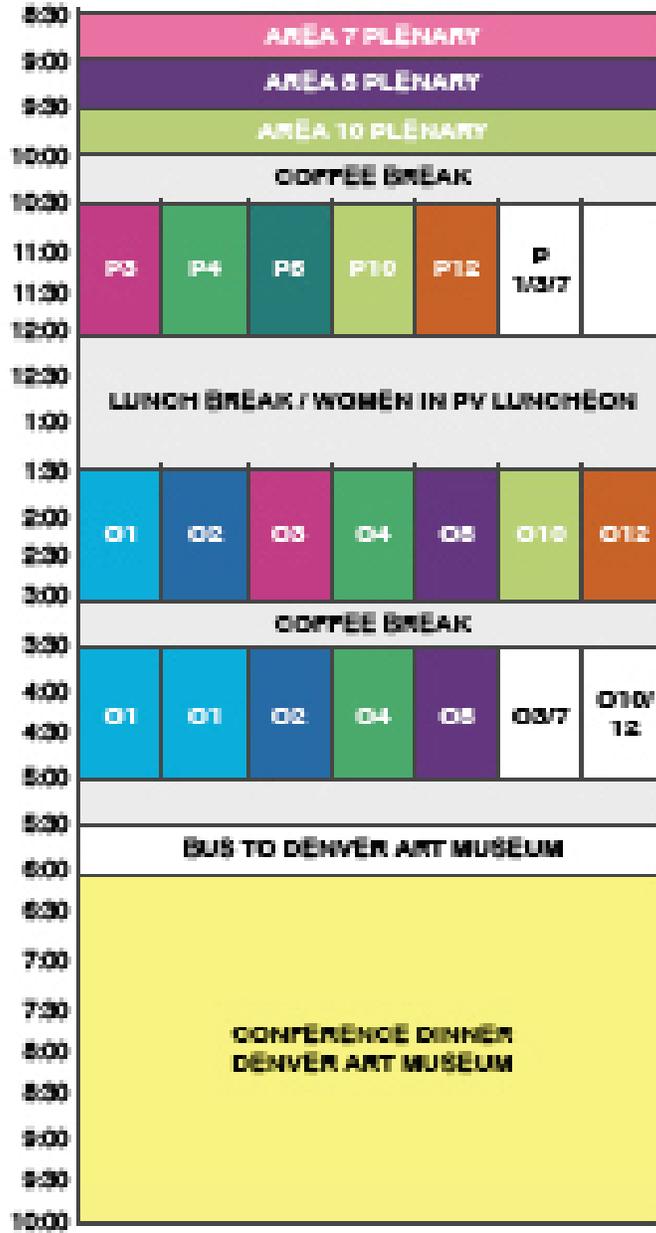
WEDNESDAY PM

Area 9 - Orals	
3:30 - 5:00 PM	Ballroom 2B
Predicting Module Performance	

Chair(s): Clifford Hansen, Joshua Stein

- 3:30 **(800) Modeling the Irradiance and Temperature Dependence of Photovoltaic Modules in PVsyst**
 Kenneth J. Sauer¹, Thomas Roessler², Clifford W. Hansen³
¹Yingli Green Energy Americas, Inc., San Francisco, CA, USA, ²Yingli Green Energy Europe GmbH, Munich, Germany, ³Sandia National Laboratories, Albuquerque, NM, USA N/A
- 3:45 **(801) Procedure for Applying IEC-61853 Test Data to a Single Diode Model**
 Aron P. Dobos, Sara M. MacAlpine
 National Renewable Energy Laboratory, Golden, CO, USA 2846
- 4:00 **Best Student Presentation Award Finalist (802) Likelihood Methods for Single Diode Model Parameter Estimation from I-V Curve Data with Noise**
 Brian Zaharatos¹, Mark Campanelli², Clifford Hansen³, Keith Emery², Luis Tenorio¹
¹Colorado School of Mines, Golden, CO, USA, ²National Renewable Energy Laboratory, Golden, CO, USA, ³Sandia National Laboratories, Albuquerque, NM, USA 2850
- 4:15 **(803) A Time Dependent Model for Utility Scale PV Module Temperature**
 William J Hayes, Lauren M Ngan
 First Solar, Inc., San Francisco, CA, USA N/A
- 4:30 **(804) Angle of incidence effects on external quantum efficiency in polycrystalline silicon photovoltaics**
 R. Beal¹, B.G. Potter¹, J.H. Simmons^{1,2}
¹University of Arizona, Tucson, AZ, USA, ²Florida Gulf Coast University, Ft. Myers, FL, USA N/A
- 4:45 **(805) Direct Analysis of the Current-Voltage Curves Applied to an Outdoor-Degrading CdTe Module**
 Carolin Ulbrich¹, Sarah Kurtz², Dirk Jordan², Marzella Görig¹, Andreas Gerber¹, Uwe Rau¹
¹IEK5-Photovoltaik, Forschungszentrum Jülich, Jülich, Germany, ²National Renewable Energy Laboratory, Golden, CO, USA 2856

THURSDAY PROGRAM SUMMARY



THURSDAY PROGRAM SUMMARY

THURSDAY AM

	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 7 - Plenary	
8:30 - 9:00 AM	Ballroom 3-4
Space PV Devices and Systems	

Chair(s): Mitsuru Imaizumi, Phillip Jenkins

- 8:30 **(806) Development and High-Irradiance High-Temperature Testing of the Solar Probe Plus Array**
 Andreea Boca, Rick Stall, Philip Blumenfeld, Karen De Zetter, Benjamin Richards, Chaz Sarver, Mark Stan, Kevin Crist, Paul Sharps
Emcore Photovoltaics, Albuquerque, NM, USA N/A

Area 8 - Plenary	
9:00 - 9:30 AM	Ballroom 3-4
Characterization Methods	

Chair(s): Keith Emery

- 9:00 **(807) Luminescence Imaging for Quantitative Solar Cell Analysis**
 Bernhard Michl, Florian Schindler, Milan Padilla, Wilhelm Warta, Martin C. Schubert
Fraunhofer ISE, Freiburg, Germany N/A

Area 10 - Plenary	
9:30 - 10:00 AM	Ballroom 3-4
PV Systems and Applications	

Chair(s): Greg Ball

- 9:30 **(808) All about PV Power Plants: Technical challenges for technical bankability**
 Boris Farnung
Fraunhofer ISE, Freiburg, Germany N/A

10:00 - 10:30 AM	Ballroom Pre-function
Coffee Break	

Joint Session: Areas 1,3,7 - Posters

10:30 - 12:00 PM

Exhibit Hall D

Quantum Confinement for Space and Multijunction Solar Cell Applications

Chair(s): Sheila Bailey, Shin-Ichiro Sato, Maria Gonzalez

(809-P41) **Growth and Characterization of GaAs/GaPAs Metamorphic, Epitaxial Nanostructures.** Phil Ahrenkiel, Nan Zheng, Joseph A. Street. *South Dakota School of Mines & Technology, Rapid City, SD, USA.* 2862

(810-P43) **Multi-quantum well solar cell modeling and optimization.** Diego Alonso-Álvarez, Markus Führer, Tomos Thomas, Ned Ekins-Daukes. *Imperial College London, London, UK.* 2865

(811-P45) **Radiation Effects on InAlGaAs / InGaAs Quantum Well Solar Cells.** Christopher G Bailey¹, Raymond Hoheisel^{1,2}, Maria Gonzalez^{1,3}, David V Forbes⁴, Matthew P Lumb^{1,2}, Seth M Hubbard⁴, David A Scheiman¹, Louise C Hirst¹, Kenneth J Schmieder¹, Scott R Messenger⁵, Brad D Weaver¹, Cory D Cress¹, Jeffrey Warner¹, Michael K Yakes¹, Phillip P Jenkins¹, Robert J Walters¹. ¹*U.S. Naval Research Laboratory, Washington, DC, USA,* ²*George Washington University, Washington, DC, USA,* ³*Sotera Defense Solutions, Annapolis Junction, MD, USA,* ⁴*Nanopower Research Labs, Rochester Institute of Technology, Rochester, NY, USA,* ⁵*University of Maryland Baltimore County, Baltimore, MD, USA* 2871

(812-P47) **Enhanced Light Trapping in Multiple Quantum Wells by Thin Film Structure and Backside Grooves with Dielectric Interface.** Tomoyuki Inoue¹, Kentaroh Watanabe², Masakazu Sugiyama¹, Yoshiaki Nakano¹. ¹*School of Engineering, the University of Tokyo, Tokyo, Japan,* ²*Research Center for Advanced Science and Technology, Tokyo, Japan.* N/A

(813-Q1) **Transport modeling of InGaN/GaN multiple quantum well solar cells.** Nicolas Cavassilas, Fabienne Michélini, Marc Bescond. *IM2NP - Aix-Marseille Université - CNRS, Marseille, France.* 2875

(814-Q3) **Thermal Survivability Characterization of Quantum Dot Multi-Junction Photovoltaic Cells.** Peter S Ericksen¹, Alex Howard², David M Wilt². ¹*Cornell University, Ithaca, NY, USA,* ²*Air Force Research Laboratory, Albuquerque, NM, USA.* 2878

(815-Q5) **Direct Measurement of Conduction Miniband Structure in Superlattice by Visible-Light Photoemission Spectroscopy.** Fumiaki Ichihashi, Daiki Shimura, Kenji Nishitani, Makoto Kuwahara, Takahiro Ito, Shunta Harada, Hiroyasu Katsuno, Miho Tagawa, Toru Ujihara. *Nagoya University, Nagoya, Japan.* 2882

(816-Q7) **Radiation Response of the Fill-Factor for GaAs Solar Cells with InGaAs Quantum Dot Layers.** Tetsuya Nakamura¹, Taishi Sumita¹, Mitsuru Imaizumi¹, Takeyoshi Sugaya², Koji Matsubara², Shigeru Niki², Toru Mochizuki³, Akihiro Takeda³, Yoshinobu Okano³, Shin-ichiro Sato⁴, Takeshi Ohshima⁴. ¹*Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan,* ²*National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan,* ³*Tokyo City University, Setagaya-ku, Japan,* ⁴*Japan Atomic Energy Agency (JAEA), Takasaki, Japan.* 2886

(817-Q9) **Analysis of GaAs/AlGaAs quantum nanodisk solar cell with intermediate band carrier transportation.** Akio Ogura, Tomah Sogabe, Daniel J Farrell, Yoshitaka Okada. *Research Center for Advanced Science and Technology(RCAST), The University of Tokyo, Tokyo, Japan.* 2892

(818-Q11) **Simulation Study of Schottky Contact Based Single Si Wire Solar Cell.** M. Golam Rabbani¹, Amit Verma², Reza Nikovei², Mahmoud M. Khader³, M. P. Anantram¹. ¹Dept. of Electrical Engineering, University of Washington, Seattle, WA, USA, ²Dept. of Electrical Engineering and Computer Science, Texas A & M University – Kingsville, Kingsville, TX, USA, ³Gas Processing Center, College of Engineering, Qatar University, Doha, Qatar. 2896

(819-Q13) **High Quality MBE grown dilute nitride quantum wells with novel Nitrogen-Plasma Source design.** Gopi Vijaya¹, Alex Freundlich¹, Dinghao Tang², David Smith². ¹University of Houston, Houston, TX, USA, ²Arizona State University, Tempe, AZ, USA. 2900

(820-Q15) **Charged Quantum Dot Towards the Concept of Intermediate Band Solar Cells.** Jiang Wu¹, Phu Lam¹, Sabina Hatch¹, Mingchu Tang¹, Vitaliy G Dorogan², Yuriy I Mazur², Gregory J Salamo², Huiyun Liu¹. ¹Department of Electronic and Electrical Engineering, University College London, London, UK, ²Institute for Nanoscience and Engineering, University of Arkansas, Fayetteville, AR, USA. N/A

(821-Q17) **Silicon Nanowire Arrays Passivated by Al₂O₃/TiO₂ Stack Layers.** Yasuharu Yamada¹, Yasuyoshi Kurokawa^{1,2}, Shinya Kato⁴, Akira Yamada^{1,3}. ¹Department of Physical Electronics, Tokyo, Japan, ²PRESTO, Saitama, Japan, ³Photovoltaics Research Center (PVREC), Tokyo, Japan, ⁴FUTURE-PV Innovation, Tokyo, Japan. 2903

(822-Q19) **Effect of Barrier Thickness on Carrier Transport inside Multiple Quantum Well Solar Cells under High-concentration Light Illumination.** Warakorn Yanwachirakul¹, Hiromasa Fujii¹, Kentaroh Watanabe², Masakazu Sugiyama¹, Yoshiaki Nakano¹. ¹Graduate School of Engineering, The University of Tokyo, Tokyo, Japan, ²Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan. N/A

(823-Q21) **Simulation of Electron Escape from GaNAs/GaAs Quantum Well Solar Cells.** Yongjie Zou¹, Christiana B. Honsberg¹, Alexandre Freundlich², Stephen M. Goodnick¹. ¹School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA, ²Photovoltaic and Nanostructures Laboratories, Center for Advanced Materials, University of Houston, Houston, TX, USA. 2908

Area 3 - Posters

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Exhibit Hall D

Low and High Concentration CPV

Chair(s): Geoffrey Kinsey, Pilar Espinet-González

(824-E21) **Performance Characterization of a Small Form-Factor 100X Micro-Optic Concentrator.** Gautam Agrawal, Tian Gu, Michael W. Haney. University of Delaware, Newark, DE, USA. 2912

(825-E24) **Sensitivity Analysis Applied to a Concentrator Photovoltaic System.** Kristine Drew, Michael Sinclair, Stefan Myrskog, John Paul Morgan. Morgan Solar Inc., Toronto, ON, Canada. 2917

(826-E27) **Comparison of Predicted, Expected, and Measured Current from CPV and Silicon PV Modules.** Geoffrey S Kinsey¹, Cameron Stark¹, Aditya Dhathathreyan¹, Tobias Gerstmaier², Renato Moretta². ¹Fraunhofer CSE, Boston, MA, USA, ²Soitec Solar, Freiburg, Germany. N/A

(827-E30) **Technical Issues and Challenges in the Fabrication of a Large High-Concentrating Photovoltaic Receiver.** Leonardo Micheli¹, Nabin Sarmah¹, Eduardo F. Fernández¹, K.S. Reddy², Tapas K. Mallick¹. ¹*Environment and Sustainability Institute, University of Exeter, Penryn Campus, Penryn, UK*, ²*Heat Transfer and Thermal Power Laboratory, Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai, India.* 2921

(828-F1) **Cost Analysis of Flat-Plate Concentrators Employing Microscale Photovoltaic Cells for High Energy Per Unit Area Applications.** Scott M. Paap¹, Vipin P. Gupta², Anna Tauke-Pedretti², Paul J. Resnick², Carlos A. Sanchez², Gregory N. Nielson², Jose Luis Cruz-Campa², Bradley H. Jared², Benjamin J. Anderson², Jeffrey S. Nelson², Murat Okandan², William C. Sweatt². ¹*Sandia National Laboratories, Livermore, CA, USA*, ²*Sandia National Laboratories, Albuquerque, NM, USA.* 2926

(829-F4) **An innovative concentrator system based on Cu(In,Ga)Se₂ microcells.** Myriam Paire^{1,2,3}, Laurent Lombez^{1,2,3}, Stéphane Collin⁴, Jean-Luc Pelouard⁴, Daniel Lincot^{1,2,3}, Jean-François Guillemoles^{1,2,3}. ¹*Institute for Research and Development on Photovoltaic Energy (IRDEP), EDF R&D, Chatou, France*, ²*IRDEP, CNRS, Chatou, France*, ³*IRDEP-Chimie Paristech, Paris, France*, ⁴*Laboratoire de photonique et nanostructures, LPN-CNRS, Marcoussis, France.* 2930

(830-F7) **Cu(In,Ga)Se₂ Solar Cells Measured under Low Flux Optical Concentration.** James S. Ward, Brian Egaas, Rommel Noufi, Miguel A. Contreras, Kannan Ramanathan, Carl Osterwald. *NREL, Golden, CO, USA.* 2934

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Materials and Junction Formation	

Chair(s): Gianluca Coletti, Thibaut Desrues, Robby Peibst

(831-G2) **The Distribution of Chromium in Multicrystalline Silicon.** Mallory Ann Jensen¹, Jasmin Hofstetter¹, David P. Fenning¹, Ashley E. Morishige¹, Gianluca Coletti², Barry Lai³, Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA*, ²*ECN Solar Energy, Petten, Netherlands*, ³*Advanced Photon Source at Argonne National Laboratory, Argonne, IL, USA.* 2938

(832-G6) **A simple approach for the simulations in the mechanical studies of drilled wafers.** Josu Barredo¹, Alberto Fraile², Covadonga Alarcón³, Lutz Hermanns². ¹*Center for Modeling in Mechanical Engineering, Madrid, Spain*, ²*Department of Structural Mechanics and Industrial Constructions, UPM, Madrid, Spain*, ³*Department of Materials Engineering, UPM, Madrid, Spain.* 2941

(833-G10) **Scanning Electron Microscopy Analysis of Defect Clusters in Multicrystalline Solar Grade Silicon Solar Cells.** charly berthod¹, tor oskar sætre¹, jan ove odden². ¹*UiA, Grimstad, Norway*, ²*Elkem Solar Silicon, Kristiansand, Norway.* 2947

(834-G14) **Indium-Doped Mono-Crystalline Silicon Substrates Exhibiting Negligible Lifetime Degradation Following Light Soaking.** Martin J. Binns, Jesse Appel, Jason Guo, Jihong Chen, T.N. Swaminathan, Ethan A. Good. *SunEdison, Inc, St. Peters, MO, USA.* N/A

(835-G18) **Analysis of the topography and the sub-surface damage of Cz- and mc-silicon wafers sawn with diamond wire.** Rajko Buchwald, Sindy Würzner, Marcel Fuchs, Stefan Retsch, Kilian Fröhlich, Toni Lehmann, Hans Joachim Möller. *Fraunhofer Technologiezentrum Halbleitermaterialien THM, Freiberg, Germany.* 2951

(836-G22) **Predicting Dislocation Recombination Strength in Multicrystalline Silicon using Etch-Pit Geometry Variation.** Sergio Castellanos¹, Jasmin Hofstetter¹, Maulid Kivambe¹, Markus Rinio², Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA,* ²*Karlstad University, Karlstad, Sweden.* 2957

(837-G26) **Investigation of Electrical Properties on Industrial PERC Mono-like Si Solar cell.** Yu-Hsuan Chang, Shang-Jue Su, Po-Sheng Huang, Li-Wei Cheng. No. 1560, Sec. 1, Zhongshan Rd., Guanyin Township, Taoyuan County, Taiwan. 2960

(838-G30) **Investigation of Cooling Effect on the formation of Al-p+ emitter For N-type Silicon Solar Cell.** Tseng-Jung Chang, Sean H.T. Chen, Chia-Yu Shen, Shao-Peng Su, Li-Wei Cheng. *Topcell solar international CO., LTD, Taoyuan County, Taiwan.* 2963

(839-G34) **Comparison of POCl₃ Diffusion with Phosphorus Ion Implantation for Czochralski and Quasi-mono Silicon Solar Cells.** Eunhwan Cho, Youngwoo Ok, Kyungsun Ryu, Brian Rounsaville, Ajay D. Upadhyaya, Vijaykumar Upadhyaya, Ajeet Rohatgi. *University Center of Excellence for Photovoltaic Research and Education, Georgia Institute of Technology, Atlanta, GA, USA.* 2966

(840-G38) **Cold-Container Crystal Growth of “Last-to-Freeze” Silicon Samples, for Enhanced Detection of Metallic Impurities by ICP-MS.** T. F. Ciszek¹, H. E. Gotts². ¹*Siliconsultant Division of Geolite, Evergreen, CO, USA,* ²*Air Liquide Electronics U. S. LP – Balazs NanoAnalysis, Fremont, CA, USA.* 2969

(841-H2) **Residual Dopant Levels in Silicon Feedstock Grown by Pilot-Scale Atmospheric Pressure Iodine Vapor Transport.** T.F. Ciszek. *Siliconsultant Division of Geolite, Evergreen, CO, USA.* 2974

(842-H6) **High Efficiency Solar Cells on Direct Kerfless 156 mm Mono Crystalline Si Wafers by High Throughput Epitaxial Growth.** Ruiying Hao¹, T.S. Ravi¹, V. Siva¹, Jean Vatus¹, Dan Miller¹, Joel Custodio¹, Ken Moyers¹, Chia-Wei Chen², Ajay Upadhyaya², Ajeet Rohatgi^{2,3}. ¹*Crystal Solar Inc., Santa Clara, CA, USA,* ²*Georgia Institute of Technology, Atlanta, GA, USA,* ³*Suniva Inc., Norcross, GA, USA.* 2978

(843-H10) **High-Throughput Si Foil Technologies at Fraunhofer ISE.** Stefan Janz, Marion Drießen, Nena Milenkovic, Martin Keller, Elke Gust, Stefan Reber. *Fraunhofer ISE, Freiburg, Germany.* 2983

(844-H14) **High quality multicrystalline silicon wafer by grain size control on directional growth method.** Ho Kai-An, Chou Jian-Kang, Tzeng Shi-Kai, Liao Lung-Sheng, Yang Chen-Hao, Wu Jui-Pin, Wu Yu-Hao, Chen Yu-Chung. *Motech Industries Inc., Tainan, Taiwan.* 2986

(845-H18) **>1.8 Millisecond Effective Lifetime in n-type Silicon Grown by the Noncontact Crucible Method.** Maulid Kivambe¹, Douglas M. Powell¹, Mallory Ann Jensen¹, Ashley E Morishige¹, Kazuo Nakajima², Ryota Murai², Kohei Morishita², Tonio Buonassisi¹. ¹*Massachusetts Institute of Technology, Cambridge, MA, USA,* ²*Graduate School of Energy Science, Kyoto University, Kyoto, Japan* 2988

(846-H22) **Ingots Pulled with Electron Beam Heating from Skull - a New Feedstock for FZ Crystals Applicable for Solar Cells.** Anatoly Kravtsov. SIA "KEPP EU", Riga, Latvia. 2991

(847-H26) **Analysis of Emitter Performance contacted with Silicide induced Dopant Segregation.** Markus Lenz, Joachim Knoch. RWTH Aachen University, Institute of Semiconductor Electronics, Aachen, Germany. 2994

(848-H30) **Double Shottcky of NiOx/Graphene/Si for Enhance Efficiency Solar Cells.** M. Mohammed^{1,3}, T. Chen². ¹Department of Applied Science, University of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, ²Department of Physics and Astronomy, University of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, ³College of Science, University of Al-Qadisiyah, Al-Qadisiyah, Iraq. 2998

(849-H34) **Elucidating and Engineering Recombination-Active Metal-Rich Precipitates in n-type Multicrystalline Silicon.** Ashley E. Morishige¹, David P. Fenning¹, Jasmin Hofstetter¹, Mallory Ann Jensen¹, Sapharishi Ramanathan², Chenlei Wang², Barry Lai³, Tonio Buonassisi¹. ¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²Sunpreme, Sunnyvale, CA, USA, ³Advanced Photon Source, Argonne National Laboratory, Argonne, IL, USA. 3004

(850-H38) **Analysis of Different Models of Iron Precipitation in Multicrystalline Silicon.** Ashley E. Morishige¹, Hannu S. Laine², Jonas Schön³, Jasmin Hofstetter¹, Antti Haarahiltunen², Martin Schubert³, Hele Savin², Tonio Buonassisi¹. ¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²Aalto University, Department of Micro and Nanosciences, Espoo, Finland, ³Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany. 3008

(851-I2) **POC13 diffusion process optimization for the formation of emitters in the crystalline silicon solar cells.** Karthick Murugesan^{1,2}, Sandeep kumbhar², Ashok Kapoor³, Anuradha Dhaul³, Saravanan S², Richard Pinto^{1,2}, Arora Brij Mohan^{1,2}. ¹Indian Institute of Technology, Powai, Mumbai 400076, India, ²National Center for Photovoltaic Research and Education, Powai, Mumbai 400076, India, ³Solid State Physics Laboratory, Lucknow Road, Delhi 110054, India. 3011

(852-I6) **Sacrificial High-Temperature Phosphorus Diffusion Gettering Process for Lifetime Improvement of Multi-Crystalline Silicon Wafers.** Stephanie M. Scott, Jasmin Hofstetter, Ashley E. Morishige, Tonio Buonassisi. Massachusetts Institute of Technology, Cambridge, MA, USA. 3014

(853-I10) **Improvement of Annealing Procedure to Suppress Defect Generation during Impurity Gettering in Multicrystalline Silicon for Solar Cells.** Isao Takahashi¹, Supawan Joonwichien¹, Kentaro Kutsukake², Satoru Matsushima¹, Ichiro Yonenaga², Noritaka Usami¹. ¹Graduate School of Engineering Nagoya University, Nagoya, Japan, ²Institute for Materials Research Tohoku University, Sendai, Japan. 3017

(854-I14) **Silicon Solar Cell Voltage Increase Based on Limited Area Junction.** Peinan Teng¹, Xinrui An¹, Alexander To¹, Hamid Mehrvarz¹, Thorsten Trupke^{1,2}, Allen Barnett¹. ¹University of New South Wales, Sydney, Australia, ²BT Imaging, Sydney, Australia. 3021

(855-I18) **The influence of phosphorus diffusion gettering in interdigitated back contact solar cells.** Yun-Kuo Tsao¹, Richard Pai². ¹Motech Industries, Inc. Science Park Branch, Tainan, Taiwan, ²Motech Industries, Inc. Science Park Branch, Tainan, Taiwan. N/A

(856-120) **Controlling the defects of mc-Si ingot in industrial scale during crystallization.** Shi-Kai Tzeng, Jui-Pin Wu, Chen-Hao Yang, Lung-Sheng Liao, Kai-An Hao, Jiang-Kang Chou, Yu-Hao Wu, Yu-Chung Chen. *1, Tainan, Taiwan.* 3025

(857-122) **The Enhancement of Thin Silicon Solar Cell by Selective Emitter Structure.** Teng-Yu Wang¹, Yu-Ruei Chen^{1,2}, Chen-Hsun Du^{1,3}, Chung-Yuan Kung². *¹Industrial Technology Research Institute, Hsinchu, Taiwan, ²National Chung Hsing University, Taichung, Taiwan, ³National Tsing Hua University, Hsinchu, Taiwan.* 3028

(858-124) **Study of P-type silicon laser doping with ALD AlOx as dopant source.** Bo Xiao, Ly Mai, Dong Lin, Brett Hallam, Chee Mun Chong, Alison Lennon, Stuart Wenham. *University of New South Wales, Sydney, Australia.* 3032

(859-126) **Crystal growth, microstructure characterization and cell performance analysis of casting-monocrystalline ingots with orientation.** Zhen Xiong¹, Yingbin Zhang^{1,2}, Shaoyong Fu¹, Zhiqiang Zhang¹, Guanchao Xu¹, Zhiqiang Feng¹, Junhao Chu², Pierre J. Verlinden¹. *¹State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China, ²Key Laboratory of Polar Materials and Devices, Ministry of Education, Department of Electronics, East China Normal University, 500 Dongchuan Road, Shanghai, China.* 3036

(860-127) **nm-scaled workfunction mapping of the interfaces of silicon heterojunction (SHJ) solar cell using Kelvin probe force microscopy.** Fumihiko Yamada, Takefumi Kamioka, Tomihisa Tachibana, Kyotaro Nakamura, Yoshio Ohshita, Itaru Kamiya. *Toyota Technological Institute, Nagoya, Japan.* 3040

(861-128) **Modeling of Hydrogenated Heavy B Diffusion for n-type Silicon Solar Cells.** Matthew G Young^{1,2,3}, Seth Shumate^{1,2,4}, Hafeezuddin Mohammed¹, Scott Little¹, Douglas Hutchings^{1,2}, Hameed Naseem³. *¹Silicon Solar Solutions, LLC, Fayetteville, AR, USA, ²Picasolar, Inc., Fayetteville, AR, USA, ³University of Arkansas Electrical Engineering, Fayetteville, AR, USA, ⁴University of Arkansas Microelectronics-Photonics, Fayetteville, AR, USA.* N/A

(862-129) **Growth of low defect density mc-Si ingots and wafers for PV application.** Zhiqiang Zhang¹, Yingbin Zhang^{1,2}, Zhen Xiong¹, Hongliang Ye¹, Feilin Ping¹, Shaoyong Fu¹, Zhiqiang Feng¹, Pierre J. Verlinden¹. *¹State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China, ²Key Laboratory of Polar Materials and Devices, Ministry of Education, Department of Electronics, East China Normal University, Shanghai, China.* 3043

(863-130) **Etch-Back Simplifies Interdigitated Back Contact Solar Cells.** Ngwe Zin, Kean Fong, Evan Franklin, Teng Kho, Nick Grant, Da Wang, Eric Wang. *Australian National University, Canberra, Australia.* 3046

Area 5 - Posters

10:30 - 12:00 PM

Exhibit Hall D

Thin Film Si: Processing and Light Management

Chair(s): Nikolas Podraza, Matthias Meier

(864-132) **Thin-Film Silicon Solar Cells Fabricated at Low Temperature: A Versatile Technology for Application on Transparent Flexible Plastic Substrates and in Integrated Photoelectrochemical Water Splitting Modules.** Karen Wilken, Vladimir Smirnov, Oleksandr Astakhov, Friedhelm Finger. *Forschungszentrum Jülich GmbH, Jülich, Germany.* 3051

(865-134) **P⁺ layer effects on a-Si:H solar cell performance.** Kibum Kim, Yue Kuo. *Texas A&M University, College Station, TX, USA. 3055*

(866-136) **Open circuit voltage ~ 0.95 V for microcrystalline silicon mixed phase solar cell.** Jatindra Kumar Rath. *Utrecht University, Faculty of Science,, Eindhoven,, Netherlands. N/A*

(867-138) **Low Temperature Deposition of Device-Quality Silicon Thin Films for Flexible PV Application.** Nilesh A Wadibhasme, Rajiv O Dusane. *Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India. 3060*

(868-140) **Study of Intrinsic Stress in Hydrogenated Amorphous Silicon PECVD Films with Cyclohexasilane (CHS) as a Precursor.** Konstantin Pokhodnya, Kenneth J. Anderson, Philip R Boudjouk. *Center for Nanoscale Science and Engineering, North Dakota State University, Fargo, ND, USA. 3065*

(869-J2) **Atmospheric Pressure Chemical Vapor Deposition of Silicon Thin Films using Cyclohexasilane.** Guruvenket Srinivasan, Justin M Hoey, Kenneth J Anderson, Matthew Frohlich, Gregory Strommen, Robert A Sailer, Philip Boudjouk. *Center for Nanoscale Science and Engineering, North Dakota State University, Fargo, ND, USA. 3068*

(870-J4) **~10% Increase in Short-Circuit Current Density using 100 nm Plasmonic Au Nanoparticles on Thin Film n-i-p a-Si:H Solar Cells.** Kazi Islam, Farsad Chowdhury, Aaisha Alnuaimi, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Department of Electrical Engineering and Computer Science (EECS), Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates. 3071*

(871-J6) **Nanoplasmonic Architecture for Semi-Transparent Nanocrystalline Silicon Thin Film.** Mohsen Mahmoudysepheh, Jahed Navid, Siva Sivoththaman. *The Centre for Advanced Photovoltaic Devices and Systems, University of Waterloo, Waterloo, ON, Canada. N/A*

(872-J8) **Optical transmission and reflection analysis for semi-transparent amorphous silicon solar cells using scattering matrix method.** Da Jung Lee^{1,2}, Seong Hyun Lee^{1,2}, Sun Jin Yun^{1,2}, Jung Wook Lim^{1,2}, Myunghun Shin³. ¹*University of Science and Technology, Daejeon, Korea, ²Electronics and Telecommunications Research Institute, Daejeon, Korea, ³Korea Aerospace University, Goyang-city, Korea. N/A*

(873-J10) **Periodic Surface texturing effect on ultra thin a-Si/DMD solar cell studied by optical modeling.** Masanori Fukuda, Kyu-Tae Lee, Jae-Yong Lee, L. Jay Guo. *University of Michigan, EECS, Ann Arbor, MI, USA. N/A*

(874-J12) **Parasitic absorption effects in metallic back reflectors with texture.** Franz-Josef Haug¹, Jia Li², Christophe Ballif¹. ¹*Ecole Polytechnique Fédérale de Lausanne, PV-Lab, Neuchatel, Switzerland, ²Ningbo Institute of Material Technology and Engineering, Ningbo, China. 3076*

(875-J14) **Efficiency Enhancement of Thin-Film a-Si:H Solar Cell with Periodic Anti-ring Back Reflector.** Hui-Hsin Hsiao, Po-Yuan Chen, I-Chun Cheng, Hung-Chun Chang, Yuh-Renn Wu. *National Taiwan University, Taipei, Taiwan. 3080*

(876-J16) **30% Increase in Available Photons/Cell Area Using Nanoelement Array Light Trapping in 700nm Thick nc-Si Solar Cells.** Wook Jun Nam^{1,2}, Diego Fischer³, Zachary Gray¹, Liming Ji¹, Douglas Neidich⁴, Stephen Fonash^{1,2,4}. ¹Center for Nanotechnology Education and Utilization, The Pennsylvania State University, University Park, PA, USA, ²Department of Engineering Science and Mechanics, The Pennsylvania State University, University Park, PA, USA, ³PV and Renewable Energy Technology and Engineering, Neuchâtel, Switzerland, ⁴Solarity LLC, State College, PA, USA. N/A

(877-J18) **Influence of Interface Textures in Thin-Film Si Solar Cells with Intermediate Reflector on Light Management.** Chao Zhang, Matthias Meier, André Hoffmann, Wendi Zhang, Markus Ermes, Karsten Bittkau, Gabrielle Jost, Ulrich Paetzold, Tsvetelina Merdzhanova. *IEK5 Photovoltaik, Forschungszentrum Jülich, Jülich, Germany.* N/A

(878-J20) **Influence of the ZnO layer on performance of a- Si/ a-SiGe tandem solar cells with Aluminum/ZnO back reflector.** changyong chen. *The University of Toledo, Toledo, OH, USA.* N/A

(879-J22) **Optimization of the Backside Metallization for a-Si:H/uc-Si:H Thin Film Tandem Solar Cells.** Xinwei Niu, Shiyong Liu, Wang Li, Jiayi Zheng, Chuan Lu. *Chint Solar (Zhejiang) Co., Ltd., 1335 Binan Lu, Hangzhou, China.* N/A

(880-J24) **Low-refractive-index silicon-oxide interlayers for high-stable-efficiency multi-junction thin-film silicon solar cells.** Mathieu Boccard, Matthieu Despeisse, Jordi Escarre, Xavier Niquille, Grégory Bugnon, Simon Hänni, Maximilien Bonnet-Eymard, Fanny Meillaud, Christophe Ballif. *PV-lab, Ecole Polytechnique Fédérale de Lausanne (EPFL), Neuchâtel, Switzerland.* N/A

(881-J25) **Optical Modeling of an Efficient Water Splitting Device Based on Bismuth Vanadate Photoanode and Micromorph Silicon Solar Cells.** Lihao Han¹, Fatwa Abdi^{2,3}, Roel van de Krol³, Bernard Dam², Miro Zeman¹, Arno Smets¹. ¹Photovoltaic Materials and Devices (PVMD) Laboratory, Delft University of Technology, Delft, Netherlands, ²Materials for Energy Conversion and Storage (MECS) Laboratory, Delft, Netherlands, ³Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Institute for Solar Fuels, Berlin, Germany. 3083

(882-J26) **Thin Heterojunction a-Si:H Photovoltaic Cell Design With No Doped a-Si:H Layers.** Erenn Ore, Gehan Amarantunga. *University of Cambridge, Cambridge, UK.* 3087

Area 10 - Posters

10:30 - 12:00 PM

Exhibit Hall D

Power Conversion**Chair(s): Ward Bower, Pierre Verlinden**

(883-N18) **Un-interrupted DC Power from Grid: Will this accelerate decentralized solar deployments at Indian homes?**. Ashok Jhunjunwala, Bhaskar Ramamurthi, Krishna Vasudevan, Lakshmi Narasamma. *Indian Institute of technology, Madras, Chennai, India.* N/A

(884-N22) **Novel 1- \emptyset Multilevel Current Source Inverter for Balanced/Unbalanced PV sources.** Phanikumar Chamarthi, Nataraj Pragallapati, Agarwal Vivek. *IIT BOMBAY, MUMBAI, India.* 3090

(885-N26) **A New Coupled Inductor Based 9-level Inverter with Reduced Number of Switches for Standalone/Grid Connected Solar PV Applications.** Phanikumar Chamarthi, Agarwal Vivek. *IIT Bombay, Mumbai, India.* 3094

(886-N30) **Development of a String Level Fault Detection System for Solar Tracking Applications.** Yunus Erkaya, Hareen Sekhr Illa, Caitlin Conway, Shirshak Dhali, Sylvain X. Marsillac. *Virginia Institute of Photovoltaics, Norfolk, VA, USA.* 3100

(887-N34) **Development of a String Level I-V Curve Tracer.** Yunus Erkaya, Isaac Flory, Sylvain X. Marsillac. *Virginia Institute of Photovoltaics, Norfolk, VA, USA.* 3104

(888-N38) **Multi-Objective Study for Down Selection of A Micro-Inverter Topology for Residential PV Applications.** Maja Harfman-Todorovic¹, Fenfeng Tao¹, Rui Zhou¹, Robert Steigerwald¹, Mohammed Agamy¹, Yan Jiang¹, Luis Garces¹, Michael Schutten¹, Donald Marabell². ¹*GE Global Research Center, Niskayuna, NY, USA,* ²*GE Critical Power, Plano, TX, USA.* 3108

(889-N42) **Smart Combiner for Fixed Commercial Photovoltaic Systems Using Power Line Communication.** Chad Herndon, Yunus Erkaya, Chunsheng Xin, Shirshak Dhali, Sylvain X. Marsillac. *Virginia Institute of Photovoltaics, Norfolk, VA, USA.* 3114

(890-N46) **Development of monolithically integrated high performance hybrid PV/a-SiC devices for photoelectrochemical water splitting.** Jian Hu¹, Feng Zhu¹, Augusto Kunrath¹, Dixit Prasher², Nicolas Gaillard². ¹*MVSystems, Inc, Golden, CO, USA,* ²*Hawaii Natural Energy Institute, Honolulu, HI, USA.* 3119

(891-O2) **Integration of PV into the Energy System : Challenges and Measures for Generation and Load management.** Stefan Krauter. *University of Paderborn, Paderborn, Germany.* 3123

(892-O6) **Comparative Evaluation of Current Source Inverters Interfacing Photo-Voltaic System to Grid for Modified Space Vector PWM Techniques.** Saravanan Sivanesan, Krishna Vasudevan. *Indian Institute of Technology, Chennai, India.* 3129

(893-O10) **The Goal Oriented PV Inverter.** Sorin Spanoche¹, Behnam Behziz². ¹*Optimhedron.com, Santa Clara, CA, USA,* ²*Lam Research Corporation, Fremont, CA, USA.* 3134

(894-O14) **A Novel Low Cost Portable Integrated Solar PV, Fuel Cell and Battery Emulator with Fast Tracking Algorithm.** Sushil Thale, Rupesh Wandhare, Vivek Agarwal. *Indian Institute of Technology-Bombay, Mumbai, India.* 3138

(895-O17) **Design of a Photovoltaic Power Conditioning System for Hierarchical Control of a Microgrid.** Rupesh Wandhare, Sushil Thale, Vivek Agarwal. *Indian Institute of Technology- Bombay, Mumbai, India.* 3144

(896-O20) **Precise Active and Reactive Power Control of the PV-DGS Integrated with Weak Grid to Increase PV Penetration.** Rupesh Wandhare, Vivek Agarwal. *Indian Institute of Technology- Bombay, Mumbai, India.* 3150

Area 12 - Posters	
10:30 - 12:00 PM	Exhibit Hall D
Reliability 2	

Chair(s): Ben Bourne, Sean Fowler, Eric Gerritsen

(897-O48) **The Reliability Assessment of Central Photovoltaic Inverter in Electric Power System.** Ahmad Alferidi, Yasser A.-R. I. Mohamed. *1, Edmonton, AB, Canada.* 3156

(898-P2) **Degradation Rate Evaluation of 26-Year-Old 200 kW Power Plant in a Hot-Dry Desert Climate.** Jonathan Belmont, Kolapo Olakonu, Jaya Mallineni, Joseph Kuitche, Govindasamy TamizhMani. *Arizona State University ASU-PRL, Mesa, AZ, USA.* 3162

(899-P4) **EL Inspection Of Thin-Film PV Modules In Between Field Operation.** Matevù Bokalič, Marko Topič. *University of Ljubljana, Faculty of Elec Eng, Ljubljana, Slovenia.* 3167

(900-P6) **Ambient Airborne Particle Concentration and Soiling of PV Cover Plates.** Liza N Boyle, Holly N Flinchpough, Michael P Hannigan. *University of Colorado Boulder, Boulder, CO, USA.* 3171

(901-P8) **Effect of Tilt Angle on Soiling of Photovoltaic Modules.** Jose Cano¹, Jim Joseph John^{1,2}, Sai Tatapudi¹, Govindasamy Tamizhmani¹. *¹Arizona State University Photovoltaic Reliability Lab, Mesa, AZ, USA, ²Indian Institute of Technology Bombay, Mumbai, India.* 3174

(902-P10) **Behavior of Light-Induced Degradation for Temperature Cycling Test.** Chien Yu Chen, Haomin Chen, C. H. Hsueh, MaoYi Chang. *AU Optronics Corporation(Benq Solar), Taichung, Taiwan.* 3177

(903-P12) **Reliability & Risk Analysis for PV Systems: The Road to Probabilistic Risk Assessment.** Alessandra Colli. *Brookhaven National Laboratory, Upton, NY, USA.* N/A

(904-P14) **Performance Degradation in Field-aged Crystalline Silicon PV Modules in Different Indian Climatic Conditions.** Rajiv Dubey¹, Shashwata Chattopadhyay¹, Vivek Kuthanazhi¹, Jim J. John¹, Chetan S. Solanki¹, Anil Kottantharayil¹, Brij M. Arora¹, K.L. Narasimhan¹, Juzer M. Vasi¹, Arun Kumar², O.S. Sastry². *¹National Centre for Photovoltaic Research and education, Indian Institute of Technology Bombay, Powai, Mumbai, 400076, India, ²Solar Energy Center, Ministry of New and Renewable Energy, New Delhi, 110003, India.* 3182

- (905-P16) **An Innovative Photovoltaic DC Arc Fault Detection Method through Multiple Criteria Algorithm Based on a New Arc Initiation Method.** Yuan Gao, Yandan Lin, Yaojie Sun. *Department of Light Sources and Illuminating Engineering, School of Information Science and Technology, Fudan University, Shanghai, China.* 3188
- (906-P18) **Outdoor exposure tests of silicon crystalline photovoltaic for reliability.** Hyun-A Kim, Jung-Jin Choi, Sang-Cheol Kim. *Korea Conformity Laboratories, Seoul, Korea.* 3193
- (907-P20) **Soiling Losses of Utility-Scale PV Systems in Hot-Dry Desert Climates: Results from Four 4-16 Years Old Power Plants.** Jaya Krishna Mallineni, Karan Rao Yedidi, Sanjay Mohan Shrestha, Brett Knisely, sai tatapudi, Joseph Kuitche, Govindasamy Tamizhmani. *Arizona State University, Mesa, AZ, USA.* 3197
- (908-P22) **Evaluation Method for Arc Fault Detection Algorithms.** Stephen McConnell¹, Zhan Wang¹, Robert S. Balog¹, Jay Johnson². ¹*Texas A&M University, College Station, TX, USA,* ²*Sandia National Laboratories, Albuquerque, NM, USA.* 3201
- (909-P24) **On-field Performance Assessment of Solar PV System under Different Operating Conditions.** Parimita Mohanty, K Rahul Sharma, Mukesh Gujar, Alekhya Datta. *TERI, India Habitat Centre, Lodhi Road, New Delhi, India.* N/A
- (910-P26) **Degradation and Failure Modes of 26-Year-Old 200 kW Power Plant in a Hot-Dry Desert Climate.** Kolapo Olakonu, Jonathan Belmont, Sai Tatapudi, Joseph Kuitche, Govindasamy TamizhMani. *Arizona State University ASU-PRL, Mesa, AZ, USA.* 3207
- (911-P28) **Comparison of trend extraction methods for calculating performance loss rates of different photovoltaic technologies.** Alexander Phinikarides, George Makrides, Nitsa Kindyni, George E. Georghiou. *FOSS Research Centre for Sustainable Energy, Photovoltaic Technology, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus.* 3211
- (912-P30) **Performance Variation of Commercially Available Modules after Six Months of Outdoor System Voltage Stress Testing.** Eric Schneller, Narendra S. Shiradkar, Neelkanth G. Dhere. *Florida Solar Energy Center, Cocoa, FL, USA.* 3216
- (913-P32) **Identification of changes in power through DC string monitoring.** Rajalakshmi Sundaramoorthy, Nicholas J Alexander, David Metacarpa, Jim R Lloyd, Pradeep Haldar. *US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.* 3220
- (914-P34) **Tightening nameplate rating tolerance below 5%: Can it be rationally and objectively required in test standards?.** GovindaSamy TamizhMani¹, Sailaja Radhakrishnan², William Shisler¹. ¹*TUV Rheinland PTL, Tempe, AZ, USA,* ²*Arizona State University, Mesa, AZ, USA* 3226
- (915-P36) **Two Years Performance Comparison of Elkem Solar Multicrystalline Silicon with Polysilicon in a PV Grid-Connected System.** Muhammad Tayyib¹, Jan Ove Odden², N Ramchander³, M B Prakash³, R Muneeshwar³, A V Sarma⁴, M Ramanjaneyulu⁴, tor Oskar Saetre⁵. ¹*Teknova AS Gimlemoen 19, 4630, Kritiansand S, Norway,* ²*Elkem Solar AS. P.O. Box 8040 Vaagsbygd. NO-4675, Kritiansand S, Norway,* ³*Padmasri Dr. B.V. Raju Inst. Of Techn., Vishnupur,, Narsapur, India,* ⁴*Titan Energy Systems Ltd., 16 Aruna Enclave, Trimulgherry,, Secunderabad, India,* ⁵*University of Agder, Postboks 509, NO-4898, Grimstad, Norway.* 3230

(916-P37) **A Statistical Analysis on the Cell Parameters Responsible for Power Degradation of Fielded PV Modules in a Hot-Dry Climate.** Suryanarayana Vasantha Janakeerama, Jaspreet Singh, Joseph Kuitche, Jaya Krishna Mallineni, GovindaSamy TamizhMani. *Arizona State University- Photovoltaic Reliability Laboratory, Mesa, AZ, USA.* 3234

(917-P38) **Arc Fault Signal Detection - Fourier Transformation vs. Wavelet Decomposition Techniques using Synthesized Data.** Zhan Wang¹, Stephen McConnell¹, Robert S. Balog¹, Jay Johnson². ¹*Texas A&M University, College Station, TX, USA,* ²*Sandia National Laboratory, Albuquerque, NM, USA.* 3239

(918-P39) **Failure and Degradation Modes and Rates of PV Modules in a Hot-Dry Climate: Results after 16 years of field exposure.** Karan Rao Yedidi, Sai Tatapudi, Jaya Krishna Mallineni, Brett Knisely, Joseph Kuitche, Govindasamy Tamizhmani. *ASU, Mesa, AZ, USA.* 3245

Special Event	
12:00 - 1:30 PM	MR 501
Women in PV Luncheon	

Area 1 - Orals	
1:30 - 3:00 PM	Ballroom 1AB
Two-step Photon Absorption Concepts and Implementation	

Chair(s): Gergely Zimanyi, Alexandre Freundlich

- 1:30 **(919) Spectrally resolved interband and intraband transitions by two-step photon absorption in InGaAs/GaAs quantum dot solar cells**
 Ryo Tamaki, Yasushi Shoji, Yoshitaka Okada, Kenjiro Miyano
Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan N/A
- 2:00 **(920) New Nanostructured Materials for Efficient Photon Upconversion**
 Diane G. Sellers¹, Steve Polly², Yujun Zhong¹, Eric Chen¹, Seth Hubbard², Joshua M.O. Zide¹, Matthew F. Doty¹
¹*Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA,*
²*NanoPower Research Labs, Rochester Institute of Technology, Rochester, NY, USA* N/A
- 2:15 **(921) Analysis and Design of Core-Shell Upconverting Nanostructures (CSUNs)**
 Mark A. Wistey, Victor Patel, Meng Qi, William A. O'Brien, Joseph L. Loof, Anthony J. Erdman, Chad Stephenson
University of Notre Dame, Notre Dame, IN, USA 3248

- 2:30 **(922) Two-photon photocurrent and voltage up-conversion in a quantum dot intermediate band solar cell**
 Iñigo Ramiro¹, Elisa Antolin^{1,2}, Pablo G. Linares¹, Esther López¹, Irene Artacho¹, Alejandro Datas¹, Antonio Martí¹, Antonio Luque¹, Mathew J. Steer³, Colin R. Stanley³
¹*Instituto de Energía Solar, Universidad Politécnica de Madrid, Madrid, Spain*, ²*School of Physics and Astronomy, University of Nottingham, Nottingham, UK*, ³*School of Engineering, Glasgow, UK 3251*
- 2:45 **(923) Dynamics and Two Photon Intersubband Absorption of Photovoltaic Quantum Structures**
 Philipp Sippel¹, Klaus Schwarzburg¹, Mario Borgwardt¹, Mikaela Elagin², Simon Heitz², Mykhaylo Semtsiv², Ted Masselink², Thomas Hannappel³, Rainer Eichberger¹
¹*Helmholtz Zentrum Berlin, Berlin, Germany*, ²*Humboldt University Berlin, Berlin, Germany*, ³*Ilmenau University of Technology, Ilmenau, Germany 3254*

Area 2 - Orals	
1:30 - 3:00 PM	MR 502-504
CdTe 1	

Chair(s): Matt Reese, Mike Walls

- 1:30 **(924) Advances in control of doping and lifetime in single-crystal and polycrystalline CdTe**
 James M Burst, David S Albin, Joel N Duenow, Matthew O Reese, Stuart B Farrell, Darius Kuciauskas, Wyatt K Metzger
National Renewable Energy Laboratory, Golden, CO, USA 3258
- 2:00 **Best Student Presentation Award Finalist (925) Arsenic Doped Heteroepitaxial CdTe by MBE for Applications in Thin-Film Photovoltaics**
 Eric Colegrove¹, Brian Stafford¹, Timothy Gessert², Sivalingam Sivananthan¹
¹*University of Illinois at Chicago, Chicago, IL, USA*, ²*National Renewable Energy Laboratory, Golden, CO, USA 3261*
- 2:15 **Best Student Presentation Award Finalist (926) Photoluminescence Spectroscopy of Cadmium Telluride Deep Defects**
 Paul J. Roland, Naba R. Paudel, Chuanxiao Xiao, Yanfa Yan, Randy J. Ellingson
Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, The University of Toledo, Toledo, OH, USA 3266
- 2:30 **Best Student Presentation Award Finalist (927) Optical properties of monocrystalline CdTe/MgCdTe double heterostructures grown by molecular beam epitaxy**
 Xin-Hao Zhao¹, Michael J. DiNezza¹, Shi Liu¹, Pathiraja A. Jayathilaka², Odille C. Noriega², Thomas H. Myers², Yong-Hang Zhang¹
¹*Arizona State University, Tempe, AZ, USA*, ²*Texas State University, San Marcos, TX, USA 3272*
- 2:45 **(928) Extracting Cu Diffusion Parameters in Polycrystalline CdTe**
 Richard Akis¹, Daniel Brinkman², Igor Sankin³, Tian Fan³, Da Gou¹, Christian Ringhofer¹
¹*School of ECEE, Arizona State University, Tempe, AZ, USA*, ²*School of Mathematical & Statistical Sciences, Arizona State University, Tempe, AZ, USA*, ³*First Solar, Perrysburg, OH, USA 3276*

Area 3 - Orals	
1:30 - 3:00 PM	Ballroom 2B
CPV Modules and Systems	

Chair(s): Kensuke Nishioka, Geoffrey Kinsey

- 1:30 **(929) Suncore's CPV Power Plant Deployment in Western China**
 James Foresi¹, Rick Han², Alaric Babej¹, Charlie Wang¹, David King³
¹Suncore Photovoltaics, Inc., Albuquerque, NM, USA, ²Suncore Photovoltaic Technology, Huainan, China, ³DK Solar Works, Albuquerque, NM, USA 3282
- 2:00 **(930) Semprius Module and System Results**
 Kanchan Ghosal, Doug Lilly, John Gabriel, Steve Seel, Brent Fisher, Scott Burroughs
 Semprius Inc., Durham, NC, USA 3287
- 2:15 **(931) Keys for the joint design of the optics and the solar cell in a CPV system**
 Pilar Espinet-González, Marta Victoria, Ignacio Rey-Stolle, Stephen Askins, Carlos Algora, Ignacio Antón, Gabriel Sala
 Solar Energy Institute (IES), Technical University of Madrid (UPM), Madrid, Spain N/A
- 2:30 **(932) Modeling nonuniform irradiance and chromatic aberration effects in a four junction solar cell using SPICE**
 Pratibha Sharma, Matthew Wilkins, Henry Schriemer, Karin Hinzer
 University of Ottawa, Ottawa, ON, Canada 3293
- 2:45 **(933) Effect of the Encapsulant Temperature on the Angular and Spectral Response of Multi-Junction Solar Cells**
 Pablo Garcia-Linares, César Dominguez, Pierre Besson, Mathieu Baudrit
 CEA-LITEN, LMPV, Le Bourget du Lac, France 3298

Area 4 - Orals	
1:30 - 3:00 PM	Ballroom 1EF
Surface Passivation	

Chair(s): Ajeet Rohatgi, Klaus Weber

- 1:30 **(934) Requirements for Achieving Extremely Low Surface Recombination Velocity and Negligible Optical Loss in Cat-CVD SiNx/a-Si Stacked Passivation**
 Koichi Koyama, Trinh Cham Thi, Koichi Higashimine, Keisuke Ohdaira, Hideki Matsumura
 Japan Advanced Institute of Science and Technology, Nomi, Japan 3304
- 1:45 **Best Student Presentation Award Finalist (935) Dielectric Charge Tailoring in PECVD SiOx/SiNx Stacks and its Impact on Industrial p-Type Si Wafer Solar Cell Efficiency**
 Shubham Duttagupta^{1,2}, Ziv Hameiri¹, Bram Hoex¹, Armin G. Aberle^{1,2}
¹Solar Energy Research Institute of Singapore, Singapore, Singapore, ²National University of Singapore, Singapore, Singapore N/A

- 2:00 **(936) Back-Side AlOx Passivation Material and Technology for the Application of High Efficiency (20%) and Low Cost PERC Solar Cells**
 Jui-Yi Hung¹, Jung-Ching Wang², Shian-Wen Chen², Tsung-Cheng Chen³, Yung-Sheng Lin³, Chen-Hao Ku³
¹2F, No. 3, Luke 1st Rd., Kaohsiung Science Park, Luzhu Dist., Kaohsiung, Taiwan, ²No. 22, Changhsing Road, Luchu District, Kaohsiung, Taiwan, ³ No. 498, Sec.2, Bentian St., An-Nan Dist., Tainan, Taiwan 3308
- 2:15 **(937) Numerical Analysis of Injection Level Dependent Effective Lifetime on 125-mm Undiffused Carrier Lifetime c-Si Samples**
 Fa-Jun Ma^{1,2}, Ziv Hameiri¹, Ganesh S. Samudra^{1,2}, Marius Peters¹, Bram Hoex¹
¹Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore, ²Department of Electrical and Computer Engineering, National University of Singapore, Singapore, Singapore 3313
- 2:30 **(938) Influence of the NH₃:SiH₄ Ratio and Surface Morphology on the Surface Passivation of Phosphorus-Diffused C-Si by PECVD SiN**
 Yimao Wan¹, Di Yan¹, Andres Cuevas¹, Keith R McIntosh²
¹Research School of Engineering, The Australian National University, Canberra, Australia, ²PV Lighthouse, Coledale, Australia 3317
- 2:45 **(939) Realization of Al-alloyed local contacts for industrial PERC cells by a two-step metallization method**
 Yifeng Chen^{1,2}, Pietro P. Altermatt³, Jianwen Dong², Jiajing Liu¹, Dianlei Wang¹, Yuling Jiang², Binhui Liu^{1,2}, Daming Chen², Weiwei Deng², Jian Sheng², Hui Shen¹, Zhiqiang Feng², Pierre J. Verlinden²
¹Institute for Solar Energy Systems, Sun Yat-Sen University, Guangzhou, China, ²State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China, ³Department of Solar Energy, Leibniz University of Hannover, Hannover, Germany 3322

Area 8 - Orals	
1:30 - 3:00 PM	Ballroom 2A
Thin Film Characterization	

Chair(s): Dean Levi, Robert Collins

- 1:30 **(940) An Arbitrarily Programmable Solar Simulator Based on a Liquid Crystal Spatial Light Modulator**
 Tasshi Dennis
 National Institute of Standards and Technology, Boulder, CO, USA 3326
- 1:45 **(941) Loss analysis on CIGS-modules by using contactless, imaging illuminated lock-in thermography and 2D electrical simulations**
 Frank W. Fecher^{1,2}, Jens Adams¹, Andreas Vetter², Claudia Buerhop-Lutz¹, Christoph J. Brabec^{1,2}
¹ZAE Bayern, Erlangen, Germany, ²i-MEET, Universität Erlangen-Nürnberg, Erlangen, Germany 3331

- 2:00 **Best Student Presentation Award Finalist (942) Direct Evidence of a Cu(In,Ga)₃Se₅ Phase in a Bulk, High Efficiency Cu(In,Ga)Se₂ Device Using Atom Probe Tomography**
Adam W Stokes^{1,2}, Brian P Gorman¹, Dave R Diercks¹, Mowafak M Al-Jassim²
¹Colorado School of Mines, Golden, CO, USA, ²National Renewable Energy Laboratory, Golden, CO, USA 3335
- 2:15 **(943) Correlating Multiple Spatially-Resolved Techniques (LBIC/Raman/PL/Reflectance/SEM/AFM) in the Study of Microscopic Inhomogeneity of Thin-Film Solar Cells: Cu₂ZnSnSe₄ as An Example**
Qiong Chen, Yong Zhang
Department of Electrical and Computer Engineering, and Energy Production and Infrastructure Center (EPIC), The University of North Carolina at Charlotte, CHARLOTTE, NC, USA 3338
- 2:30 **(944) Nanoscale electrical properties of wide bandgap Cu(In,Ga)Se₂ and Cu₂ZnSn(SSe)₄ thin films**
C.-S. Jiang, M.A. Contreras, I.L. Repins, L.M. Mansfield, C. Beall, K. Ramanathan, M.M. Al-Jassim
National Renewable Energy Laboratory, Golden, CO, USA 3341
- 2:45 **(945) Analysis of Light Propagation in Thin-Film Solar Cells by Dual-Probe Scanning Near-Field Optical Microscopy**
Stephan Lehnen, Ulrich Wilhelm Paetzold, Markus Ermes, Karsten Bittkau, Reinhard Carius
Forschungszentrum Jülich GmbH, Jülich, Germany 3347

Area 10 - Orals	
1:30 - 3:00 PM	Ballroom 1CD
System Design	

Chair(s): Mark Albers, Nicolas Bogdanski

- 1:30 **(946) Integrative Approach to PV Plant and Power Conversion Design**
Michael Schenck
Ipsium Power, San Rafael, CA N/A
- 2:00 **(947) National Electrical Code Changes in 2014 for Photovoltaics: Processes, Critical Industry Consensus Topics and Impacts**
Ward I Bower
Ward Bower Innovations LLC, Albuquerque, NM, USA 3352
- 2:15 **(948) Reducing Solar PV Soft Costs: A Focus on Installation Labor**
Koben Calhoun¹, Joseph Goodman², Jesse Morris¹, Daniel Seif¹
¹Rocky Mountain Institute, Snowmass, CO, USA, ²Georgia Tech Research Institute, Atlanta, GA, USA 3356
- 2:30 **(949) Mechanical Design Methodology for Lightweight Deployable Solar Electric System for Commercial Rooftops**
Kevin S Myers, Yi Han, Charles S Korman
GE Global Research, Niskayuna, NY, USA 3362
- 2:45 **(950) Hard Balance of System Cost Reduction from Module Level Power Optimizers**
Jonathan Topham¹, Dr. John Schmalzel²
¹Graduate of Rowan University, Glassboro, NJ, USA, ²Professor at Rowan University, Founding Chair, Glassboro, NJ, USA N/A

Area 12 - Orals**1:30 - 3:00 PM****Ballroom 2C****Field Reliability Experience****Chair(s): Charlie Hasselbrink, Ralph Gottschalg**

- 1:30 **(951) Field Performance of 1.7 Gigawatts of Photovoltaic Systems**
Dirk C Jordan, Sarah R Kurtz
NREL, Golden, CO, USA N/A
- 2:00 **(952) Visual Degradation in Field-aged Crystalline Silicon PV Modules in India and Correlation with Electrical Degradation**
Shashwata Chattopadhyay¹, Rajiv Dubey¹, Vivek Kuthanazhi¹, Jim J. John¹, Chetan S. Solanki¹, Anil Kottantharayil¹, Brij M. Arora¹, K.L. Narasimhan¹, Juzer M. Vasi¹, Arun Kumar², O.S. Sastry²
¹National Centre for Photovoltaic Research and education, Indian Institute of Technology Bombay, Powai, Mumbai, 400076, India, ²Solar Energy Center, Ministry of New and Renewable Energy, New Delhi, 110003, India N/A
- 2:15 **(953) Evaluation of 12-Year-Old PV Power Plant in Hot-Dry Desert Climate: Potential Use of Field Failure Metrics for Financial Risk Calculation**
Jaya Krishna Mallineni, Brett J Knisley, Karan R Yedidi, Sai Tatapudi, Joseph Kuitche, Govindasamy Tamizhmani
Arizona State University Photovoltaic Reliability Laboratory(ASU-PRL), Mesa, AZ, USA 3366
- 2:30 **Best Student Presentation Award Finalist (954) FMECA on Field Deployed c-Si Modules under Hot-Dry Desert Climate for Determining Dominant Failure Modes**
Sanjay M Shrestha, Jaya K Mallineni, Sai Tatapudi, Brett Knisely, Karan Yedidi, Joseph Kuitche, Govindsamy TamizhMani
Arizona State University, Mesa, AZ, USA N/A
- 2:45 **(955) Fifteen Years and Counting: The Reliable Long Term Performance of the First Grid-Connected, Building-Integrated, Thin-Film Photovoltaic Installation in Brazil**
Lucas Nascimento, Ricardo Ruther
Universidade Federal de Santa Catarina / UFSC, Florianopolis, Brazil 3372

3:00 - 3:30 PM**Ballroom Pre-function****Coffee Break****TECHNICAL PROGRAM****THURSDAY PM**

Joint Session: Areas 10,12 - Orals

3:30 - 5:00 PM

MR 505-507

PV System Safety

Chair(s): Nicolas Bogdanski, Kent Whitfield

- 3:30 **(956) Comparative Evaluation of DC Fault Mitigation Techniques in Large PV Systems** N/A
Mark J. Albers¹, Greg Ball²
¹SunPower Corporation, Richmond, CA, USA, ²DNV GL, Oakland, CA, USA N/A
- 4:00 **(957) Characterizing Fire Danger from Low Power Photovoltaic Arc-Faults**
Kenneth M. Armijo, Michael Hibbs, Jay Johnson, Armando J. Fresquez
¹Sandia National Laboratories, Albuquerque, NM, USA **H I I**
- 4:15 **(958) Recommendations for RCD and Riso Ground Fault Detector Trip Thresholds**
Jack D. Flicker¹, Jay Johnson¹, Mark Albers², Greg Ball³
¹Sandia National Laboratories, Albuquerque, NM, USA, ²Sunpower Corporation, Richmond, CA, USA, ³DNV GL-Energy, San Francisco, CA, USA 3391
- 4:30 **(959) PV Module System Fire Classification**
Christopher Flueckiger
Underwriters Laboratories, Northbrook, IL, USA N/A
- 4:45 **Best Student Presentation Award Finalist (960) Fault Experiments in a Commercial-Scale PV Laboratory and Fault Detection Using Local Outlier Factor**
Ye Zhao¹, Florent Balboni², Thierry Arnaud², Jerry Mosesian³, Roy Ball³, Brad Lehman¹
¹Northeastern University, Boston, MA, USA, ²Mersen France SB SAS, Annecy Le Vieux Cedex, France, ³Mersen USA Newburyport-MA, LLC, Newburyport, MA, USA 3398

Joint Session: Areas 3,7 - Orals

3:30 - 5:00 PM

Ballroom 2B

Material Aspects and Design of III-V Solar Cells

Chair(s): Robert Walters, Andreas W. Bett

- 3:30 **(961) Implications of redesigned, high-radiative-efficiency GaInP junctions on III-V multijunction concentrator solar cells**
John F. Geisz¹, Myles A. Steiner¹, Ivan Garcia^{1,2}, Daniel J. Friedman¹, Sarah R. Kurtz¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Instituto de Energia Solar, Universidad Politecnica de Madrid, Madrid, Spain N/A
- 4:00 **Best Student Presentation Award Finalist (962) Investigations on Al_xGa_{1-x}As Solar Cells Grown by MOVPE**
Stefan Heckelmann, David Lackner, Frank Dimroth, Andreas W. Bett
Faunhofer Institute for Solar Energy Systems, Freiburg, Germany N/A

- 4:15 **(963) Conversion Efficiency Limits and Optimized Designs for Tandem Solar Cells with Realistic Sub-cell Material Quality**
Lin Zhu¹, Toshimitsu Mochizuki¹, Masahiro Yoshita¹, Shaoqiang Chen¹, Shintaroh Sato¹, Changsu Kim¹, Hidefumi Akiyama¹, Yoshihiko Kanemitsu²
¹Institute for Solid State Physics, University of Tokyo and JST-CREST, Kashiwa, Chiba, Japan, ²Institute for Chemical Research, Kyoto University and JST-CREST, Uji, Kyoto, Japan 3404
- 4:30 **(964) Practical Limits of Multijunction Solar Cell Performance Enhancement from Radiative Coupling Considering Realistic Spectral Conditions**
Ngai Lam A Chan, Tomos Thomas, Ned Ekins-Daukes
Imperial College London, London, UK 3409
- 4:45 **(965) “Minority Carrier Lifetimes in 1.0eV p-In_{0.27}Ga_{0.73}As Layers Grown on GaAs Substrates”**
Rao Tatavarti¹, Keun-Yong Ban¹, Andree Wibowo¹, Darius Kuciauskas², Steve Johnston², Kim Jones², Harvey Guthrey², Andrew Norman², Mowafak Al-Jassim², Dean Levi²
¹MicroLink Devices, Inc, Niles, IL, USA, ²National Renewable Energy Laboratory, Golden, CO, USA 3414

Area 1 - Orals	
3:30 - 5:00 PM	Ballroom 1AB
Advances in Hot Carrier Solar Cells	

Chair(s): Daniell Farrell, Gavin Conibeer

- 3:30 **(966) A Hot Carrier Photovoltaic Cell by Offset Resonant Tunneling**
James A.R Dimmock, Stephen Day, Katherine Smith, Jon Heffernan, Matthias Kauer
Sharp Laboratories of Europe Ltd, Oxford, UK 3417
- 4:00 **(967) Hot-Carriers in InGaAs Quantum Wells: Generation and Extraction**
Louise C. Hirst¹, Michael K. Yakes¹, Christopher G. Bailey¹, Joseph G. Tischler¹, Matthew P. Lumb², Maria Gonzalez³, Markus F. Fuhrer⁴, Nicholas J. Ekins-Daukes⁴, Robert J. Walters¹
¹U.S. Naval Research Laboratory, Washington, DC, USA, ²The George Washington University, Washington, DC, USA, ³Sotera Defense Solutions Inc., Annapolis Junction, MD, USA, ⁴Imperial College London, London, UK N/A
- 4:15 **(968) Hot Carrier Extraction Using Energy Selective Contacts and Its Impact on the Limiting Efficiency of a Hot Carrier Solar Cell**
Steven Limpert, Stephen Bremner
University of New South Wales School of Photovoltaic and Renewable Energy Engineering, Sydney, Australia 3422

- 4:30 **(969) Accurate measurement of temperature and electrochemical potential of InGaAsP/InP heterostructures: a first indication of hot carriers solar cell operation**
 Laurent Lombez¹, Jean Rodière¹, Hervé Folliot², Alain LeCorre², Olivier Durand², Jean-François Guillemoles¹
¹IRDEP, Institute of R&D on Photovoltaic Energy, UMR 7174, CNRS-EDF-Chimie ParisTech 6 Quai Watier-BP 49, 78401, Chatou, France, ²Université Européenne de Bretagne, INSA, CNRS, FOTON, UMR 6082, F-35708, Rennes, France 3425
- 4:45 **(970) Evaluation of Hafnium Nitride and Zirconium Nitride as Hot Carrier Absorber**
 Santosh Shrestha, Simon Chung, Neeti Gupta, Yu Feng, Xiaoming Wen, Hongze Xia, Gavin Conibeer
 School of Photovoltaic and Renewable Energy Engineering, UNSW Australia, Sydney, Australia 3428

Area 1 - Orals	
3:30 - 5:00 PM	Ballroom 1CD
Novel Materials and Concepts	

Chair(s): Mariana Bertoni, Adele Tamboli, Mike Scarpulla

- 3:30 **Best Student Presentation Award Finalist (971) Growth morphology of ZnSe/Zn₃P₂ heterojunction solar cells**
 Jeffrey P Bosco¹, Steve J Rozeveld², Harry A Atwater¹
¹California Institute of Technology, Pasadena, CA, USA, ²The DOW Chemical Company, Midland, MI, USA N/A
- 4:00 **(972) Intrinsic defect engineering of cuprous oxide to enhance electrical transport properties for photovoltaic applications**
 Michael A. Lloyd¹, Sin Cheng Siah¹, Riley E. Brandt¹, James Serdy¹, Steve W. Johnston², Yun Seog Lee¹, Tonio Buonassisi¹
¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²National Renewable Energy Laboratory, Golden, CO, USA N/A
- 4:15 **(973) Development of ZnSiP₂ for Si-Based Tandem Solar Cells**
 Aaron D Martinez¹, Brenden R Ortiz¹, Nicole E Johnson¹, Lakshmi Krishna¹, Sukgeun Choi², Bobby To², Andrew G Norman², Vladan Stevanovic^{1,2}, Eric S Toberer^{1,2}, Paul Stradins^{1,2}, Adele C Tamboli^{1,2}
¹Colorado School of Mines, Golden, CO, USA, ²National Renewable Energy Laboratory, Golden, CO, USA N/A
- 4:30 **(974) Exotic phase Si nanoparticles and Si-ZnS nanocomposites: new paradigms to improve the efficiency of MEG solar cells**
 Marton Voros¹, Stefan Wippermann², Adam Gali^{3,4}, Francois Gygi⁵, Gergely Zimanyi¹, Giulia Galli⁶
¹Department of Physics, University of California Davis, Davis, CA, USA, ²Interface Chemistry and Surface Engineering Department, Max-Planck-Institute for Iron Research, Düsseldorf, Germany, ³Department of Atomic Physics, Budapest University of Technology and Economics, Budapest, Hungary, ⁴Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Budapest, Hungary, ⁵Department of Computer Science, University of California, Davis, Davis, CA, USA, ⁶Institute for Molecular Engineering, The University of Chicago, Chicago, IL, USA 3432

- 4:45 **(975) Improving Electron Transport in Ga-doped Zn_{0.7}Mg_{0.3}O, a Wide-Gap Band-Edge-Energy-Tunable Transparent Conducting Oxide**
 John D. Perkins¹, Yi Ke^{1,2}, Stephan Lany¹, Joseph J. Berry¹, Andriy Zakutayev¹, Brian Gorman², Tim Ohno², Philip A. Parilla¹, Ryan O'Hayre², David S. Ginley¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado School of Mines, Golden, CO, USA 3435

Area 2 - Orals	
3:30 - 4:30 PM	MR 502-504
Novel Materials and Concepts	

Chair(s): Rebekah Garris, Takahiro Wada

- 3:30 **(976) Hydrazine-free Molecular Inks for 10.5% Efficient Cu₂ZnSn(S,Se)₄ Solar Cells and their Use in Combinatorial Exploration of Material Properties**
 Hugh W. Hillhouse, Andrew D. Collord, Hao Xin, John Katahara, Steven Gaik
University of Washington, Seattle, WA, USA N/A
- 4:00 **(977) The Potential of Nanoparticle Ink-based Processing for Chalcogenide Photovoltaics**
 Charles J. Hages¹, Caleb K. Miskin¹, Steven M. McLeod¹, Wei-Chang Yang², Nathaniel J. Carter¹, Eric A. Stach³, Rakesh Agrawal¹
¹School of Chemical Engineering, Purdue University, West Lafayette, IN, USA, ²School of Material Science Engineering, Purdue University, West Lafayette, IN, USA, ³Center for Functional Nanomaterials, Brookhaven National Laboratory, Upton, NY, USA N/A
- 4:15 **Best Student Presentation Award Finalist (978) Nanoscale Engineering of Solution-processed CdTe Solar Cells using Nanocrystalline Precursors**
 Ryan W. Crisp^{1,2}, Matthew G. Panthani³, Joseph J. Berry², William L. Rance², Joel N. Duenow², Dmitri V. Talapin³, Joseph M. Luther²
¹Colorado School of Mines, Golden, CO, USA, ²National Renewable Energy Lab, Golden, CO, USA, ³University of Chicago, Chicago, IL, USA 3438

Area 4 - Orals	
3:30 - 5:00 PM	Ballroom 1EF
Passivated Contacts	

Chair(s): Stefaan de Wolf, Paul Stradins

- 3:30 **(979) Tunnel oxide passivated carrier selective contacts**
 Frank Feldmann, Maik Simon, Martin Bivour, Christian Reichel, Martin Hermle, Stefan Glunz
Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany N/A
- 4:00 **Best Student Presentation Award Finalist (980) Passivated Contacts to n⁺ and p⁺ Silicon Based on Amorphous Silicon / Dielectric Stacks**
 James Bullock¹, Di Yan¹, Andres Cuevas¹, Benedicte Demareux², Aicha Hessler-Wyser², Stefaan De Wolf²
¹The Australian National University, Canberra, Australia, ²Ecole Polytechnique Fédérale de Lausanne, Neuchatel, Switzerland 3442

- 4:15 **(981) Low Temperature, Si/SiO₂/pc-Si Passivated Contacts to n-type Si Solar Cells**
William Nemeth, David L. Young, Benjamin G. Lee, Paul Stradins. *National Renewable Energy Laboratory, Golden, CO, USA* 3448
- 4:30 **(982) >22.4% High Efficiency Tunnel Oxide Junction Bifacial Solar Cell with Electroplated Cu Gridlines.**
Jiunn Benjamin Heng, Jianming Fu, Bob Kong, Yongkee Chae, Wei Wang, Zhigang Xie, Anand Reddy, Kevin Lam, Chris Beitel, Chris Liao, Christoph Erben, Zhiquan Huang, Zheng Xu. *Silevo, Inc, Fremont, CA, USA* N/A

Area 8 - Orals	
3:30 - 5:00 PM	Ballroom 2A
Silicon Characterization	

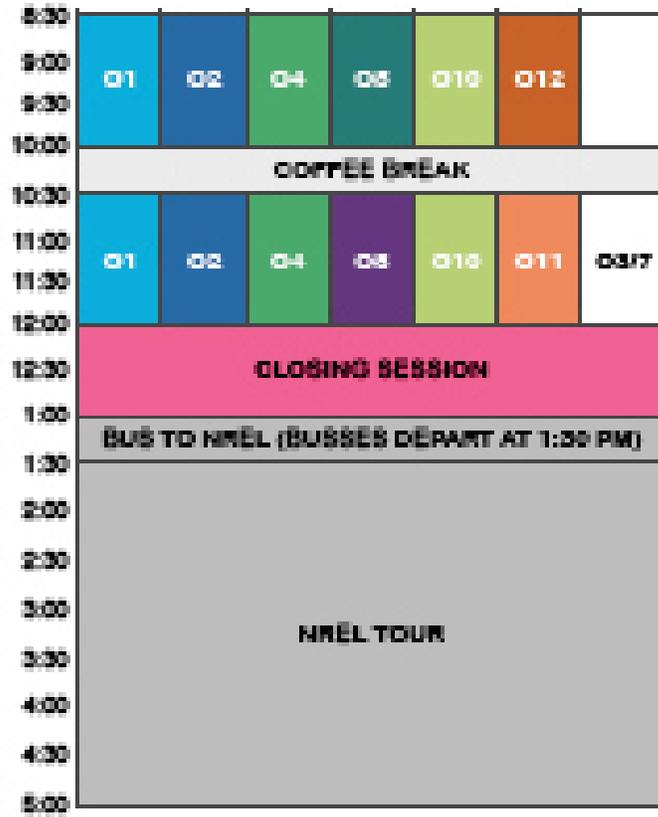
Chair(s): Mowafak Al-Jassim, Fabian Fertig

- 3:30 **(983) On the Use of I-V Curves as a Diagnosis Tool for Proper External Quantum Efficiency Measurements of Multijunction Solar Cells.** Enrique Barrigon, Pilar Espinet-González, Yedileth Contreras, Ignacio Rey-Stolle, Carlos Algora. *Solar Energy Institute - Technical University of Madrid, Madrid, Spain* 3453
- 3:45 **(984) Degradation of Tandem Solar Cells: Separating Matching Effects from Staebler-Wronski-Effect using the Power-Matching-Method**
Beatrix Blank, Carolin Ulbrich, Tsvetelina Merdzhanova, Jakob Kuhs, Christoph Zahren, Andreas Gerber, Uwe Rau. *Forschungszentrum Jülich, Jülich, Germany* 3457
- 4:00 **(985) In-situ Observations of Glass Frit Related Effects during the Front Side Paste Contact Formation.** Markus Eberstein, Ulrike Schmidt, Kathrin Reinhardt, Stefan Körner, Robert Jurk. *Fraunhofer IKTS, Dresden, Germany* 3463
- 4:15 **(986) Correlating Defect Band Luminescence to Elemental Distribution by X-ray Fluorescence**
Mariana I Bertoni¹, Steve Johnston², Mowafak Al-Jassim², Barry Laj³, ¹Arizona State University, Tempe, AZ, USA, ²National Renewable Energy Laboratory, Golden, CO, USA, ³Advanced Photon Source, Argonne, IL, USA 3470
- 4:30 **(987) Quantitative local current-voltage analysis with different spatially-resolved camera-based techniques of silicon solar cells with cracks**
Tobias M. Pletzer¹, Justus I. van Mülken¹, Sven Reißland², Emanuele Cornagliotti³, Joachim John³, Otwin Breitenstein², Joachim Knoch¹
¹RWTH Aachen University, Aachen, Germany, ²Max Planck Institute of Microstructure Physics, Halle, Germany, ³IMEC, Leuven, Belgium 3473
- 4:45 **(988) Iron contamination in silicon solar cell production environments**
Malcolm D. Abbott¹, Dmitry Poplavskyy², Giuseppe Scardera², Daniel Inns², Francesco Lemmi², Keith R. McIntosh¹, Simeon C. Baker-Finch¹
¹PV Lighthouse, Coledale, Australia, ²DuPont, Sunnyvale, CA, USA 3479

THURSDAY PM

Special Event	
6:00 - 10:00 PM	Denver Art Museum
Conference Dinner	

FRIDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

FRIDAY PROGRAM SUMMARY

FRIDAY AM

Area 1 - Orals

8:30 - 10:00 AM

Ballroom 1AB

Quantum-Confined Structures

Chair(s): Seth Hubbard, Masakazu Sugiyama, Diego Alonso Alvarez

- 8:30 **(989) Enhancement of current collection in epitaxial lift-off InAs/GaAs quantum dot thin film solar cell and concentrated photovoltaic study**
Tomah Sogabe¹, Yasushi Shoji¹, Peter Mulder², John Schermer², Efrain Tamayo¹, Yoshitaka Okada¹
¹Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan, ²Institute for Molecules and Materials, Radboud University Nijmegen, Nijmegen, Netherlands 3485
- 8:45 **(990) The Effect of Barrier Composition on Quantum Dot Solar Cell Performance**
David V. Forbes¹, Yushuai Dai¹, Stephen J. Polly¹, Christopher G. Bailey², Staffan D. Hellstroem¹, Seth M. Hubbard¹
¹Rochester Institute of Technology, Rochester, NY, USA, ²Naval Research Laboratory, Washington, DC, USA 3488
- 9:00 **(991) Electric Field Effect on Carrier Escape from InAs/GaAs Quantum Dots Solar cells**
Yushuai Dai, Stephen Polly, Staffan Hellstroem, David Forbes, Seth Hubbard
NanoPower Research Laboratory, Rochester Institute of Technology, Rochester, NY, USA 3492
- 9:15 **(992) Probing the operation mechanism within PbS quantum dot-based solar cells**
Rachelle Ihly^{1,2}, Sanjini U. nanayakkara¹, Jianbo Gao¹, Jianbing Zhang¹, William Nemeth¹, Matt Law², Joseph M. Luther¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²University of California, Irvine, Irvine, CA, USA 3498
- 9:30 **(993) Dual reactor deposition of quantum confined nanocrystalline silicon**
Chito Kendrick^{1,2}, Grant Klafehn^{1,2}, Tianyuan Guan^{1,2}, San Theingj^{1,2}, Reuben Collins^{1,2}
¹Colorado School of Mines, Golden, CO, USA, ²Renewable Energy Materials Research Science and Engineering Center, Golden, CO, USA 3502
- 9:45 **(994) Achieving Near-Unity Broadband Absorption in Sparse Arrays of GaAs Nanowires via a Fundamental Understanding of Localized Radial Modes**
Katherine T. Fountaine^{1,2}, William S. Whitney^{2,4}, Harry A. Atwater^{2,3}
¹Division of Chemistry & Chemical Engineering, California Institute of Technology, Pasadena, CA, USA, ²Joint Center for Artificial Photosynthesis, California Institute of Technology, Pasadena, CA, USA, ³Division of Applied Physics & Materials Science, Pasadena, CA, USA, ⁴Department of Physics, California Institute of Technology, Pasadena, CA, USA 3507

Area 2 - Orals

8:30 - 10:00 AM

MR 502-504

CdTe 2

Chair(s): Teresa Barnes, Gang Xiong

- 8:30 **(995) CdTe Thin Films doped by Cu and Ag – a Comparison in Substrate Configuration Solar Cells**
Christina Gretener, Michael Wyss, Lukas Kranz, Julian Perrenoud, Stephan Buecheler, Ayodhya N. Tiwari
Empa - Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland 3510
- 8:45 **(996) Low Cost Non-Toxic Alternatives to the CdCl₂ Treatment Step in CdTe Thin Film Solar Cells**
Jonathan D Major, Robert E Treharne, Laurie J Phillips, Ken Durose
Stephenson Institute for Renewable Energy, University of Liverpool, Liverpool, UK N/A
- 9:00 **(997) Measurement of Chlorine Concentrations at CdTe Grain Boundaries**
Dan Mao, Charles E Wickersham, Jr., Markus Gloeckler
First Solar, Perrysburg, OH, USA N/A
- 9:15 **(998) Qualitative and Quantitative Analysis of Grain Boundaries and Grain Interiors in CdTe Thin-Films by Low-Temperature Cathodoluminescence Spectrum Imaging**
John M Moseley^{1,2}, Mowafak M Al-Jassim¹, Helio R Moutinho¹, Harvey L Guthrey¹, Naba Paudel³, Yanfa Yan³, Wyatt K Metzger¹, Richard K Ahrenkiel¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado School of Mines, Golden, CO, USA, ³University of Toledo, Toledo, OH, USA N/A
- 9:30 **(999) Surface Passivation of CdTe Single Crystals and Polycrystalline Films**
Matthew O. Reese, Craig L. Perkins, James M. Burst, Joseph M. Luther, Steven W. Johnston, Darius Kuciauskas, Teresa M. Barnes, Tim A. Gessert, Wyatt K. Metzger
National Renewable Energy Lab, Golden, CO, USA N/A
- 9:45 **(1000) Reduction of Carrier Recombination by the Addition of a Cd_{1-x}Mg_xTe Electron Reflector Film**
DE Swanson¹, RM Geisthardt², PS Kobayakov¹, JM Raguse², J Drayton², KL Barth¹, JR Sites², WS Sampath¹
¹Mechanical Engineering Department Colorado State University, Fort Collins, CO, USA, ²Physics Department Colorado State University, Fort Collins, CO, USA N/A

Area 4 - Orals	
8:30 - 10:00 AM	Ballroom 1EF
Material Technology	

Chair(s): Mariana Bertoni, Michio Tajima

- 8:30 **(1001) Epitaxial Si films carried by thick polycrystalline Si as a drop-in replacement for conventional Si wafers**
 Rolf Brendel^{1,2}, Verena Steckenreiter¹, Jan Hensen¹, Sarah Kajari-Schröder¹
¹Institute for Solar Energy Research Hamelin, 31860, Germany, ²Institute for Solid State Physics, Leibniz Universität Hannover, 30167, Germany 3515
- 9:00 **(1002) Use of Indium Doping to Mitigate Light Induced Degradation in High Efficiency p-Type Silicon Solar Cells**
 J.-H. Lai¹, A.D. Upadhyaya¹, E. Cho¹, A. Rohatgi¹, M.J. Binns², J. Appel², J. Guo², H. Fang², E.A. Good²
¹Georgia Institute of Technology, Atlanta, GA, USA, ²SunEdison, St. Peters, MO, USA N/A
- 9:15 **(1003) Numerical Analysis of Oxygen Control During Growth of Czochralski Silicon Single Crystals**
 Moez Jomâa¹, Mohammed M'Hamdi¹, Yu Hu², Øyvind Nielsen²
¹SINTEF Materials and Chemistry, Oslo, Norway, ²NorSun AS, Oslo, Norway 3521
- 9:30 **(1004) High-Lifetime Kerfless Wafers through Epitaxy on Porous Silicon**
 Douglas M. Powell¹, Jasmin Hofstetter¹, David P. Fenning¹, Ruiying Hao², Mallory Ann Jensen¹, T.S. Ravi², Tonio Buonassisi¹
¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²Crystal Solar Inc., Santa Clara, CA, USA 3526
- 9:45 **(1005) High Speed Growth of Square-like Si Single Bulk Crystals with a Size of 23 x 23 cm² for Solar Cells using the Noncontact Crucible Method**
 Kazuo Nakajima¹, Ryota Murai¹, Kohei Morishita¹, Doug M. Powell², Maulid Kivambe², Tonio Buonassisi²
¹Graduate School of Energy Science, Kyoto University, Kyoto, Japan, ²Massachusetts Institute of Technology, Cambridge, MA, USA 3530

Area 5 - Orals	
8:30 - 10:00 AM	Ballroom 2A
Manufacturing and Process Control	

Chair(s): Matthias Meier, Nikolas Podraza

- 8:30 **(1006) Processing Glass-bonded epitaxial Silicon Foils with very high Lifetimes into highly efficient Solar Devices**
 Ivan Gordon, Hariharsudan Sivaramakrishnan, Stefano N Granata, Twan Bearda, Valerie Depauw, Jonathan Govaerts, Marwa Karim, Riet Labie, Roberto Martini, Hosny Meddeb, Kris van Nieuwenhuysen, Jef Poortmans
imec, Leuven, Belgium N/A

- 9:00 **(1007) Nanocrystalline Silicon Based Solar Cell Technology for Large Volume Manufacturing**
 Anhong Hu, Minghao Qu, Jinyan Zhang, Xinghong Zhou, Shaofei Yang, Jack Xiao, Chuck Hu, Changtao Peng, Xixiang Xu
Hanergy Solar Group, Chengdu, China 3534
- 9:15 **(1008) Flexible thin film silicon module for indoor energy harvesting**
 Marina Foti¹, Anna Battaglia², Cristina Tringali¹, Noemi Sparta¹, Salvatore Lombardo³, Cosimo Gerardi¹
¹STMicroelectronics, Catania, Italy, ²3SUN, Catania, Italy, ³CNR IMM, Catania, Italy N/A
- 9:30 **(1009) Optimization of Thin Film Silicon Based Solar Cells**
 Frank Liu^{1,2}, Wei Zi², Xiaojing Liu², Fengwei Xiao², Bo Yang²
¹Dalian Institute of Chemical Physics, Dalian National Lab for Clean Energy, Chinese Academy of Sciences, Dalian, China, ²Key Laboratory of Applied Surface and Colloid Chemistry, National Ministry of Education, School of Materials Science and Engineering, Shaanxi Normal University, Xi'an, China N/A
- 9:45 **(1010) Spectroscopic Ellipsometry Applied in the Full p-i-n a-Si:H Solar Cell Device Configuration**
 Maxwell M. Junda^{1,2}, Robert W. Collins^{1,2}, Nikolas J. Podraza^{1,2}
¹Wright Center for Photovoltaics Innovation and Commercialization, Toledo, OH, USA, ²University of Toledo, Toledo, OH, USA N/A

Area 10 - Orals	
8:30 - 10:00 AM	Ballroom 1CD
BOS and Off-Grid Advances	

Chair(s): Dave Click, Alexander Scheis, John Berdner

- 8:30 **(1011) Evaluation of mounting mechanisms for the installation of lightweight PV systems on commercial rooftops**
 Ankush Halbe, Jennifer Novak, Chris Hull, Kevin Sharpe, Pradeep Haldar
SUNY College of Nanoscale Science & Engineering, Albany, NY, USA 3539
- 8:45 **(1012) Parametric Study of PV Arc-Fault Generation Methods and Analysis of Conducted DC Spectrum**
 Jay Johnson¹, Kenneth M. Armijo²
¹Sandia National Laboratories, Albuquerque, NM, USA, ²Sandia National Laboratories, Albuquerque, NM, USA 3543
- 9:00 **(1013) Arc Fault Risk Assessment and Degradation Model Development for Photovoltaic Connectors**
 Benjamin B. Yang, Jay Johnson, Kenneth M. Armijo, Jason M. Taylor, N. Robert Sorensen
Sandia National Laboratories, Albuquerque, NM, USA 3549
- 9:15 **(1014) Remote Markets 2.0 the Next Wave of PV Expansion**
 Bill Rever¹, Paula J Mints²
¹WB Rever and Associates, Linthicum Heights, MD, USA, ²SPV Market Research, San Jose, CA, USA 3556

- 9:30 **(1015) Potential and Cost-Effectiveness of Off-Grid PV Systems in Indonesia Evaluated on a Provincial Level**
Anton J. Veldhuis, Angele H.M.E. Reinders
University of Twente, Enschede, Netherlands 3562
- 9:45 **(1016) A High Performance Power Supply for an Electric Vehicle with Solar PV, Battery and Ultracapacitor Support for Extended Range and Enhanced Dynamic Response**
Manmesha Patankar, Rupesh Wandhare, Vivek Agarwal
Indian Institute of Technology- Bombay, Mumbai, India 3568

Area 12 - Orals	
8:30 - 10:00 AM	Ballroom 2B
Design and Manufacturing for Reliability	

Chair(s): Masaaki Yamamichi, Chris Flueckiger

- 8:30 **(1017) Requirements for Quality Management System for PV Module Manufacturing**
Yoshihito Eguchi¹, Govind Ramu², Sumanth V Lokanath³, Masaaki Yamamichi⁴, Sarah Kurtz⁵, John Wohlgemuth⁵, Eiji Yamada¹, Michio Kondo⁴
¹Japan Electrical safety & Environment Technology Laboratories, Yokohama, Japan, ²SunPower Corporation, San Jose, CA, USA, ³First Solar Inc., Tempe, AZ, USA, ⁴National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, ⁵National Renewable Energy Laboratory, Golden, CO, USA 3574
- 9:00 **(1018) Regional Influence on Module Design Quality: Qualification Testing Failure Rate Results from Regional Labs of TUV Rheinland around the World**
GovindaSamy TamizhMani¹, Bo Li¹, William Shisler¹, Christos Monokroussos², Christian Dreier², SooBong Lim³, CS Kamalaksha⁴, Seiya Sugita⁵, Eckart Janknecht⁶
¹TUV Rheinland, Tempe, AZ, USA, ²TUV Rheinland, Shanghai, China, ³TUV Rheinland, Gyeongsan, Korea, ⁴TUV Rheinland, Bangalore, India, ⁵TUV Rheinland, Yokohama, Japan, ⁶TUV Rheinland, Cologne, Germany 3580
- 9:15 **Best Student Presentation Award Finalist (1019) Predicting Thermal Runaway in Bypass Diodes in Photovoltaic Modules**
Narendra Shiradkar¹, Eric Schneller¹, Neelkanth G. Dhere¹, Vivek Gade²
¹Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA, ²Jabil Circuit Inc., St. Petersburg, FL, USA 3585
- 9:30 **(1020) Reverse Bias Behavior of n-Type Cz-Si Solar Cells**
Elmar Lohmüller, Sabrina Werner, Fabian Fertig, Florian Clement, Daniel Biro
Fraunhofer ISE, Freiburg, Germany N/A
- 9:45 **(1021) Photovoltaic Module Qualification Plus Testing**
John H Wohlgemuth
N, Golden, CO, USA 3589

10:00 - 10:30 AM	Ballroom Pre-function
Coffee Break	

Joint Session: Areas 3,7 - Orals	
10:30 - 12:00 PM	MR 505-507
III-V Solar Cells for Space and CPV	

Chair(s): Paul Sharps, Tatsuya Takamoto

- 10:30 **(1022) Development of Lightweight Space Solar Cells with 30% Efficiency at End-of-Life**
Gerhard F.X. Strobl
AZUR SPACE Solar Power GmbH, Heilbronn, Germany 3595
- 11:00 **Best Student Presentation Award Finalist (1023) Effects of Luminescent Coupling in Single- and 4-Junction Dilute Nitride Solar Cells**
Matthew M. Wilkins, Ahmed Gabr, Anna H. Trojnar, Henry Schriemer, Karin Hinzer
University of Ottawa, Ottawa, ON, Canada 3601
- 11:15 **(1024) High Efficiency Quadruple Junction, Four-Terminal Solar Cells and Modules by Transfer Printing**
Xing Sheng¹, Christopher Bower², Salvatore Bonafede², John Wilson², Brent Fisher², Matthew Meitl², Homan Yuen³, Shuodao Wang¹, Ling Shen⁴, Anthony Banks¹, Christopher Corcoran¹, Ralph Nuzzo¹, Scott Burroughs², John Rogers¹
¹University of Illinois at Urbana-Champaign, Urbana, IL, USA, ²Semprius, Inc., Durham, NC, USA, ³Solar Junction, San Jose, CA, USA, ⁴China University of Mining and Technology, Xuzhou, China 3605
- 11:30 **(1025) Environmental Testing of Inverted Metamorphic Solar Cells for Space**
E. M. Rehder, B. Jun, P. Chiu, S. Wierman, K. Edmondson, X.-Q. Liu, S. Mesropian, P. Pien, J. Boisvert, N. H. Karam
Spectrolab, Sylmar, CA, USA 3608
- 11:45 **(1026) Thermal runaway in multijunction solar cells**
Claus Zimmermann
EADS Astrium, Munich, Germany 3612

Area 1 - Orals	
10:30 - 12:00 PM	Ballroom 1AB
Advances in Intermediate Band Solar Cells	

Chair(s): David Forbes, Antonio Marti

- 10:30 **(1027) Targeted Search for Effective Intermediate Band Solar Cell Materials**
Joseph T. Sullivan¹, C. B. Simmons¹, Tonio Buonassisi¹, Jacob J. Krich²
¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²University of Ottawa, Ottawa, ON, Canada N/A

- 10:45 **(1028) Identification of trap states for two-step two-photon-absorption processes in InAs quantum structures for intermediate-band solar cells**
 David Tex^{1,2}, Itaru Kamiya³, Yoshihiko Kanemitsu^{1,2}
¹*Institute for Chemical Research, Kyoto University, Uji, Kyoto 611-0011, Japan*, ²*Japan Science and Technology Agency, CREST, Uji, Kyoto 611-0011, Japan*, ³*Toyota Technological Institute, Nagoya, Aichi 468-8511, Japan* 3618
- 11:00 **(1029) Urbach Tail in Intermediate Band InAs/GaAs Quantum Dot Solar Cells**
 Tian Li, Mario Dagenais
University of Maryland, College Park, MD, USA 3622
- 11:15 **(1030) Experimental Examination of an InAs/GaAs(Sb)/AlAsSb Quantum Dot Approach to the Intermediate Band Solar Cell**
 Zachary S Bittner¹, Ramesh B Laghumavarapu², Staffan Hellstroem¹, Diana Huffaker², Baolai Liang², Seth M Hubbard¹
¹*Rochester Institute of Technology, Rochester, NY, USA*, ²*University of California at Los Angeles, Los Angeles, CA, USA* 3626
- 11:30 **(1031) Electron barrier engineering in a thin-film intermediate band solar cell**
 Nazmul Ahsan¹, Naoya Miyashita¹, Kin Man Yu², Wladek Walukiewicz², Yoshitaka Okada¹
¹*The University of Tokyo, Tokyo, Japan*, ²*Lawrence Berkeley National Laboratory, Berkeley, CA, USA* N/A
- 11:45 **(1032) Limiting Efficiency of Silicon Intermediate Band Solar Cells**
 Esther Lopez, Antonio Marti, Elisa Antolin, Antonio Luque
Instituto Energia Solar - UPM, Madrid, Spain N/A

Area 2 - Orals	
10:30 - 11:45 AM	MR 502-504
CIGS 2	

Chair(s): Thomas Unold, Bill Shafarman

- 10:30 **(1033) Co-evaporated CuInSe₂: Influence of Na and Temperature on Solar Cell Performance**
 Stephan Brunken, Dieter Greiner, Hengameh Allaf Navirian, Christian A. Kaufmann, Thomas Unold
Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany 3629
- 10:45 **(1034) Incorporation of Na In Cu(In,Ga)Se₂ Thin Film Solar Cells: a Statistical Comparison Between Na from Soda Lime Glass and from a Precursor Layer of NaF**
 P M P Salomé, Adam Hultqvist, Viktor Fjällström, Marika Edoff
Ångström Solar Center, Solid State Electronics, Uppsala University, Ångström Laboratory, Uppsala, Sweden N/A
- 11:00 **(1035) In-Se surface treatment of Cu-rich grown CuInSe₂**
 Tobias Bertram, Valérie Deprédurand, Susanne Siebentritt
Laboratory for Photovoltaics, University of Luxembourg, Belvaux, Luxembourg 3633

- 11:15 **(1036) Enhanced Performance in Cu(In,Ga) Se₂ Solar Cells Fabricated by the Two-step Selenization Process with a Potassium Fluoride Post-deposition Treatment**
 Lorelle M Mansfield¹, Rommel Noufi², Christopher P Muzzillo^{1,3}, Clay DeHart¹, Karen Bowers¹, Bobby To¹, Joel W Pankow¹, Robert C Reedy¹, Kannan Ramanathan¹
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Retired, Golden, CO, USA, ³University of Florida, Gainesville, FL, USA N/A
- 11:30 **(1037) Microstructural and chemical investigation of PVD-CdS/ PVD-CuIn_{1-x}GaxSe₂ heterojunctions: a transmission electron microscopy study**
 X. Q. He¹, G. Brown², K. Demirkan², N. Mackie², V. Lordi³, A. Rockett¹
¹University of Illinois Urbana-Champaign, Urbana, 61801, IL, USA, ²MiaSolé Hi-Tech, Santa Clara, 95051, CA, USA, ³Lawrence Livermore National Laboratory, Livermore, 94550, CA, USA N/A

Area 4 - Orals	
10:30 - 12:00 PM	Ballroom 1EF
Junction Technology and Gettering	

Chair(s): Stuart Bowden, Frederic Dross

- 10:30 **(1038) High efficiency n-type PERT and PERL solar cells**
 Jan Benick, Bernd Steinhauser, Ralph Müller, Jonas Bartsch, Mathias Kamp, Andrew Mondon, Armin Richter, Martin Hermle, Stefan Glunz
 Fraunhofer ISE, Freiburg, Germany 3637
- 10:45 **(1039) Iron Precipitation upon Gettering in Phosphorus-Implanted Czochralski Silicon and its Impact on Solar Cell Performance**
 David P Fenning^{1,2}, Ville Vähänissi³, Jasmin Hofstetter¹, Ashley E Morishige¹, Hannu Laine³, Antti Haarahiltunen³, Sergio Castellanos¹, Mallory Ann Jensen¹, Barry Lai⁴, Hele Savin³
¹Massachusetts Institute of Technology, Cambridge, MA, USA, ²Department of Nanoengineering, University of California San Diego, La Jolla, CA, USA, ³Department of Micro and Nanosciences, Aalto University, Espoo, Finland, ⁴Advanced Photon Source, Argonne National Laboratory, Argonne, IL, USA 3641
- 11:00 **(1040) Lithography-free Interdigitated Back-Contacted Silicon Heterojunction Solar Cells with Efficiency >21%**
 Andrea Tomasi¹, Bertrand Paviet-Salomon¹, Damien Lachenal², Silvia Martin de Nicolas Ag¹, Martin Ledinsky^{1,3}, Antoine Descoedres⁴, Nicolay Sylvain⁴, Stefaan De Wolf¹, Christophe Ballif¹
¹EPFL, Neuchâtel, Switzerland, ²Roth&Rau Research AG, Hauterive, Switzerland, ³Institute of Physics, Prague, Czech Republic, ⁴PV center - CSEM, Neuchâtel, Switzerland 3644
- 11:15 **(1041) Application of ion implantation emitter in PERC solar cells**
 Jian Wu^{1,2}, Yunyu Liu^{1,2}, Xusheng Wang^{1,2}, Lingjun Zhang^{1,2}
¹Canadian Solar Inc, Suzhou, China, ²Photovoltaic Research Center of Soochow University, Suzhou, China N/A

- 11:30 **(1042) N-type Bifacial Cell Using Simplified Ion Doping System**
 Kyotaro Nakamura¹, Tomohiro Soga², Yoshinobu Murakami², Yoshio Ohshita³
¹Meiji University, Kawasaki, Japan, ²Sumitomo Heavy Industries, Ltd., Niihama, Japan, ³Toyota Technological Institute, Nagoya, Japan 3649
- 11:45 **(1043) High-efficiency Large Area Ion-implanted N-type Front Junction Si Solar Cells with Screen-printed Contacts and SiO₂ Passivated Boron Emitters**
 Yuguo Tao¹, Ajeet Rohatgi^{1,2}
¹Georgia Institute of Technology, Atlanta, GA, USA, ²Suniva Inc., Norcross, GA, USA 3654

Area 8 - Orals	
10:30 - 12:00 PM	Ballroom 2A
Cell & Module Characterization	

Chair(s): Jim Sites, Bernhard Michl, Yoshihiro Hishikawa

- 10:30 **(1044) Spectral Mismatch Considerations in Multi-irradiance Characterization of PV Modules**
 Nicholas J. DeLong, Geoffrey D. Rich
 First Solar, Inc., Perrysburg, OH, USA 3659
- 10:45 **(1045) The effect of shunt resistance on External Quantum Efficiency measurements at high light bias conditions**
 Vasiliki Paraskeva¹, Maria Hadjipanayi¹, Matthew Norton^{1,2}, Mauro Pravettoni³, George E. Georghiou¹
¹FOSS Research Centre for Sustainable Energy, University of Cyprus, Nicosia, Cyprus, ²European Commission, DG JRC, Ispra, Italy, ³Institute of Applied Sustainability to the build Environment, University of Applied Sciences and Arts of Southern Switzerland, Canobbio, Switzerland 3664
- 11:00 **(1046) Uncertainty Analysis for Maximum Power at SRC Using Hierarchical Monte Carlo Simulation**
 Mark Campanelli¹, Keith Emery¹, Ryan Elmore¹, Brian Zaharatos²
¹National Renewable Energy Laboratory, Golden, CO, USA, ²Colorado School of Mines, Golden, CO, USA 3670
- 11:15 **(1047) Performance Stabilization of CdTe PV Modules Using Dark Bias**
 Timothy J Silverman, Michael G. Deceglie, Bill Marion, Sarah Kurtz
 National Renewable Energy Laboratory, Golden, CO, USA 3676
- 11:30 **(1048) Electrostatic Force and Kelvin Probe Force Microscopies on Cu(In,Ga)Se₂ Solar Cells**
 Tomoaki Ishii¹, Takashi Minemoto³, Takuji Takahashi^{1,2}
¹Institute of Industrial Science, The University of Tokyo, Tokyo, Japan, ²Institute for Nano Quantum Information Electronics, The University of Tokyo, Tokyo, Japan, ³Graduate School of Science and Engineering, Ritsumeikan University, Shiga, Japan 3682
- 11:45 **Best Student Presentation Award Finalist (1049) Sensitivity of Concentrating Photovoltaics to Solar Tracking Error**
 Joshua Morse¹, Mark Campanelli², Keith Emery²
¹University of Rochester, Rochester, NY, USA, ²National Renewable Energy Laboratory, Golden, CO, USA 3685

Area 10 - Orals	
10:30 - 12:00 PM	Ballroom 1CD
Inverter Innovations	

Chair(s): Ward Bower, Mike Coddington

- 10:30 **Best Student Presentation Award Finalist (1050) Limits of Incremental Conductance for determining the Maximum Power Point under rapidly changing irradiance and an alternative technique based on fast scanning**
Wenpeng Deng, Gehan A. J. Amaratunga
University of Cambridge, Cambridge, UK 3690
- 10:45 **(1051) Solid State Transformer applied on Utility Scale Solar Power Plants**
Nicole Campos Foureaux¹, Sidelmo Magalhães Silva², Jose Antonio de S. Brito³, Braz de Jesus Cardoso F.²
¹Postgraduate Program in Electrical Engineering, Belo Horizonte/MG, Brazil, ²Dept. of Electrical Engineering, Belo Horizonte/MG, Brazil, ³COELBA, Salvador/BA, Brazil 3695
- 11:00 **(1052) “Low Cost, Robust and Efficient Implementation of MPPT based Buck-Boost Converter for Off-grid PV Applications”**
Muhammad Nouman Qaiser, Muhammad Usama, Bilal Ahmad, Muhammad Ali Tariq, Hassan Abbas Khan
Dept of Electrical Engineering, LUMS, Lahore, Pakistan 3701
- 11:15 **Best Student Presentation Award Finalist (1053) An APWM Soft Switched DC-DC Converter for PV and EV**
K.V. Ravi Kishore¹, Naga Brahmendra², B. Sivaneasan¹, P.L. So¹, C.C. Chan¹
¹Nanyang Technological University, Singapore, Singapore, ²Singapore Polytechnic, Singapore, Singapore 3707
- 11:30 **(1054) Experimental Studies and Performance Evaluation of Solar PV Powered BLDC Motor Drive with an Integrated MPPT in Fan applications**
Veeraraghavan S, M Kumaravel, Krishna Vasudevan, Ashok Jhunjhunwala
Indian Institute of Technology Madras, Chennai, India 3713
- 11:45 **(1055) Central Seven-level Current-fed Inverter with Module-integrated DC-DC Converters for Grid-connected PV Plant**
Vishal Vekhande, B. G. Fernandes
Indian Institute of Technology Bombay, Mumbai, India 3719

Area 11 - Orals

10:30 - 12:00 PM

Ballroom 2B

Interconnection, Power Electronics & Inverters

Chair(s): Murali Baggu, Michael Mills-Price

- 10:30 **(1056) Characterizing Local High-frequency Solar Variability for use in Distribution Studies**
Matthew Lave¹, Robert Broderick²
¹Sandia National Laboratories, Livermore, CA, USA,
²Sandia National Laboratories, Albuquerque, NM,
USA N/A
- 10:45 **(1057) Design, Operation and Controlled Island Operation of the US DOE 2013 Solar Decathlon Microgrid**
Chuck Kurnick¹, Olga Lavrova², Robert Butt¹, Ian Metzger¹, Van Vagner³, Gray Brewster³, Greg Wiegand⁴, Siva Patibandla², Mark Frankosky³
¹National Renewable Energy Laboratory, Denver, CO, USA, ²University of New Mexico, Albuquerque, NM, USA, ³Schneider Electric Corporation, Troy, MI, USA, ⁴Microplanet Corporation, Woodinville, WA, USA N/A
- 11:00 **(1058) Utility PV Array Planning Optimization and Investment Return for Solar Farm in Southwest Arizona**
Christopher R Lashway, Osama Mohammed
Florida International University, Miami, FL, USA N/A
- 11:15 **(1059) Optimal Operation of Distribution Networks with Increased Photovoltaic Penetration**
Emiliano Dall'Anese¹, Sairaj Dhople¹, Brian Johnson², Georgios Giannakis¹
¹University of Minnesota, Minneapolis, MN, USA,
²National Renewable Energy Laboratory, Golden, CO, USA N/A
- 11:30 **(1060) Power Converter Configuration with Integrated High-Frequency Transformer for High-Voltage Grid-Connected Large-Scale Photovoltaic System**
M A Moonem, Turgay Duman, Hariharan Krishnaswami N/A
- 11:45 **Best Student Presentation Award Finalist (1061) Impact of PV Variability and Ramping Events on Distribution Voltage Regulation Equipment**
Matthew J. Reno^{1,2}, Kyle Coogan¹, Robert J. Broderick², John Seuss¹, Santiago Grijalva¹
¹Georgia Institute of Technology, Atlanta, GA, USA,
²Sandia National Laboratories, Albuquerque, NM, USA N/A

Keynote - Plenary

12:00 - 1:00 PM

Ballroom 3-4

Closing Session

- 12:00 **(1062) Closing Remarks**
Richard R. King
- 12:05 **(1063) Technical Highlights**
Angèle Reinders
- 12:15 **(1064) PVSC Napkin Award Presentation**
Richard R. King
- 12:20 **(1065) 29th European PV Solar Energy
Conference (EU PVSEC-29)**
- 12:24 **(1066) 6th World Conference on PV Energy
Conversion (WCPEC-6)**
- 12:27 **(1067) 42nd IEEE Photovoltaic Specialists
Conference (PVSC-42)**
Steve Ringel
- 12:30 **(1068) Best Poster Awards**
Kyle Montgomery, Chris Bailey
- 12:45 **(1069) Best Student Paper Awards**
Kyle Montgomery, Chris Bailey
- 1:00 **(1070) Close of Conference**
Richard R. King

TECHNICAL PROGRAM

FRIDAY AM