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AREA 1 PROGRAM SUMMARY

Monday, June 4
Fundamentals and New Concepts: Plenary
9:30 - 10:00 AM (Blrm D)

Fundamentals and New Concepts: Session 1 (Posters)
1:30 - 3:00 PM (EH4-A)

Fundamentals and New Concepts: Intermediate-Band Solar Cells (Orals)
3:30 - 5:00 PM (18AB)

Tuesday, June 5
Fundamentals and New Concepts: Session 2 (Posters)
10:30 - 12:00 PM (EH4-A)

Fundamentals and New Concepts: Quantum Well Solar Cells (Orals)
1:30 - 3:00 PM (18AB)

Fundamentals and New Concepts: Light Concentration and Light Trapping 1 (Orals)
3:30 - 5:00 PM (18AB)

Wednesday, June 6
Fundamentals and New Concepts: Simulation and Modeling of Advanced Concept Solar Cells (Orals)
10:30 - 12:00 PM (18AB)

Fundamentals and New Concepts: Quantum Dot Solar Cells (Orals)
1:30 - 3:00 PM (18AB)

SCREAM Workshop
3:00 - 4:00 PM (19B)

Fundamentals and New Concepts: Session 3 (Posters)
3:30 - 5:00 PM (EH4-A)

Thursday, June 7
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10:30 - 12:00 PM (EH4-A)

Fundamentals and New Concepts: Advanced Approaches for Photoconversion (Orals)
1:30 - 3:00 PM (18AB)

Fundamentals and New Concepts: Novel Materials 1 (Orals)
3:30 - 5:00 PM (18AB)

Friday, June 8
Fundamentals and New Concepts: Novel Materials 2 (Orals)
8:30 - 10:00 AM (18AB)

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10:30 - 12:00 PM (18AB)

AREA 2 PROGRAM SUMMARY

Monday, June 4
Polycrystalline Thin Films: Absorber Formation and Characterization 1 (Posters)
1:30 - 3:00 PM (EH4-B)

Polycrystalline Thin Films: Wide Bandgap Devices (Orals)
3:30 - 5:00 PM (18CD)

Tuesday, June 5
Polycrystalline Thin Films: Device Properties, Modeling, Stability, and Defect Characterization (Posters)
10:30 - 12:00 PM (EH4-B)

Polycrystalline Thin Films: Absorber and Device Modeling (Orals)
1:30 - 3:00 PM (18CD)

Polycrystalline Thin Films: Junctions and Device Stability (Orals)
3:30 - 5:00 PM (18CD)

Wednesday, June 6
Polycrystalline Thin Films: Window Layers and Flexible Devices (Orals)
10:30 - 12:00 PM (18CD)

Polycrystalline Thin Films: Thin-Film Manufacturing (Orals)
1:30 - 3:00 PM (18CD)

Polycrystalline Thin Films: Alternate Substrates, Back Contact Materials, Buffer Compounds, TCOs, Manufacturing, Metrology, Process Control, and Reliability (Posters)
3:30 - 5:00 PM (EH4-B)

Thursday, June 7
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8:30 - 9:00 AM (Blrm D)

Polycrystalline Thin Films: Absorber Formation and Characterization 2 (Posters)
10:30 - 12:00 PM (EH4-B)

Polycrystalline Thin Films: Kesterites (Orals)
1:30 - 3:00 PM (18CD)

Polycrystalline Thin Films: CIGS Absorber Processing (Orals)
3:30 - 5:00 PM (18CD)

Friday, June 8
Polycrystalline Thin Films: CdTe Processing & Devices (Orals)
8:30 - 10:00 AM (18CD)

Polycrystalline Thin Films: CIGS Processing & Devices (Orals)
10:30 - 12:00 PM (18CD)

AREA 3 PROGRAM SUMMARY

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10:30 - 12:00 PM (EH4-C)

Wednesday, June 6
III-V's and Concentrators: Plenary
9:30 - 10:00 AM (Blrm D)

III-V's and Concentrators: Cells (Orals)
10:30 - 12:00 PM (17B)

III-V's and Concentrators: Modules and Systems (Orals)
1:30 - 3:00 PM (17B)

III-V's and Concentrators: Cells, Modules, and Systems 2 (Posters)
3:30 - 5:00 PM (EH4-C)

Thursday, June 7
III-V's and Concentrators: High-Efficiency Cells (Orals)
1:30 - 3:00 PM (17B)

AREA 4 PROGRAM SUMMARY

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Crystalline Silicon: Fundamentals (Posters)
1:30 - 3:00 PM (EH4-C)

Crystalline Silicon: New Device Concepts (Orals)
3:30 - 5:00 PM (Blrm G)

Tuesday, June 5
Crystalline Silicon: Plenary
8:30 - 9:00 AM (Blrm D)

Crystalline Silicon: Passivation and Advanced Devices (Posters)
10:30 - 12:00 PM (EH4-D)

Crystalline Silicon: Fundamentals (Orals)
1:30 - 3:00 PM (Blrm G)

Crystalline Silicon: Advanced Devices (Orals)
3:30 - 5:00 PM (Blrm G)

Wednesday, June 6
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10:30 - 12:00 PM (Blrm G)

Crystalline Silicon: Crystallization and Wafering (Orals)
1:30 - 3:00 PM (Blrm G)

Crystalline Silicon: Industrial Cell Technology (Posters)
3:30 - 5:00 PM (EH4-D)

Thursday, June 7
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10:30 - 12:00 PM (EH4-C)

Crystalline Silicon: Texture, Emitter, and ARC (Orals)
1:30 - 3:00 PM (Blrm G)

Crystalline Silicon: Discussion and Harumph (Workshop)
3:30 - 5:00 PM (Blrm G)

Friday, June 8
Crystalline Silicon: Feedstock (Orals)
8:30 - 10:00 AM (Blrm G)

Crystalline Silicon: Metallization (Orals)
10:30 - 12:00 PM (Blrm G)

AREA 5 PROGRAM SUMMARY

Monday, June 4
Thin-Film Silicon: Solar Cells: Fundamentals, Processing, and Light Trapping (Posters)
1:30 - 3:00 PM (EH4-D)

Thin-Film Silicon: Light Trapping in Solar Cells 1 (Orals)
3:30 - 5:00 PM (19A)

Tuesday, June 5
Thin-Film Silicon: Solar Cells, Novel Concepts, Thin Crystalline Silicon Film, Solar Cells and Modules (Posters)
10:30 - 12:00 PM (EH4-E)

Thin-Film Silicon: Solar Cells and Modules (Orals)
1:30 - 3:00 PM (19A)

Thin-Film Silicon: Novel Concepts: Hybrid, Plasmonics and Diagnostic Tools (Orals)
3:30 - 5:00 PM (19A)

Wednesday, June 6
Thin-Film Silicon: Plenary
8:30 - 9:00 AM (Blrm D)

Thin-Film Silicon: Thin-Crystalline Silicon Technology (Orals)
1:30 - 3:00 PM (19A)

Thursday, June 7
Thin-Film Silicon: Light Trapping in Solar Cells 2 (Orals)
1:30 - 3:00 PM (19A)

Thin-Film Silicon: Fundamentals and Defects in Solar Cells (Orals)
3:30 - 5:00 PM (19A)

AREA 6 PROGRAM SUMMARY

Wednesday, June 6
Organic Photovoltaics: Contacts and Dye Cells (Posters)
3:30 - 5:00 PM (EH4-E)

Thursday, June 7
Organic Photovoltaics: Plenary
9:00 - 9:30 AM (Blrm D)

Organic Photovoltaics: OPV Materials and Devices (Posters)
10:30 - 12:00 PM (EH4-D)

Organic Photovoltaics: New Organic and Interface Materials (Orals)
1:30 - 3:00 PM (17A)

Organic Photovoltaics: Device Concepts (Orals)
3:30 - 5:00 PM (17A)

Friday, June 8
Organic Photovoltaics: Lifetime Processing and Reliability (Orals)
8:30 - 10:00 AM (17A)

Organic Photovoltaics: OPV Modeling and Inorganic Hybrids (Orals)
10:30 - 12:00 PM (17A)

AREA 7 PROGRAM SUMMARY

Wednesday, June 6
Space Technologies: Plenary
9:00 - 9:30 AM (Blrm D)

Thursday, June 7
Space Technologies: Space PV Technologies (Posters)
10:30 - 12:00 PM (EH4-E)

Space Technologies: High Performance PV for Space Applications (Orals)
3:30 - 5:00 PM (17B)

Friday, June 8
Space Technologies: Testing and Design of Space PV Technologies (Orals)
8:30 - 10:00 AM (17B)

AREA 8 PROGRAM SUMMARY

Monday, June 4
PV Characterization: Session 1 (Posters)
1:30 - 3:00 PM (EH4-E)

PV Characterization: PV Modules: Testing and Standards (Orals)
3:30 - 5:00 PM (17A)

Tuesday, June 5
PV Characterization: Plenary
9:00 - 9:30 AM (Blrm D)

PV Characterization: Session 2 (Posters)
10:30 - 12:00 PM (EH4-F)

PV Characterization: Challenges in Characterization of Multijunction Devices (Orals)
1:30 - 3:00 PM (17A)

PV Characterization: Defects in PV Materials and Solar Cells (Orals)
3:30 - 5:00 PM (17A)

Wednesday, June 6
PV Characterization: Characterization of Thin Films (Orals)
10:30 - 12:00 PM (17A)

PV Characterization: Advanced Characterization Methods and Instruments (Orals)
1:30 - 3:00 PM (17A)

AREA 9 PROGRAM SUMMARY

Monday, June 4
Modules and Systems: Grid-Tied Systems (Posters)
1:30 - 3:00 PM (EH4-F)

Modules and Systems: Utility Scale and High Penetration (Orals)
3:30 - 5:00 PM (16AB)

Tuesday, June 5
Modules and Systems: Inverters, Balance-of-System Devices, and Module Shading (Posters)
10:30 - 12:00 PM (EH4-G)

Modules and Systems: Systems Design, Control, and Performance (Orals)
1:30 - 3:00 PM (16AB)

Modules and Systems: Inverters and Balance-of-System Devices (Orals)
3:30 - 5:00 PM (16AB)

Wednesday, June 6
Modules and Systems: PV Reliability (Orals)
10:30 - 12:00 PM (16AB)

Modules and Systems: Module Materials, Durability, and Performance 1 (Orals)
1:30 - 3:00 PM (16AB)

Modules and Systems: Module Materials, Durability, and Performance (Posters)
3:30 - 5:00 PM (EH4-F)

Thursday, June 7
Modules and Systems: Plenary
9:30 - 10:00 AM (Blrm D)

Modules and Systems: Irradiance Resources, PV Modeling, and Off-Grid Applications (Posters)
10:30 - 12:00 PM (EH4-F)

Modules and Systems: PV Performance Modeling Collaborative (Orals)
1:30 - 3:00 PM (16AB)

Modules and Systems: Module Materials, Durability, and Performance 2 (Orals)
3:30 - 5:00 PM (16AB)

Friday, June 8
Modules and Systems: Irradiance Resources (Orals)
8:30 - 10:00 AM (16AB)

Modules and Systems: Off-Grid Applications (Orals)
8:30 - 10:00 AM (19A)

Modules and Systems: Performance Modeling (Orals)
10:30 - 12:00 PM (16AB)

AREA 10 PROGRAM SUMMARY

Monday, June 4
PV Velocity Forum: Equipment-Related PV ESH (Orals)
1:30 - 3:00 PM (19B)

PV Velocity Forum: Sustainability and PV EHS (Orals)
3:30 - 5:00 PM (19B)

Tuesday, June 5
PV Velocity Forum: Plenary
9:30 - 10:00 AM (Blrm D)

PV Velocity Forum: PV Executive Forum
10:30 - 12:00 PM (19B)

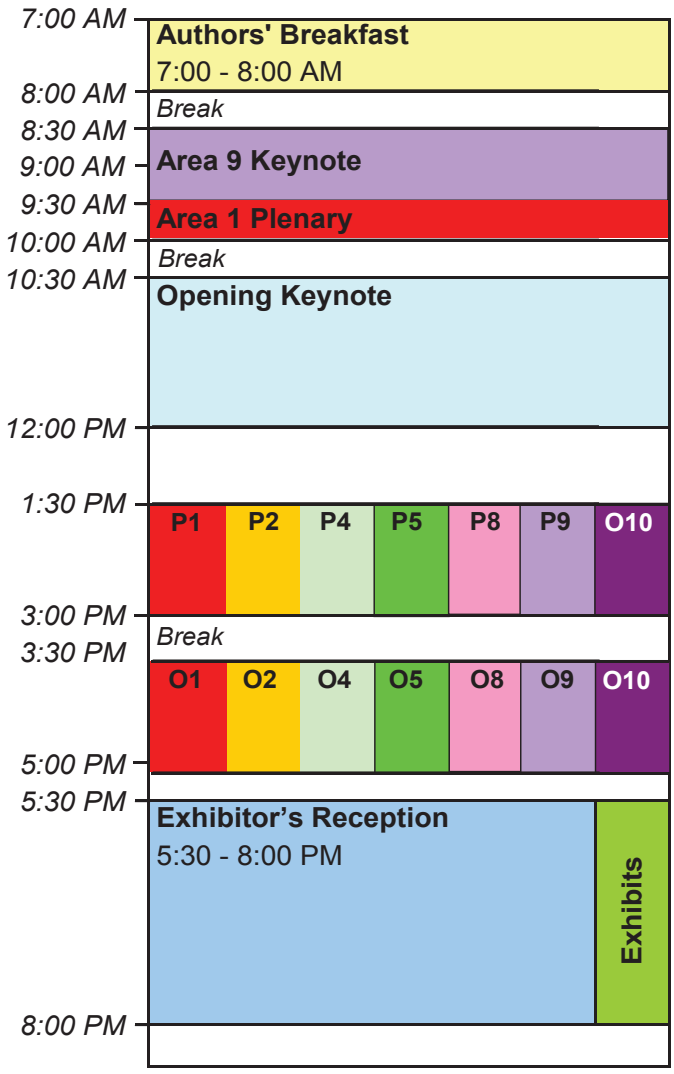
PV Velocity Forum: National Programs (Orals)
1:30 - 3:10 PM (19B)

PV Velocity Forum: Markets and Scalability (Orals)
3:30 - 5:00 PM (19B)

Wednesday, June 6
PV Velocity Forum: Models and Markets (Orals)
10:30 - 12:00 PM (19B)

PV Velocity Forum: Session (Posters)
3:30 - 5:00 PM (EH4-G)

MONDAY PROGRAM SUMMARY



AREA LEGEND

- Area 1: Fundamentals and New Concepts for Future Technologies
- Area 2: Thin Film Polycrystalline Photovoltaics
- 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 Terrestrial Systems
- Area 10: PV Velocity Forum

O = Oral Session P = Poster Session

8:00 - 8:30 AM **4th Floor Foyer**

Coffee Break

8:30 - 9:30 AM **Blrm D**

Area 9: Modules and Systems: Keynote

Chair(s): Greg Ball, Barry Mather

8:30 1 **Residential PV and Smart Grid Activities** **N/A**
Scott Hinson
Pecan Street Project

8:45 2 **High-Penetration PV Deployment in the Arizona Public Service System, Phase 1 Update 1**
David Narang[1], Joshua Hambrick[2]
[1]Arizona Public Service, Pheonix, AZ, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

9:00 3 **Large PV System Control and Utility Integration Strategies** **N/A**
Robert Johnson
SunPower Corporation

9:15 4 **Battery Storage for PV and Smart Grid Applications** **N/A**
Richard Fioravanti
DNV KEMA

9:30 - 10:00 AM **Blrm D**

Area 1: Fundamentals and New Concepts: Plenary

Chair(s): Ryne Raffaelle, Yoshitaka Okada

9:30 5 **High-Performance Photovoltaics from Earth-Abundant Thin-Film Absorbers** **N/A**
David B. Mitzi
IBM T. J. Watson Research Center, Yorktown Heights, NY, USA

10:00 - 10:30 AM **4th Floor Foyer**

Coffee Break

10:30 - 12:00 PM **Blrm D**

Welcoming Session and Keynotes

Chair(s): BJ Stanbery, Angus Rocket

10:30 6 **Opening Remarks N/A**
BJ Stanbery
PVSC 38 General Chair

10:45 7 **Cherry Award Presentation N/A**
Stuart Wenham
Cherry Award Chair

10:50 8 **Cherry Award Acceptance Speech: N/A**
Persistence in the Face of Skepticism. Our Response When the World Says “It Can’t Be Done”.
Sarah Kurtz
National Renewable Energy Laboratory

11:20 9 **Renewable Electricity Futures: How Much of Our Power Can Renewables Supply? N/A**
Samuel Baldwin
EERE US DOE, Washington, DC, USA

1:30 - 3:00 PM **EH4-A**

Area 1: Fundamentals and New Concepts: Session 1 (Posters)

Chair(s): Annick Anctil, Chris Bailey, Seth Hubbard

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Sabina Abdul Hadi[1], Pouya Hashemi[2], Nicole DiLello[2], Ammar Nayfeh[1], Judy Hoyt[2]
[1]Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates, [2]MIT Microsystems Technology Laboratories, Cambridge, MA, USA

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Diego Alonso-Álvarez, David Ross, Bryce Richards
School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, United Kingdom

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Hasan Baig, Tapas Kumar Mallick
Mechanical Engineering Department, Heriot Watt University, Edinburgh, United Kingdom

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Marko Berginc[1], Ursa Opara Krasovec[1], Etienne Quesnel[2], Marko Topic[1]
[1]University of Ljubljana, Faculty of Elec Eng, Ljubljana, Slovenia, [2]CEA, LITEN, Grenoble, France

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University of New South Wales, Sydney, Australia

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Apollo CdTe Solar Energy Research Center, NJIT, Newark, NJ, USA

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Qsolar Technology, Inc, Cupertino, CA, USA

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Photovoltaics Centre of Excellence, University of New South Wales, Sydney, Australia

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[1]Escuela Superior de Física y Matemáticas del IPN, Mexico, Mexico, [2]Materials Science Institute, University of Valencia, Valencia, Spain, [3]Facultad de Física de la Universidad de La Habana, La Habana, Cuba, [4]Universidad Autónoma de la Ciudad de México, Mexico, Mexico, [5]Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Mexico, Mexico, [6]Centro de Investigación y de Estudios Avanzados del IPN, Mexico, Mexico, [7]Centro de Investigaciones en Micro- y Nanotecnología, Universidad Veracruzana, Veracruz, Mexico

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[1]NanoPower Research Laboratory, Rochester Institute of Technology, Rochester, NY, USA, [2]Naval Reasearch Laboratory, Washington, DC, USA

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[1]University of Ottawa, Ottawa, ON, Canada, [2]McMaster University, Hamilton, ON, Canada

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[1]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA, [2]Microelectronics and Photonics Program, University of Arkansas, Fayetteville, AR, USA, [3]Natural Science Division, Lebanese American University, Lebanon, Byblos, Lebanon

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[1]Department of Electro-Physics, National Chiao-Tung University, Hsinchu, Taiwan, [2]Department of Photonics and Institute of Electro-Optical Engineering, National Chiao-Tung University, Hsinchu, Taiwan, [3]Department of Electronic Engineering, Chang Gung University, Taoyuan, Taiwan, [4]Compound Semiconductor Solar Cell Department, Next Generation Solar Cell Division, Green Energy and Environment Research Laboratories, Industrial Technology Research Institute (ITRI), Hsinchu, Taiwan, [5]Photovoltaic Metrology Laboratory, Energy & Environment Metrology Division, Center for Measurement Standards, Industrial Technology Research Insitute (ITRI), Hsinchu, Taiwan

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[1]National Chiao-Tung University, Hsinchu, Taiwan, [2]University of Michigan, Ann Arbor, Ann Arbor, MI, USA

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[1]Institute of Electronic Engineering, National Chiao-Tung University, Hsinchu, Taiwan, [2]Department of Electro-Physics, National Chiao-Tung University, Hsinchu, Taiwan

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University of Arkansas at Little Rock and Arkansas GREEN Solar Cell Research Center, Little Rock, AR, USA

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[1]Graduate School of Science and Engineering, Saitama University, Saitama, Japan, [2]Department of Advanced Materials Science, The University of Tokyo, Chiba, Japan

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[1]Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA, [2]Department of Chemical Engineering, University of Michigan, Ann Arbor, MI, USA

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[1]McMaster University, Hamilton, ON, Canada, [2]University of Ottawa, Ottawa, ON, Canada

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Teknova AS, Kristiansand, Norway

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Hokkaido University, Sapporo, Japan

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Vladimir Svrcek[1], Davide Mariotti[2], Koji Matsubara[1], Michio Kondo[1]

[1]Research Center for Photovoltaic Technologies, National Institute of Advanced Industrial Science and Technology (AIST), Tsukiba, Japan, [2]Nanotechnology & Integrated Bio-Engineering Centre (NIBEC), University of Ulster, Ulster, United Kingdom

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Katsuaki Tanabe, Katsuyuki Watanabe, Yasuhiko Arakawa

University of Tokyo, Tokyo, Japan

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[1]Department of Electrical and Electronic Engineering, Saga University, Saga, Japan, [2]PRESTO, Japan Science and Technology Agency, Kawaguchi, Japan, [3]Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

D19 39 **Very-High Efficient Solar System by Current Matched Partitions N/A**

Donald Wagner[1], Lili He[2]

[1]Sol Solution, Inc., Los Gatos, CA, USA, [2]San Jose State University, San Jose, CA, USA

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Hsun-Wen Wang[2], Pei-Chen Yu[1], Shiuan-Huei Lin[2], Hao-Chung Kuo[1]

[1]Department of Photonics & Institute of Electro-Optical Engineering, National Chiao-Tung University, Hsinchu, Taiwan, [2]Department of Electrophysics, National Chiao Tung University, Hsinchu, Taiwan

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[1]Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan, [2]Department of Electrical Engineering and Information Systems, School of Engineering, The University of Tokyo, Tokyo, Japan, [3]Central Technical Research Laboratory, JX Nippon Oil & Energy Corporation, Yokohama, Japan

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Simon Watson, Andy Skumanich
SolarVision Consulting, Los Gatos, CA, USA

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Jian Wu[1,2], Xusheng Wang[2], Lingjun Zhang[2], Wenzhong Shen[1]
[1]Institute of Solar Cell, Physics Department, Shanghai Jiao Tong University, Shanghai, China, [2]Canadian Solar Inc., Suzhou, China

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[1]Department of Photonic & Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Department of Electrophysics, National Chiao Tung University, Hsinchu, Taiwan

1:30 - 3:00 PM **EH4-B**

Area 2: Polycrystalline Thin Films: Absorber Formation and Characterization 1 (Posters)

Chair(s): Tim Gessert, Chris Ferekides, Bernhard Dimmler

E6 46 **Effect of Substrate Bias on Growth of RF-Sputtered CdTe Films** **129**
Hui Li, Xiangxin Liu, Fang Huang
The Key Laboratory of Solar Thermal Energy and Photovoltaic System, Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing, China

E10 47 **The Effect of Cadmium Chloride Treatment on Close Spaced Sublimated Cadmium Telluride Thin-Film Solar Cells** **N/A**
Ali Abbas[1,2], Geoff West[1], Paul Rowley[2], Jake Bowers[2], Biancamaria Maniscalco[2], John M. Walls[2], Keegan Barricklow[3,4], W.S. Sampath[3], Kurt L. Barth[3,4]
[1]Department of Materials, Loughborough University, Loughborough, United Kingdom, [2]CREST (Centre for Renewable Energy Systems and Technology), Loughborough, United Kingdom, [3]NSF I/UCRC for Next Generation Photovoltaics, Colorado State University, Fort Collins, CO, USA, [4]Abound Solar, Loveland, CO, USA

E14 48 **Fabrication of Thin-Film Solar Cells with Indium-Doped CdTe Crystals** **N/A**
Tursunjan Ablekim, Kelvin G. Lynn
Center for Materials Research, Washington State University, Pullman, WA, USA

E18 49 **Real Time and Post-Deposition Optical Analysis of Interfaces in CdTe Solar Cells** **134**
Prakash Koirala, Naba Paudel, Jie Chen, Dinesh Attygalle, Yanfa Yan, Robert W Collins
The University of Toledo, Toledo, OH, USA

E22 50 **Correlation Between Roughness and Performance of Sputtered CdTe Solar Cells** **N/A**
DoHyoung Kwon, Yunsic Shim, Kristopher A Wieland, Alvin D. Compaan
Dept. of Physics and Astronomy, The University of Toledo, Toledo, OH, USA

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Victor Rejon, Oscar Ares, Juan M. Camacho, Araceli Rios-Flores, Juan Luis Peña
Applied Physics Department, CINVESTAV-IPN, Mérida, Yucatán, Mexico

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Mohammed A. Tashkandi, W.S. Sampath
Materials Eng NSF I/UCRC for Next Generation Photovoltaics, Colorado State University, Fort Collins, CO, USA

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Guogen Liu[1,2], Zimeng Cheng[1], George E. Georgiou[1], Jingong Pan[3], Ken Chin[1], Alan Delahoy[1], Robert B. Barat[2]
[1]Apollo CdTe Solar Energy Research Center, Newark, NJ, USA, [2]Chemical, Biological and Pharmaceutical Engineering, Newark, NJ, USA, [3]Apollo Solar Energy, Inc., Chengdu, China

F10 54 **Effects of Thermal Annealing on Structural and Optical Properties of Sputtered CdS Thin Films for Photovoltaic Application 151**
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[1]Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia, [2]Solar Energy Research Institute, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia, [3]CEREM, College of Engineering, King Saud University, Riyadh, Saudi Arabia

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[1]Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia, [2]Solar Energy Research Institute, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

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NSF I/UCRC for Next Generation Photovoltaics, Colorado State University, Fort Collins, CO, USA

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[1]The Pennsylvania State University, University Park, PA, USA, [2]The University of Toledo, Toledo, OH, USA

F26 58 **Atmospheric-Pressure Chemical Vapor Deposition of Iron-Pyrite Thin Films N/A**
Nicholas E. Berry[1], Ming Cheng[2], Craig L. Perkins[3], John C. Hemminger[2], Matt Law[2]
[1]Department of Physics, University of California, Irvine, Irvine, CA, USA, [2]Department of Chemistry, University of California, Irvine, Irvine, CA, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA

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Tara P. Dhakal, Lakshmi K. Ganta, Charles R. Westgate
Center for Autonomous Solar Power (CASP), SUNY-Binghamton, Binghamton, NY, USA

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Anantha Sunil Maligi, Deepa K.G., Nagaraju Jampana
Indian Institute of Science, Bangalore, India

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Krishna C. Mandal, Sandip Das
University of South Carolina, Columbia, SC, USA

G14 62 **Study of $CuInS_2$-Based Solar Cells with Chemically-Deposited ZnS and In_2S_3 Buffer Layers N/A**
Clara L. Calderón[1], Johana S. Oyola[1], Pascual Bartolo[2], Gerardo Gordillo[1]
[1]Departamento de Física, Universidad Nacional de Colombia, Bogotá, Columbia, [2]Departamento de Física Aplicada, CINVESTAV- IPN, Mérida, Mexico

G18 63 **Characterization of $(AgCu)(InGa)Se_2$ Absorb Layer Fabricated by Selenization Process from Metal Precursor N/A**
Yuki Tauchi[1,3], Kihwan Kim[1], Hyeonwook Park[1,4], William 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, [3]Electric Research Laboratory, Kobe Steel, LTD., Kobe, Japan, [4]School of Display and Chem. Eng., Yeungnam University, Gyeongsan, South Korea

G22 64 **Preparation of $CuInSe_2$ Thin Films by Post-Deposition Selenization of Sputter-Deposited $CuInO_x$ Films N/A**
Emre Yassitepe[1], William N. Shafarman[1,2], S. Ismat Shah[1,3]
[1]Materials Science and Engineering, University of Delaware, Newark, DE, USA, [2]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [3]Department of Physics and Astronomy, University of Delaware, Newark, DE, USA

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McGill University, Montreal, QC, Canada

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[1]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan, [2]Center for Nano Science and Technology, National Chiao Tung University, Hsinchu, Taiwan, [3]Low Carbon Energy Research Center, National Tsing Hua University, Hsinchu, Taiwan, [4]Nuclear Science and Technology Development Center, National Tsing Hua University, Hsinchu, Taiwan

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[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Corning, Inc., Corning, NY, USA

1:30 - 3:00 PM **EH4-C**

Area 4: Crystalline Silicon: Fundamentals (Posters)

Chair(s): Hele Savin

I24 68 **Industrially Fabricated Bifacial Si Solar Cells with n^+-p-p^+ Structure N/A**
Galina Grigorieva[1], Kira Zviagina[1], Marlen Kagan[1], Lev Kreinin[2], Nelli Bordin[2], Jacob Broder[2], Naftali Eisenberg[2]
[1]KVANT Research and Production Enterprise, Moscow, Russia, [2]Jerusalem College of Technology, Jerusalem, Israel

I28 69 **Modeling Isotextured Silicon Solar Cells 192**
Simeon C. Baker-Finch[1], Keith R. McIntosh[2], Mason L. Terry[3]
[1]Australian National University, Canberra, ACT, Australia, [2]PV Lighthouse, Coledale, NSW, Australia, [3]Dupont Innovalight, Sunnyvale, CA, USA

J4 70 **Modeling Recombination at the Si–Al_2O_3 Interface 199**
Lachlan E. Black[1], Keith R. McIntosh[2]
[1]Centre for Sustainable Energy Systems, Australian National University, Canberra, Australia, [2]PV Lighthouse, Coledale, NSW, Australia

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Enrique Cabrera[1], Sara Olibet[1], Dominik Rudolph[1], Joachim Glatz-Reichenbach[1], Radovan Kopecek[1], Daniel Reinke[2], Anne Götz[2], Gunnar Schubert[2]
[1]International Solar Energy Research Center (ISC) Konstanz, Konstanz, Germany, [2]Sunways AG, Konstanz, Germany

J12 72 **Study of the Effect of Different Hole Sizes on Mechanical Strength of Wafers for Back Contact Solar Cells 209**
Eneko Cereceda[1], Josu Barredo[2], Jose Rubén Gutiérrez[1], Juan Carlos Jimeno[1], Alberto Fraile[3], Lutz Hermanns[3]
[1]Technological Institute of Microelectronics (TiM), University of the Basque Country, Zamudio, Spain, [2]Centre for Modeling in Mechanical Engineering (CEMIM-F2I2), Madrid, Spain, [3]Department of Structural Mechanics and Industrial Constructions, UPM, Madrid, Spain

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Renyu Chen[1], Hannes Wagner[2], Amir Dastgheib-Shirazi[3], Michael Kessler[4], Zihua Zhu[5], Pietro Altermatt[2], Scott Dunham[1]
[1]Department of Electrical Engineering, University of Washington, Seattle, WA, USA, [2]Dep. Solar Energy, Inst. Solid-State Physics, Leibniz University of Hannover, Hannover, Germany, [3]Div. Photovoltaics, Dep. of Physics, University of Konstanz, Konstanz, Germany, [4]Institute for Solar Energy Research Hamelin (ISFH), Emmerthal, Germany, [5]Environmental Molecular Sciences Lab, Pacific Northwest National Lab, Richland, WA, USA

J20 74 **Revisiting Models for Lifetime Degradation in Si Due to B/O Complexes** **N/A**
Scott T. Dunham, Renyu Chen, Bart Tryznadlowski
Department of Electrical Engineering, University of Washington, Seattle, WA, USA

J24 75 **Coupled Modeling of Evolutuion of Impurity/Defect Distribution and Cell Performance** **217**
Scott T. Dunham, Bart Tryznadlowski, Armin Yazdani, Renyu Chen
Department of Electrical Engineering, University of Washington, Seattle, WA, USA

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Kunal Ghosh, Clarence Tracy, Stephen Goodnick, Stuart Bowden
Arizona State university, Tempe, AZ, USA

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Harvey L. Guthrey[1,2], Steve W. Johnston[2], Fei Yan[2], Brian P. Gorman[1], Mowafak M. Al-Jassim[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

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Andre Kalio, Steve Olweya, Markus Glatthaar
Fraunhofer ISE, Freiburg, Germany

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Chinna Venkadasamy Kannan, Ramu Maddu, Ivan Saha
MoserBaer Photovoltaic Ltd, Greater Noida, U.P, India

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Heraeus Precious Metals North America Conshohocken LLC, West Conshohocken, PA, USA

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Chao-Hu Li, Albert W. Lu, Kuo-Ling Chiang
Topcell Solar International Co., Ltd., Taoyuan County, Taiwan

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Zhonglan Li[1], Yifeng Chen[2], Yang Yang[1], Zhiqiang Feng[1], Qiang Huang[1]
[1]State Key Lab of PV Science and Technology, Trina Solar Limited Company, Changzhou, China, [2]Institute for Solar Energy Systems, Sun Yat-sen University, Guangzhou, China

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AnYao Liu, Daniel Walter, Sieu Pheng Phang, Daniel Macdonald
Research School of Engineering, Australian National University, Canberra, Australia

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Linyan Liu[1], Jianting Gao[2], Liyuan Sun[3], Tao Zhang[1], Xiaojuan Cheng[1]
[1]LDK Solar, Xinyu, China, [2]LDK Solar, Sunnyvale, CA, USA, [3]LDK Solar, Nanchang, China

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Fort Hare Institute of Technology, Alice, Eastern Cape, South Africa

L8 86 **Towards Cost-Effective Antireflectve Coating and Surface-Texturing 258**
Yasuhiro Matsumoto, Gabriel Romero
Centro de Investigacion y de Estudios Avanzados del IPN, Mexico, Mexico

L11 87 **OPAL 2.0: Rapid Optical Simulation of Practical Silicon Solar Cells 265**
Keith R. Mcintosh[1], Simeon C. Baker-Finch[2]
[1]PV Lighthouse, Coledale, Australia, [2]Australian National University, Canberra, Australia

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Naoto Miyzaki[1], Yuki Tsuchiya[1], Takashi Sameshima[1], Tomihisa Tachibana[1], Takuto Kojima[2], Yoshio Ohshita[2], Koji Arafune[3], Atsushi Ogura[1]
[1]Meiji Univ., Kawasaki, Japan, [2]Toyota Tech. Inst., Nagoya, Japan, [3]Univ. of Hyogo, Himeji, Japan

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Karthick Murukesan[1], D.V. Sridhara Rao[2], Muraleedharan K.[2], Ashok Kumar Kapoor[3], Anuradha Dhaul[3], Brajesh Singh Yadav[3], Brij Mohan Arora[1]
[1]NCPRE, Department of Electrical Engineering, IIT Bombay, Mumbai, India, [2]Defence Metallurgical Research Laboratory, Kanchanbagh, Hyderabad, India, [3]Solid State Physics Laboratory, Lucknow Road, Delhi, India

L20 90 **Laser-Transferred Contacts: Modeling of the Transfer Process 282**
Tobias C. Röder, Jügen R. Köhler
Institute of Photovoltaics, University of Stuttgart, Stuttgart, Germany

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Martin C. Schubert, Jonas Schön, Bernhard Michl, Alireza Abdollahinia, Wilhelm Warta
Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany

L26 92 **Modeling the Size Distribution of Iron Precipitates in Multicrystalline Silicon 292**
Jonas Schön[1], Antti Haarahiltunen[2], David Fenning[3], Tonio Bounassisi[3], Wilhelm Warta[1], Martin C. Schubert[1]
[1]Fraunhofer Institute for Solar Energy Systems (ISE), Freiburg, Germany, [2]Aalto University, Aalto, Finland, [3]Massachusetts Institute of Technology, Cambridge, MA, USA

M1 93 **Bow Analysis After Soldering Process for Silicon Solar Cell with Special Bus Bar Pattern Design N/A**
Pin-Hsueh Tsai, Yu-Ning Chang, Chien-Wen Chen, Wen-Pin Chen, Chih-Hsyong Wu
Motech Industries, Inc., Tainan, Taiwan

M4 94 **Correlation Between Carbon Incorporation and Defect Formation in Quasi-Single Crystalline Silicon 297**
Yuki Tsuchiya[1], Hiroki Kusunoki[1,2], Naoto Miyazaki[1], Takashi Sameshima[1], Tomihisa Tachibana[1], Takuto Kojima[3], Koji Arafune[4], Yoshio Ohshita[3], Haruhiko Ono[2], Atsushi Ogura[1]
[1]Meiji University, Kawasaki, Japan, [2]Kanagawa Industrial Technology Center, Ebina, Japan, [3]Toyota Technological Institute, Nagoya, Japan, [4]University of Hyogo, Himeji, Japan

M7 95 **Mapping of the Dopant Compensation Effects on the Reverse and Forward Characteristics of Solar Cells 302**
J. Andrew Veirman, S. Dubois, N. Enjalbert, T. Desrues
CEA, LITEN, INES, 50 av du Lac Léman, F-73377, Le Bourget-du-Lac, France

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[1]Centre for Sustainable Energy Systems, Australian National University, Canberra, Australia, [2]School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia, [3]BT Imaging, Sydney, Australia

M13 97 **Analyzing emitter dopant inhomogeneities at textured Si surfaces by using 3D process and device simulations in combination with SEM imaging 313**
Hannes Wagner[1], Silke Steingrube[1], Bettina Wolpensinger[2], Renyu Chen[3], Scott Dunham[3], Pietro Altermatt[1]
[1]Dep. Solar Energy, Inst. Solid-State Physics, Leibniz University of Hannover, Appelstr. 2, 30167 30167 Hannover, Germany, Hannover, Germany, [2]Institute for Solar Energy Research Hamelin (ISFH), 31860, Emmerthal, Germany, [3]Electrical Engineering Department, University of Washington, Seattle, WA, USA

M16 98 **The Spot-Like Defect on Aluminum Oxide Passivation Layer for Crystalline Silicon Wafer 317**

Teng-Yu Wang[1], Cheng-Chi Liu[1,2], Chien-Hsiung Hon[1,2], Chen-Hsun Du[1,3], Chung-Yuan Kung[2], Jeng-Lang Lue[4], Chi-Chun Li[4]
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1:30 - 3:00 PM **EH4-D**

Area 5: Thin-Film Silicon: Solar Cells: Fundamentals, Processing, and Light Trapping (Posters)

Chair(s): X Niu, Nieuwenhuysen

O3 99 **Thinner Absorber Layers and Improved Relative Stability of a-Si:H p-i-n Junctions Using n-Doped µc-SiO_x:H Reflector Layers 321**

Pavel Babal, Ravi Vasudevan, Johan Blanker, Arno H.M. Smets, Miro Zeman
TU Delft, Delft, Netherlands

O5 100 **Large-Area Imprinted-Surface Textures for Omnidirectional Conformal AR Coatings on Flexible Amorphous Silicon Solar Cells 327**

Arvinder M. Chadha[1], Eric D. Cline[2], Meng Tao[3], Weidong Zhou[1]
[1]University of Texas at Arlington, Arlington, TX, USA, [2]ZT Solar Inc, Dallas, TX, USA, [3]Arizona State University, Tempe, AZ, USA

O7 101 **Amorphous Silicon Solar Cell on Block-Textured Glass 331**

Keum Chang Min[1], Moon Seung Jae[1], Kim Beom jun[2], Lee Jong Mo[2], Bae Byung Seung[1,2]
[1]New it Engineering, Hoseo University, Asan, Chungnam, South Korea, [2]Dep. of Semiconductor and Display Engineering, Hoseo University, Asan, Chungnam, South Korea

O9 102 **Monolithic Thin-Film Photovoltaic Device with Enhanced Output Voltage N/A**

Boris Gilman
CoolSol R&C, Mountain View, CA, USA

O11 103 **Solvent-Induced Growth of Crystalline Silicon on Glass 333**
Robert Heimburger, Roman Bansen, Thomas Teubner, Torsten Boeck
Leibniz Institute for Crystal Growth, Berlin, Germany

O13 104 **Blazed Pyramidal Gratings for Enhanced Light Trapping In Very-Thin-Film Solar Cells 338**
Liming Ji[1], Matthew Allan Thomas[2], Jingbiao Cui[2], Vasundara Varadan[1]
[1]University of Arkansas, Fayetteville, AR, USA, [2]University of Arkansas at Little Rock, Little Rock, AR, USA

O15 105 **Structural Properties of p-Type Polycrystalline Silicon Seed Layer by Electron Beam Annealing Method N/A**
Changheon Kim[1,2], Sangwoo Lim[2], Jin Hyeok Kim[3], Chaehwan Jeong[1]
[1]Applied Optics & Energy Research Group, Korea Institute of Industrial Technology, Gwangju, South Korea, [2]Department of Chemical and Biomolecular Engineering, Yonsei University 262 Seongsanno Seodaemun-gu, Seoul, South Korea, [3]Department of Materials Science Engineering, Chonnam National University, Gwangju, South Korea

O17 106 **Crystallization of a-Si Thin-Film Using an Ultrathin n+ Poly-Si Seed Layer for Solar Cell Applications 342**
Yue Kuo[1], Chi-Chou Lin [1], Stanislav Verkhoturov[2]
[1]Thin Film Nano & Microelectronics Research Laboratory, Texas A&M University, College Station, TX, USA, [2]Department of Chemistry, College Station, TX, USA

O19 107 **Layer Transfer of Crystalline Si Thin Film by Metal-Assisted Chemical Etching Concerning Different H_2O_2/HF Ratios 346**
Tzu-Ching Lin[1], Shu-Chia Shiu[2], Keng-Lam Pun[2], Hong-Jhang Syu[2], Ching-Fuh Lin[1,2,3]
[1]Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan, [2]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [3]Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan

O21 108 **Non-Metallic, Manufacturable Arrays for High-Performance Single-Junction Thin-Film nc-Si Solar Cells 350**
Wook Jun Nam[1,2], Stephen Fonash[1,2], Liming Ji[3], Vasundara Varadan[3]
[1]Solarity LLC, State College, PA, USA, [2]Center for Nanotechnology Education and Utilization, The Pennsylvania State University, University Park, PA, USA, [3]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA

O23 109 **Optical Characterization of Structurally-Graded $Si_{1-x}Ge_x$:H Thin Films 354**
Nikolas J. Podraza[1], David B. Saint John[2]
[1]Department of Physics and Astronomy, University of Toledo, Toledo, OH, USA, [2]Department of Materials Science and Engineering, The Pennsylvania State University, University Park, PA, USA

O25 110 **Plasmon-Enhanced Optical Absorption in Silicon Nanohole Array for Thin-Film Solar Cells Application 360**
Pushpa Raj Pudasaini, Arturo A. Ayon
University of Texas at San Antonio, San Antonio, TX, USA

O27 111 **Raman Study of Localized Recrystallization of Amorphous Silicon Induced by Laser Beam 364**
Nouar A. Tabet[1], Abduljabar Q. Sayoud[2], Seyed A. Said[2], A. Seyed[3], X. Yang[3], Y. Yang[3], E. Diallo[3], Z. Wang [3], X. Wang[3], Eric Johlin[4], Christie Simmons[4], Tonio Buonassisi[4]
[1]KFUPM-MIT Center of Research for Clean Water and Clean Energy, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, [2]Center of Research Excellence in Renewable Energy, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, [3]Nanofabrication Core Laboratory, King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia, [4]Massachusetts Institute of Technology, Cambridge, MA, USA

P1 112 **Numerical Simulation of Multijunction Thin-Film Silicon Solar Cells: From Single-Junction to Triple-Junction Solar Cells 367**
Karsten von Maydell, Stefan Geißendörfer, Jürgen Lacombe, Thilo Kilper, Oleg Sergeev, Kambulakwao Chakanga
EWE Forschungszentrum für Energietechnologie - NEXT ENERGY, Oldenburg, Germany

P3 113 **Large-Grain Polysilicon Seed Layers on Glass for Epitaxial Silicon Solar Cells 371**
Seth D. Shumate[1,2], Mohammed K. Hafeezuddin[2], Douglas A. Hutchings[2], Hameed A. Naseem[3]
[1]Microelectronics-Photonics, University of Arkansas, Fayetteville, AR, USA, [2]Silicon Solar Solutions, Fayetteville, AR, USA, [3]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA

1:30 - 3:00 PM **EH4-E**

Area 8: PV Characterization: Session 1 (Posters)

Chair(s): Manuel Romero, Yoshihiro Hishikawa, Gerald Siefer

Q20 114 **Tracking Cell Parameters in Fully Packaged Modules After Stress Testing N/A**
Glann Alers[1], Abaham Ishihara[2], Jeremy Olson[3], Nathan Green[3]
[1]Uinversity of California, Santa Cruz, CA, USA, [2]Carnegie Mellon, Mountain View, CA, USA, [3]APV Research, Mountain View, CA, USA

Q22 115 **Through-the-Glass Optical Metrology for Mapping 60 cm x 120 cm CdTe Photovoltaic Panels in Off-Line and Online Configurations 377**
Jie Chen[1], Prakash Koirala[1], Carl Salupo[1], Robert W. Collins[1], Sylvain Marsillac[2], Kenneth R. Kormanyos[3], Blaine D. Johs[4], Jeffrey S. Hale[4], Galen L. Pfeiffer[4]
[1]Center for Photovoltaics Innovation & Commercialization and Department of Physics & Astronomy, University of Toledo, Toledo, OH, USA, [2]Department of Electrical and Computer Engineering, Old Dominion University, Norfolk, VA, USA, [3]Calyxo USA Inc., Perrysburg, OH, USA, [4]J. A. Woollam Co., Lincoln, NE, USA

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[1]Dpto. de Física Aplicada I, Lab. de Materiales y Superficies, Universidad de Málaga, Málaga, Spain, [2]Instituto de Energía Solar-Universidad Politécnica de Madrid, Madrid, Spain

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[1]SERIS, Singapore, Singapore, [2]PV Lighthouse, Coledale, Australia, [3]UNSW, Sydney, Australia

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[1]University of Nevada, LasVegas (UNLV), Las Vegas, NV, USA, [2]Institute for Synchrotron Radiation, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, [3]Colorado State University (CSU), Fort Collins, CO, USA

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[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado State University, Fort Collins, CO, USA, [3]Calisolar, Sunnyvale, CA, USA

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[1]The University of Toledo, Toledo, OH, USA, [2]Old Dominion University, Norfolk, VA, USA

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[1]School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, [2]Department of Physics, Purdue University, West Lafayette, IN, USA

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[1]Dpto. de Física Aplicada I, Lab. de Materiales y Superficies, Univ. de Málaga, Málaga, Spain, [2]Instituto de Ciencia de Materiales de Madrid, (ICMM-CSIC), Madrid, Spain

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[1]Departamento de Física Aplicada, Univeridad de Málaga, Málaga, Spain, [2]Instituto de Energía Solar-Universidad Politécnica de Madrid, Madrid, Spain

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[1]MKS Instruments, San Jose, CA, USA, [2]MKS Instruments UK Ltd. Spectra Products, Crewe, Cheshire, United Kingdom, [3]Pure Crystal Solutions, Mountain View, CA, USA

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[1]Delft University of Technology, Department of Materials Science & Engineering, Delft, Netherlands, [2]Energy Research Centre of the Netherlands, Solar Energy, PV Module Technology, Petten, Netherlands

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[1]Old Dominion University, Norfolk, VA, USA, [2]The University of Toledo, Toledo, OH, USA

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[1]NEXCIS, Rousset, France, [2]IREC, Barcelona, Spain, [3]Universitat Barcelona, Barcelona, Spain

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[1]E.I.DuPont de Nemours & Co., Wilmington, DE, USA, [2]Ecole Polytechnique Federale de Lausanne, Institute of Microengineering, Neuchatel, Switzerland, [3]DuPont de Nemours International, Geneva, Switzerland

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Semilab Semiconductor Physics Laboratory Co. Ltd., Budapest, Hungary

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Luca Tenconi[1], Cristina S. Polo Lopez[1,2], Fabio Lo Castro[1], Stefano Brambillasca[1]
[1]IRcCOS S.c.a r.l. - Research and certification Institute for Sustainable Construction, Legnano, Italy, [2]Institute of Applied Sustainability to the Built Environment (ISAAC) - Swiss BiPV Competence Centre, University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Cannobio, Switzerland

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[1]GP Solar GmbH, Konstanz, Germany, [2]GP Inspect GmbH, Neuried, Germany

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[1]Zeta Instruments, San Jose, CA, USA, [2]TetraSun, Milpitas, CA, USA

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[1]Supsi, Canobbio, Switzerland, [2]Pasan, Neuchatel, Switzerland

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[1]Solar Energy Research Institute of Singapore, Singapore, Singapore, [2]Trina Solar Limited, Changzhou, China

T6 144 **Equivalent Cell Temperature Calculation for PV Modules with Variable Ideality Factors 505**
Georgi Hristov Yordanov[1,2], Ole-Morten Midtgård[1,2], Tor Oskar Saetre[1]
[1]University of Agder (UiA), Grimstad, Norway, [2]Norwegian University of Science and Technology (NTNU), Trondheim, Norway

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Fei Zeng, Zongcun Liang, Yuan Feng, Hui Shen
Institute for Solar Energy System, School of Physics and Engineering, State Key Laboratory of Optoelectronic Materials and Technologies, Sun Yat-Sen University, Guangzhou, China

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[1]Koiné Multimedia, Pisa, Italy, [2]Scienza Industria Tecnologia srl, Pisa, Italy, [3]DIEEI - University of Catania, Catania, Italy

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Edoardo Sarda[1], Brad Starks[1], Nikolai Dowd[1], Justin Lacroix[1], Paul Weber[1], Tim Hebrink[2]
[1]Lake Superior State University, School of Engineering and Technology, Sault Ste Marie, MI, USA, [2]3M Company, Corporate Research Laboratory, St. Paul, MN, USA

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Adria E. Brooks[1,2], Nathan Allen[3], Vincent P. Lonij[1], Alexander D. Cronin[1]
[1]University of Arizona, Department of Physics, Tucson, AZ, USA, [2]Arizona Research Institute for Solar Energy, Tucson, AZ, USA, [3]University of Arizona, Biosphere 2, Tucson, AZ, USA

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PUCRS-Catholic University, Porto Alegre, Brazil

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Arizona State University, Mesa, AZ, USA

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[1]NTT Facilities, Inc., Tokyo, Japan, [2]Hitachi, Ltd., Hitachi, Japan, [3]Tokyo Institute of Technology, Tokyo, Japan

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Vincent P. Lonij[1], Adria E. Brooks[1], Kevin Koch[2], Alexander D. Cronin[1]
[1]University of Arizona, Tucson, AZ, USA, [2]Technicians for Sustainability, Tucson, AZ, USA

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Cari D. Williamette, Lucius N. Jonett, Eric Hansen
Westwood Professional Services, Eden Prairie, MN, USA

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Johann A. Hernández[1], Carlos A. Arredondo[2], William A. Vallejo[3], Gerardo Gordillo[4]
[1]Facultad de Ingeniería, Universidad Distrital Francisco José de Caldas, Bogota, Columbia, [2]Facultad de Ingeniería Electrónica y Biomédica, Universidad Antonio Nariño, Bogota, Columbia, [3]Facultad de Ingeniería, Universidad América, Bogota, Columbia, [4]Departamento de Física, Universidad Nacional de Colombia, Bogota, Columbia

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Johann A. Hernández[1], Ana M. Blanco[2], Luis E. Luna[2]
[1]Facultad de Ingeniería, Universidad Distrital Francisco José de Caldas, Bogota, Columbia, [2]Facultad de Ingeniería Eléctrica, Universidad Nacional, Bogota, Columbia

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ABB Corporate Research, Västerås, Sweden

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Chee Lim Nge[1,2], Ole-Morten Midtgard[2], Lars Norum[1]
[1]Norwegian University of Science and Technology, Trondheim, Norway, [2]University of Agder, Grimstad, Norway

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Department of Electrical Engineering, Indian Institute of Technology, Bombay, Mumbai, India

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National Renewable Energy Laboratory, Golden, CO, USA

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Vivek Sharma, Jaewon Oh, Stuart Bowden
Solar Power Lab, Arizona State University, Tempe, AZ, USA

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Sandia National Laboratories, Albuquerque, NM, USA

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[1]Northern Plains Power Technologies, Brookings, SD, USA, [2]Advanced Energy, Bend, OR, USA, [3]Schweitzer Engineering Laboratories, Pullman, WA, USA

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Robert Lofaro, Michael Villaran, Alessandra Colli
Brookhaven National Laboratory, Upton, NY, USA

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Jumie N. Yuventi
Stanford University, Stanford, CA, USA

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Harley E. Denio, III, Harley E. Denio
Oregon Infrared, Aloha, OR, USA

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Chair(s): Vasilis Fthenakis, Jeanne Yturri

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Eugene Ngai
Chemically Speaking LLC, Whitehouse Station, NJ, USA

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Molly E. McKenna[1], Ken C. Jeffcoat[2]
[1]Zephyr Environmental Corp., Austin, TX, USA, [2]Heliovolt, Austin, TX, USA

2:15 170 **Economic PV Waste Recycling Solutions - Results from R&D and Practice** **628**
Wolfram J. Palitzsch, Ulrich M. Loser
Loser Chemie GmbH, Langenweißbach, Germany

2:30 171 **Managing PV-Related EHS at the National Renewable Energy Laboratory** **632**
Troy D. McCuskey, Brent P. Nelson
NREL, Golden, CO, USA

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John B. Visty
Salus Engineering International, Santa Clara, CA, USA

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Coffee Break

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Chair(s): Seth Hubbard, Yoshitaka Okada, Ryne Raffaelle

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Nicholas J. Ekins-Saukes[1], Stephen P. Bremner[2], Christiana B. Honsberg[3], Stephen Goodnick[3]
[1]Imperial College, London, United Kingdom, [2]University of New South Wales, Sydney, Australia, [3]Arizona State University, Tempe, AZ, USA

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Stephen J. Polly[1], Zachary S. Bittner[1], Christopher G. Bailey[2], David V. Forbes[1], Yushuai Dai[1], Seth M. Hubbard[1]
[1]NanoPower Research Laboratories, RIT, Rochester, NY, USA, [2]U.S. Naval Research Laboratory, Washington, DC, USA

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[1]Instituto de Energía Solar, ETSI Telecomunicación, Universidad Politécnica de Madrid, Madrid, Spain, [2]School of Engineering, University of Glasgow, Glasgow, United Kingdom, [3]Instituto de Microelectrónica de Madrid, CNM (CSIC), Madrid, Spain, [4]Dpto. de Ciencia de los Materiales e Ingeniería Metalúrgica y Química Inorgánica, Facultad de Ciencias, Universidad de Cádiz, Cádiz, Spain

4:30 176 **InGaAs/GaAsSb Type-II Quantum Dots for Intermediate-Band Solar Cell N/A**
Yasushi Shoji[1,2], Katsuhiro Akimoto[2], Yoshitaka Okada[1]
[1]Research Center for Advanced Science and Technology, The University of Tokyo, Meguro-ku, Japan, [2]Institute of Applied Physics, University of Tsukuba, Tsukuba, Japan

4:45 177 **Towards Intermediate-Band Formation in Solar Cells with AlGaInAs Quantum Dots 657**
Stefan Kremling[1], Christian Schneider[1], Tristan Braun[1], Nadezda V. Tarakina[2], Maxwell Adams[1], Matthias Lermer[1], Stephan Reitzenstein[1,3], Lukas Worschech[1], Sven Höfling[1], Alfred Forchel[1], Martin Kamp[1]
[1]Technische Physik, Universität Würzburg, Germany, [2]Experimentelle Physik III, Universität Würzburg, Germany, [3]Institute of Solid State Physics, Technische Universität Berlin, Germany

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Area 2: Polycrystalline Thin Films: Wide Bandgap Devices (Orals)

Chair(s): William Shafarman, Rebekah Feist

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Gregory M. Hanket, Christopher P. Thompson, Erter Eser, William N. Shafarman
Institute of Energy Conversion, University of Delaware, Newark, DE, USA

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Cu Off-Stoichiometry of $CuInS_2$ Thin-Film Solar Cell Absorbers: Effect on the Electronic Surface Structure N/A
M. Bär[1,2,3], J. Klaer[1], L. Weinhardt[2,4], N. Barreau[5], C. Heske[2,4,6], H.-W. Schock[1]
[1]Solar Energy Research, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany, [2]Department of Chemistry, University of Nevada, Las Vegas, Las Vegas, NV, USA, [3]Institut für Physik und Chemie, Brandenburgische Technische Universität Cottbus, Cottbus, Germany, [4]Institute for Synchrotron Radiation, Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany, [5]Institut des Matériaux Jean Rouxel, Université de Nantes, CNRS, Nantes, France, [6]Institute for Chemical Technology and Polymer Chemistry, Karlsruhe Institute of Technology, Karlsruhe, Germany

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Joel B. Li[1], Vardaan Chawla[2], Bruce M. Clemens[3]
[1]Department of Electrical Engineering, Stanford University, Stanford, CA, USA, [2]AQT Solar, Sunnyvale, CA, USA, [3]Department of Materials Science & Engineering, Stanford University, Stanford, CA, USA

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Byungha Shin, Yu Zhu, Nestor A. Bojarczuk, Jay S. Chey, Supratik Guha
IBM T. J. Watson Research Center, Yorktown Heights, NY, USA

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Wan-Ching Hsu[1], Ingrid Repins[2], Carolyn Beall[2], Glenn Teeter[2], Clay DeHart[2], Bobby To[2], Yang Yang[1], Rommel Noufi[2]
[1]Department of Materials Science and Engineering, University of California, Los Angeles, Los Angeles, CA, USA, [2]Renewable Energy Laboratory, Golden, CO, USA

3:30 - 5:00 PM **Blrm G**

Area 4: Crystalline Silicon: New Device Concepts (Orals)

Chair(s): Giso Hahn, Rubin Sidhu

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Giuseppe Galbiati[1], Valentin D. Mihailetchi[1], Andreas Halm[1], Lejo J. Koduvelikulathu[1], Razvan Roescu[1], Radovan Kopecek[1], Kristian Peter[1], Joris Libal[2]
[1]International Solar Energy Research Center (ISC), Konstanz, Germany, [2]Silfab S.p.A., Padova, Italy

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Q-Cells SE, Saxony Anhalt, Germany

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Bifacial n-Type Cells with >20% Front-Side Efficiency for Low-Cost Production N/A
Tim S. Böscke, Daniel Kania, Anke Helbig, Thomas Roth, Claus Schöllhorn, Martin Dupke, Patrick Sadler, Matthias Braun, Daniel Stichtenoth, Tobias Wütherich, Reik Jesswein, Dennis Fiedler, Robert Carl, Jan Lossen, H.-J. Krokoszinski
Bosch Solar Energy, Arnstadt, Germany

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David H. Hook[1], Seyman Aygun[1], Jon-Paul Maria[1], Brian J. Laughlin[2], William J. Borland[2]
[1]North Carolina State University, Raleigh, NC, USA, [2]DuPont Microcircuit Materials, Research Triangle Park, NC, USA

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Hao-Chih Yuan[1], Jihun Oh[1], Yuanchang Zhang[2], Oleg A. Kuznetsov[2], Dennis J. Flood[2], Howard M. Branz[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Natcore Technology, Red Bank, NJ, USA

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Xi Xi, Wenjuan Wu, Liping Chen, Jin Xu, Feng Gao, Zhengxin Wang, Haidong Zhu, Yongfei Jiang, Cheng Huang, Jingjia Ji, Zhengrong Shi
Suntech Power Co., Ltd., Wuxi, China

3:30 - 5:00 PM **19A**

Area 5: Thin-Film Silicon: Light Trapping in Solar Cells 1 (Orals)

Chair(s): Olindo Isabella, Matthieu Despeisse

3:30
189 **Advances in Light Trapping for Hydrogenated Nanocrystalline Silicon Solar Cells N/A**
Laura M. Sivec, Baojie Yan, Guozhen Yue, Jessica M. Owens-Mawson, Jeffrey Yang, Subhendu Guha
United Solar Ovonic LLC, Troy, MI, USA

4:00
190 **Gen5 Production Tool for Light Management Textures 690**
A.J.M. van Erven, M. Steltenpool, M. Bos, J. Rutten, G. van der Hofstad, J. Muller, H. de Groot, J. de Ruijter, B. Titulaer, G. Rajeswaran
OM&T B.V. / Moser Baer Technologies, Eindhoven, Netherlands

4:30
191 **Stencil-Nanopatterned Back Reflectors for Thin-Film Amorphous Silicon n-i-p Solar Cells 694**
Celine Pahud[1], Veronica Savu[2], Mona Klein[3], Oscar Vazquez-Mena[4], Karin Söderström[1], Franz-Joseph Haug[1], Jürgen Brugger[2], Christophe Ballif[1]
[1]EPFL, IMT, Photovoltaics and Thin Film Electronics Laboratory, Neuchatel, Switzerland, [2]EPFL, IMT, Microsystem Laboratory, Lausanne, Switzerland, [3]IBM Research, Zurich, Switzerland, [4]Berkeley University, San Francisco, CA, USA

4:45
192 **Investigation of Textured Back Reflectors with Periodic Honeycomb Patterns in Thin-Film Silicon Solar Cells for Improved Photovoltaic Performance N/A**
Hitoshi Sai[1], Kimihiko Saito[2], Michio Kondo[1]
[1]National Institute of Advanced Industrial Science and Techonology (AIST), Tsukuba, Japan, [2]Photovoltaic Power Generation Technology Research Association (PVTEC), Tsukuba, Japan

3:30 - 5:00 PM **17A**

Area 8: PV Characterization: PV Modules: Testing and Standards (Orals)

Chair(s): Michael Kempe, Gerald Siefer

3:30
193 **Evaluating the IEC 61215 Ed.3 NMOT Procedure Against the Existing NOCT Procedure with PV Modules in a Side-by-Side Configuration 697**
Matthew T. Muller, Bill Marion, Jose Rodriguez
NREL, Golden, CO, USA

3:45
194 **Systematic Approaches to Ensure Correct Representation of Measured Multi-Irradiance Module Performance in PV System Energy Forecasting Models 703**
Kenneth J. Sauer[1], Thomas Roessler[2]
[1]Yingli Green Energy Americas, Inc., San Francisco, CA, USA, [2]Yingli Green Energy Europe GmBh, Munich, Germany

4:00
195 **Non-Destructive Determination of the Degree of Cross-Linking of EVA Solar Module Encapsulation Using DMA Shear Measurements 710**
Rafal A. Mickiewicz, Edward Cahill, Po-I Wu
Fraunhofer Center for Sustainable Energy Systems (CSE), Cambridge, MA, USA

4:15
196 **Analytical Techniques Used to Determine Chemical Degradation of Polymeric Materials Used in PV Modules After Sustained Exposure to Partial Discharge Voltages 714**
Nancy H. Phillips[1], Bradley L. Givot[1], William D. O'Brien[1], Jaylon J. Loyd[2], Gary A. Korba[1]
[1]3M Company, Saint Paul, MN, USA, [2]3M Company, Austin, TX, USA

4:30
197 **Differentiating Series and Parallel Photovoltaic Arc-Faults 720**
Jay Johnson[1], Scott McCalmont [2], Gil Katzir [2], Sigifredo Gonzalez[1], Jennifer Granata[1], Armando Fresquez[1], Michael Montoya [1]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Tigo Energy, Los Gatos, CA, USA

4:45
198 **Qualification of Arcing Risks in PV Modules 727**
Florian Reil[1], Annett Sepanski[1], Mirco Vosen[1], Willi Vaassen[1], Werner Herrmann[1], Heribert Schmidt[2]
[1]TÜV Rheinland Energie und Umwelt GmbH, Cologne, Germany, [2]Fraunhofer Institute ISE, Freiburg, Germany

3:30 - 5:00 PM **16AB**

Area 9: Modules and Systems: Utility Scale and High Penetration (Orals)

Chair(s): Michael Coddington, Chris Barker

3:30
199
Current Results of the US DOE High Penetration Solar Deployment Project **731**
Holly Thomas[1], Kevin Lynn[2], Alvin Razon[2]
[1]US DOE, Golden, CO, USA, [2]US DOE, Washington, DC, USA

3:45
200
Economic Value of Photovoltaic Generation at High Penetration Levels **N/A**
Andrew D. Mills, Ryan H. Wiser
Lawrence Berkeley National Laboratory, Berkeley, CA, USA

4:00
201
Initial Operating Experience of the 1.2-MW La Ola Photovoltaic System **N/A**
Jay Johnson [1], Benjamin Schenkman[1], Abraham Ellis[1], Jimmy Quiroz[1], Carl Lenox [2]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]SunPower Corporation, Richmond, CA, USA

4:15
202
Integrating High Penetrations of PV into Southern California: Year 2 Project Update **737**
Barry Mather[1], Russell Neal[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Southern California Edison, Westminster, CA, USA

4:30
203
Evaluation of Alternatives to the Federal Energy Regulatory Commission (FERC) Small Generator Interconnection Procedures (SGIP) Screens for PV Interconnection Studies **742**
Robert J. Broderick, Abraham Ellis
Sandia National Laboratories, Albuquerque, NM, USA

4:45
204
Guidelines Document for Helping Utility Protection Engineers Determine When Additional Anti-Islanding Studies Are Prudent **748**
Michael E. Ropp[1], Abraham Ellis[2]
[1]Northern Plains Power Technologies, Brookings, SD, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA

3:30 - 5:00 PM **19B**

Area 10: PV Velocity Forum: Sustainability and PV EHS (Orals)

Chair(s): Amy Galland, Troy McCuskey

3:30 205 **Greenhouse Gases Emissions and Energy Payback of Large Photovoltaic Power Plants in the Northeast United States 753**
Annick Anctil, Vasilis Fthenakis
Brookhaven National Laboratory, Upton, NY, USA

3:45 206 **Electrothermal Heating Process Applied to c-Si PV Recycling 757**
Angelo Doni, Fabrizio Dughiero
Department of Industrial Engineering - University of Padua, Padua, Italy

4:00 207 **Exploring Large-Scale Solar Deployment in DOE's SunShot Vision Study 763**
Easan Drury[1], Greg Brinkman[1], Paul Denholm[1], Robert Margolis[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]National Renewable Energy Laboratory, Washington DC, DC, USA

4:15 208 **Direct Te Mining: Resource Availability and Impact on CdTe PV Life Cycles N/A**
Vasilis Fthenakis[1,2], Annick Anctil[2]
[1]Columbia University, New York, NY, USA, [2]Brookhaven National Laboratory, Upton, NY, USA

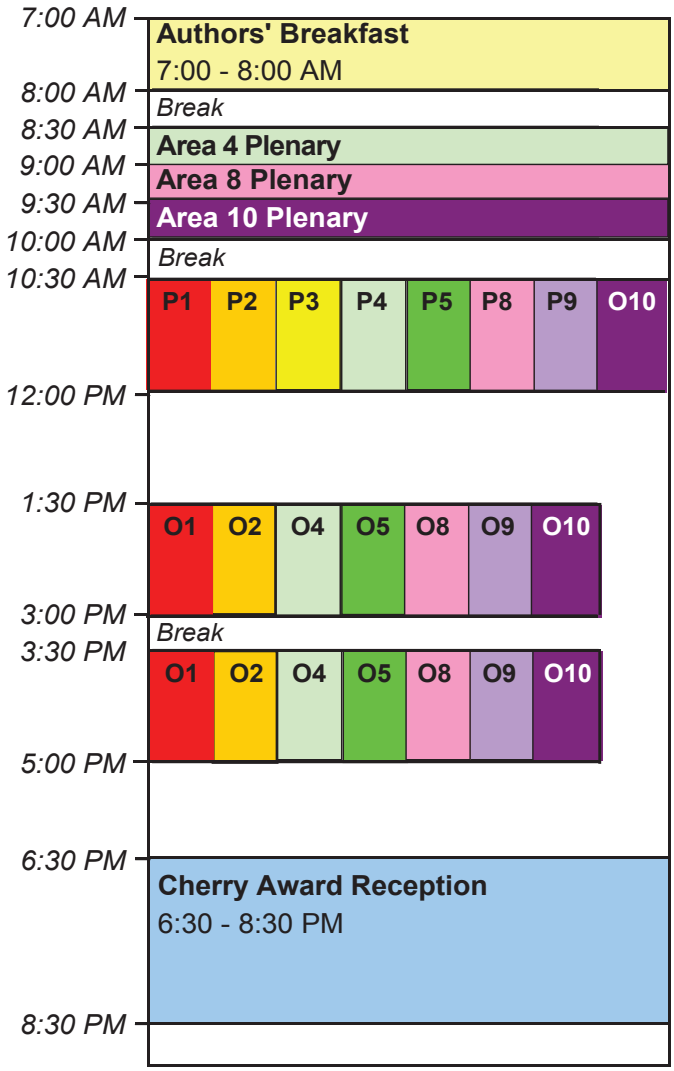
4:30 209 **Life Cycle Water Usage in CdTe Photovoltaics N/A**
Parikhit Sinha[1], Amy Meader[2], Mariska de Wild-Scholten[3]
[1]First Solar, Tempe, AZ, USA, [2]First Solar, Perrysburg, OH, USA, [3]SmartGreenScans, Groet, Netherlands

4:45 210 **Current and Conceivable Supply-Chain Dynamics of Tellurium and Indium Within the Context of PV Module Manufacturing Costs N/A**
Michael A. Woodhouse[1], Alan Goodrich[1], Martin Lokanc[2], Roderick Eggert[2]
[1]Strategic Energy Analysis Center, The National Renewable Energy Lab, Golden, CO, USA, [2]Department of Mineral and Energy Economics, Golden, CO, USA

5:30 - 8:00 PM **EH4-A**

Exhibitor's Opening Reception

TUESDAY PROGRAM SUMMARY



AREA LEGEND

- Area 1: Fundamentals and New Concepts for Future Technologies
- Area 2: Thin Film Polycrystalline Photovoltaics
- 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 Terrestrial Systems
- Area 10: PV Velocity Forum

O = Oral Session P = Poster Session

8:00 - 8:30 AM **4th Floor Foyer**

Coffee Break

8:30 - 9:00 AM **Blrm D**

Area 4: Crystalline Silicon: Plenary

8:30 211 **The Future of Crystalline Silicon Photovoltaic Technology N/A**
Eicke Weber
Fraunhofer ISE, Freiburg, Germany

9:00 - 9:30 AM **Blrm D**

Area 8: PV Characterization: Plenary

Chair(s): Gerald Siefer

9:00 212 **Calibration and Rating of Photovoltaics** **769**
Keith A. Emery
NREL, Golden, CO, USA

9:30 - 10:00 AM **Blrm D**

Area 10: PV Velocity Forum: Plenary

Chair(s): Elaine Ulrich

9:30 213 **Area 10: Plenary The DOW POWERHOUSE™ Solar Shingle Launch – Investment & Technology Decisions N/A**
Dave Parrillo
The Dow Chemical Company

10:00 - 10:30 AM **Exhibit Hall 4**

Coffee Break

10:30 - 12:00 PM **EH4-A**

Area 1: Fundamentals and New Concepts: Session 2 (Posters)

Chair(s): Annick Anctil, Chris Bailey, Seth Hubbard

A2
214 **Effect of Base Width Variation on the Performance of a Proposed Ultraviolet Low-Cost High-Efficiency Solar Cell Structure 775**
Marwa Salem Basyoni
Ain Shams University, Cairo, Egypt

A6
215 **Broadband Quantum Dots-in-a-Well Solar Cells 778**
C. H. Chang[1], T. E. Tzeng[1], T. S. Lay[1], H. Cho[2], David J.Y. Feng[2]
[1]National Sun Yat-Sen University, Kaohsiung, Taiwan, [2]National University of Kaohsiung, Kaohsiung, Taiwan

A10
216 **Photovoltaic Response for High Density InGaAs Coupled Quantum Dots 781**
Kuei-Ya Chuang[1], K. D. Tzeng[1], T. E. Tzeng[1], T. S. Lay[1], Chien-chung Lin[2], H. Cho[3], David J. Y. Feng[3]
[1]Department of Photonics, National Sun Yat-Sen University, Kaohsiung, Taiwan, [2]Institute of Photonic Systems, College of Photonics, National Chiao-Tung University, Tainan, Taiwan, [3]Department of Electrical Engineering, National University of Kaohsiung, Kaohsiung, Taiwan

A14
217 **Fabrication of Silicon Nanostructures via Self-Assembled Silver Nanoparticles Catalyzed Chemical Etching for Solar Cells N/A**
Bingfei Dou, Rui Jia, Haofeng Li, Chen Chen, Xinyu Liu, Tianchun Ye
Institute of Microelectronics, Chinese Academy of Sciences, Beijing, China

A18
218 **Design and Simulation of a Multi-Quantum-Well AlGaAs/GaAs Single-Junction Solar Cell with Back Surface Reflector 785**
Hamid Fardi[1], Mohammed Jan[1], Bart Van Zeghbroeck[2]
[1]University of Colorado Denver, Denver, CO, USA, [2]University of Colorado at Boulder, Boulder, CO, USA

A22
219 **Enhanced V_{oc} in InAs Quantum-Dot-Based *p-i-n* Solar Cells Using a Non-Alternating Strain-Balancing Epitaxial Growth Method 789**
Jateen S. Gandhi, Choong-un Kim, Wiley P. Kirk
University of Texas at Arlington, Arlington, TX, USA

A26 220 **In-Plane Miniband Formation of Si Nanodisk and Its Application in Intermediate-Band Photovoltaics 794**
W. Hu[1,2], M. F. Budiman[1,2], M. Igarashi[1,2], M.-Y. Lee[3], Y. Li[3], S. Samukawa[1,2]
[1]Institute of Fluid Science, Tohoku University, Sendai, Japan, [2]Japan Science and Technology Agency, CREST, Tokyo, Japan, [3]Department of Electrical Engineering, National Chiao Tung University, Taiwan, China

B2 221 **Effect of Variation in Energy Bandgap and Intrinsic Layer Thickness on Silicon Quantum Dot Solar Cell Performance N/A**
Paresh Kale, Chetan Solanki
Indian Institute of Technology Bombay, Mumbai, India

B6 222 **Effect of Variation in Energy Bandgap and Intrinsic Layer Thickness on Silicon Quantum Dot Solar Cell Performance N/A**
Paresh Kale, Chetan Solanki
Indian Institute of Technology Bombay, Mumbai, India

B10 223 **SnS Quantum Dot Solar Cells with Cu_2S as Counter Electrode 798**
Deepa K.G., Anantha Sunil M., Nagaraju J.
Department of Instrumenation and Applied Physics, Bangalore, India

B14 224 **Application of Ge Quantum Wells Fabricated by Laser Annealing as Energy Selective Contacts for Hot-Carrier Solar Cells 801**
Sammy Lee, Shujuan Huang, Gavin J. Conibeer, Martin A. Green
ARC Photovoltaics Centre of Excellence, Sydney, Australia

B18 225 **Optical Bandgap Tuning of ICPCVD-Made Silicon Nanocrystals for Next Generation Photovoltaics 806**
Narasimha Rao Mavilla[1,2], Dharmendra Kumar R. Rai[1,3], Chetan S. Solanki[1,3], Vasi Juzer[1,2]
[1]National Centre for Photovoltaic Research and Education, IIT Bombay, Mumbai, India, [2]Department of Electrical Engineering, IIT Bombay, Mumbai, India, [3]Department of Energy Science and Engineering, IIT Bombay, Mumbai, India

B22 226 **Improvement in Short Circuit Current of *p-i-n* Solar Cell with Silicon Quantum Dot Superlattice Structure by Optimizing SiN_x Thickness 810**
Dharmendra kumar R. Rai[1], Narasimha Rao Mavilla[2], Ashish K. Panchal[3], Chetan S. Solanki[1]
[1]NCPRE, Department of Energy Science and Engineering, IIT Bombay, Mumbai, India, [2]NCPRE, Department of Electrical Engineering, IIT Bombay, Mumbai, India, [3]Department of Electrical Engineering, S. V. NIT, Surat, India

B26 227 **Transport Mechanism of Novel Silicon-Riched Nitride (SRN)/Silicon-Riched Oxide (SRO) Superlattice Quantum Dot 815**
Yeliao Tao, Yuhua Zuo, Jun Zheng, Qian Cao, Tianwei Zhou, Chunlai Xue, Buwen Cheng, Xiangbo Zeng, Qiming Wang
State Key Laboratory on Integrated Optoelectronics, Institute of Semiconductors, Chinese Academy of Sciences, Beijing, China

C2 228 **One-Step Catalyst-Assist Formation of Silicon Nanohole Arrays with Omnidirectional Antireflection Properties 818**
Subramani Thiyagu, B.Parvathy Devi, Zingway Pei
National Chung Hsing University, Taichung, Taiwan

C6 229 **Transition Rate in the InGaN Quantum Dot Intermediate-Band Solar Cell 822**
Kuang-Chung Wang, Yuh-Renn Wu Wu
Natiional Taiwan University, Taipei, Taiwan

C10 230 **Photoelectrochemical Characterization of Si Microwire Array Solar Cells 826**
Emily L. Warren[1], Daniel B. Turner-Evans[2], Ron L. Grimm[1], Harry A. Atwater[2], Nathan S. Lewis[1]
[1]Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, CA, USA, [2]Department of Applied Physics and Materials Science, California Institute of Technology, Pasadena, CA, USA

C14 231 **(In)GaAsN Materials and Solar Cells for Super-High-Effiency Multijunction Solar Cells 831**
Masafumi Yamaguchi[1], Boussairi Bouzazi[1], Hidetoshi Suzuki[2], Nobuaki Kojima[1], Yoshio Ohshita[1]
[1]Toyota Technological Institute, Nagoya, Japan, [2]Miyazaki University, Miyazaki, Japan

C18 232 **Photovoltaic Performances Enhanced by Novel Indium Nanoparticles Using Surface Plasmonic in GaAs-Based 3-Junction Solar Cells 835**
Cheng-Ming Yu[1], Wen-Jeng Ho[1], Yi-Yu Lee[1], Jheng-Jie Liu[1], Chin-Cing Liao[1], Wei-Ting Wang[1], Shu-Chia Shiu[2], Ching-Fuh Lin[2], Hung-Pin Shiau[3]
[1]Department of Electro-Optical Engineering, National Taipei University of Technology, Taipei, Taiwan, [2]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [3]Win Semiconductor Corp., Taoyuan, Taiwan

10:30 - 12:00 PM **EH4-B**

Area 2: Polycrystalline Thin Films: Device Properties, Modeling, Stability, and Defect Characterization (Posters)

Chair(s): Susanne Siebentritt, Jim Sites

E7
233 **Nanopatterning and Bandgap Grading to Reduce Defects in CdTe Solar Cells 838**
Jose L. Cruz-Campa[1], David Zubia[2], Xiaowang Zhou[3], Donald Ward[3], Carlos A. Sanchez[1], Jose J. Chavez[2], Brandon A. Aguirre[2], Farhana Anwar[2], Damian Marrufo[2], Ping Lu[1], Michael J. Rye[1], John C. McClure[2], Gregory N. Nielson[1]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]University of Texas at El Paso, El Paso, TX, USA, [3]Sandia National Laboratories, Livermore, CA, USA

E11
234 **Cu Effects on CdS/CdTe Thin-Film Solar Cells Prepared on Flexible Substrates 843**
Xianjin Feng, Kartikay Singh, Sushma Bhavanam, Vasilios Palekis, Don L. Morel, Chris Ferekides
University of South Florida, Tampa, FL, USA

E15
235 **Impact of Interface Recombination on Time-Resolved Photoluminescence Decays (TRPL) in CdTe Solar Cells (Numerical Simulation Analysis) 848**
Ana Kanevce, Darius Kuciauskas, Timothy A. Gessert, Dean H. Levi
National Renewable Energy Laboratory, Golden, CO, USA

E19
236 **Sputtered Oxygenated CdS Window Layers for Higher Current in CdS/CdTe Thin-Film Solar Cells 854**
Jason M. Kephart, Russell Geisthardt, W.S. Sampath
Colorado State University, Fort Collins, CO, USA

E23
237 **Plasma Cleaning of TCO Surfaces Prior to CdS/CdTe Deposition 859**
Drew E. Swanson, Ryan M. Lutze, W.S. Sampath, John D. Williams
Materials Engineering Lab, NSF I/UCRC for Next Generation Photovoltaic, Colorado State University, Fort Collins, CO, USA

E27
238 **3-D Simulations for the Optimization of Antireflection Subwavelength Structures in CIGS Solar Cells 864**
Sehyun Hwang[1], Jae-Hyung Jang[1,2]
[1]Research Institute for Solar and Sustainable Energies (RISE), Gwangju Institute of Science and Technology (GIST), Gwangju, South Korea, [2]Department of Information and Communications, Gwangju Institute of Science and Technology (GIST), Gwangju, South Korea

F3 239 **Study of Point Defects in ns-Pulsed Laser-Annealed $CuInSe_2$ Thin Films N/A**

Ashish Bhatia[1], Helen Meadows[2], Mitchell C. Hymas[1], Elizabeth M. Smith[1], Phillip J. Dale[2], Michael A. Scarpulla[1,3]

[1]Materials Science and Engineering, University of Utah, Salt Lake City, UT, USA, [2]Laboratory Photovoltaic, University of Luxembourg, Belvaux, Luxembourg, [3]Electrical and Computer Engineering, University of Utah, Salt Lake City, UT, USA

F7 240 **Reverse Stress Metastability of Shunt Current in CIGS Solar Cells 868**

Sourabh Dongaonkar[1], Erik Sheets[2], Rakesh Agrawal[2], Muhammad A. Alam[1]

[1]School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, [2]School of Chemical Engineering, Purdue University, West Lafayette, IN, USA

F11 241 **J_{sc} Improvement of CdS/$Cu(In,Ga)Se_2$ Solar Cells After Rapid Thermal Annealing 873**

D.S. Chen[1,2], J. Yang[1], F. Xu[1], H.W. Du[1], J.W. Shi[1], Z.S. Yu[3], Y.H. Zhang[3], Z.Q. Ma[1]

[1]SHU-SolarE R&D Lab, Shanghai University, shanghai, China, [2]College of Mathematics and Physics, Shanghai University of Electric Power, shangha, China, [3]Shanghai Solar EnerTech Co.Ltd, shangha, China

F15 242 **Effects of Annealing in Sulfur Vapor on Electrodeposited $CuInSe_2$ Films 879**

Ashish Bhatia[1], Makarand A. Karmarkar[1], Helen Meadows[2], Mitchell C. Hymas[1], Elizabeth M. Smith[1], Phillip J. Dale[2], Michael A. Scarpulla[1,3]

[1]Materials Science and Engineering, University of Utah, Salt Lake City, UT, USA, [2]Laboratory Photovoltaic, University of Luxembourg, Belvaux, Luxembourg, [3]Electrical and Computer Engineering, University of Utah, Salt Lake City, UT, USA

F19 243 **Analysis of (Ag,Cu)(In,Ga)Se2 Solar Cells Deposited by a Hybrid Process 884**

Scott Little[1], Vikash Ranjan[2], Robert W. Collins[1], Sylvain Marsillac[2]

[1]University of Toledo, Toledo, OH, USA, [2]Old Dominion University, Norfolk, VA, USA

F23 244 **The Impact of Selenisation on Damp Heat Degradation of the CIGS Back Contact Molybdenum N/A**

Mirjam Theelen[1,2,3], Mathieu Tomassini[4], Nicolas Barreau[4], Henk Steijvers[1], Annalisa Branca[1], Sylvie Harel[4], Zeger Vroon[1], Miro Zeman[2]

[1]TNO, Eindhoven, Netherlands, [2]Delft University of Technology, Delft, Netherlands, [3]M2i, Delft, Netherlands, [4]IMN-UMR, Nantes, France

F27 245 **Determination of Moisture Ingress Through Various Encapsulants Used in CIGS PV Module Under Continuously Varying Environment 887**
Namsu Kim[1], Chanwoon Han[1], Dohyun Baek[2], Jaehoon Lee[2], Dongseop Kim[2]
[1]Components and Materials Physics Research Center, Korea Electronic Research Center, Gyeongi-Do, South Korea, [2]Solar Energy Business Division, Samsung SDI Co., Ltd., Gyeongi-Do, South Korea

G3 246 **Reliability Studies of Mo Layer Deposited on Polyimide Substrate for CIGS Solar Cell Applications 891**
Dung-Ching Perng, Ming-Chen Hung, Kuo-Yu Wang
National Cheng Kung University, Tainan, Taiwan

G7 247 **Development of a High-Pressure CdS Sputtering Process for Improved Efficiency in CIGS-Based Photovoltaic Devices 895**
Melissa Mushrush, Rebekah Feist, Steve Rozeveld, Gary Mitchell, Jeffrey Fenton
The Dow Chemical Company, Midland, MI, USA

G11 248 **Impact of P2 Scribe Geometry on Monolithic Series Interconnected CIGS Modules N/A**
Mathew N Rekow[1], Dominik Bartl[2], Christian Sandfort[3], Andreas Letsch[2]
[1]ESI-PyroPhotonics, Montreal, QC, Canada, [2]Robert Bosch GmbH, Stuttgart, Germany, [3]Bosch Solar CISTech GmbH, Brandenburg, Germany

G15 249 **Growth and Characterization of Cu_2ZnSnS_4 Single Crystal N/A**
Akira Nagaoka[1], Kenji Yoshino[1], Hideto Miyake[2]
[1]University of Miyazaki, Miyazaki, Japan, [2]Mie University, Mie, Japan

G19 250 **Interface Modification by In-S Soaking Process on CIGS Solar Cells with CBD-ZNS Buffer Layer 899**
Yu-Han Chang[1], Chia-Hsiang Chen[1], Yan-huei Wu[1], Shih-Yuan Wei[1], Chih-Huang Lai[1,2]
[1]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan, [2]Low Carbon Energy Research Center, National Tsing Hua University, Hsinchu, Taiwan

G23 251 **Batch Simulation of Solar Cells by Using Matlab and wxAMPS 902**
Yiming Liu[1], Yun Sun[1], Angus Rockett[2]
[1]Nankai University, Tianjin, China, [2]University of Illinois at Urbana Champaign, Urbana, IL, USA

G27 252 **Graded Band gap CIGS Solar Cells Considering the Valence Band Widening 906**
Nima Eshaghi Gorji[1], Ugo Reggiani[1], Leonardo Sandrolini[1]
[1]Department of Electrical Engineering, University of Bologna, Bologna, Italy, [2]Department of Electrical Engineering, University of Bologna, Bologna, Italy, [3]Department of Electrical Engineering, University of Bologna, Bologna, Italy

10:30 - 12:00 PM **EH4-C**

Area 3: III-V's and Concentrators: Cells, Modules, and Systems 1 (Posters)

Chair(s): Alexander Hass

H9 253 **Ultrathin Tunnel Junction for Use in III-V Multijunction Solar Cells 909**
Gerard J. Bauhuis, Peter Mulder, Erik J. Haverkamp, John J. Schermer
Radboud University Nijmegen, Nijmegen, Netherlands

H11 254 **Towards High-Efficiency GaAs Thin-Film Solar Cells Grown via Close Space Vapor Transport from a Solid Source 913**
Shannon W. Boettcher, Andrew J. Ritenour
Department of Chemistry and the Materials Science Institute, University of Oregon, Eugene, OR, USA

H13 255 **Nonpolar Substrates for III-V-Based Solar Cells: Hydrogen Termination of Si(100) and Ge(100) Surfaces in MOVPE Process Ambient N/A**
Sebastian Brueckner[1,2], Henning Doescher[1,2], Anja Dobrich[1], Enrique Barrigón[3], Oliver Supplie[1], Claas Loebbel[1], Johannes Luczak[1], Ignacio Rey-Stolle[3], Peter Kleinschmidt[1,4], Thomas Hannappel[1,2,4]
[1]Helmholtz-Zentrum Berlin, Berlin, Germany, [2]Ilmenau University of Technology, Ilmenau, Germany, [3]Instituto de Energía Solar, Madrid, Spain, [4]CiS Research Institute, Erfurt, Germany

H15 256 **GEN 2 of CPV Technology at ISOFOTON: System Market Penetration N/A**
Javier Cabrera, Vicente Díaz, Ricardo Hernández, Jorge López
Isofoton, S.A., Málaga, Spain

H17 257 **Lattice-Matched GaP/SiGe Virtual Substrates for Low-Dislocation Density GaInP/GaAsP/Si Solar Cells 918**
Andrew M. Carlin[1], Tyler J. Grassman[1], Mark R. Brenner[1], Javier Grandal[1], Chris Ratcliff[1], Limei Yang[2], Michael Mills[2], Prithu Sharma[3], Eugene A. Fitzgerald[3], Steven A. Ringel[1]
[1]Dept. of Electrical and Computer Engineering, The Ohio State University, Columbus, OH, USA, [2]Dept. of Materials Science & Engineering, The Ohio State University, Columbus, OH, USA, [3]Dept. of Materials Science & Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA

H19 258 **Quantifying the Impact of Individual Atmospheric Parameters on CPV System Power and Energy Yield 922**
Ngai L.A. Chan, Helen E. Brindley, Nicholas J. Ekins-Daukes
Department of Physics, Imperial College London, London, United Kingdom

H21 259 **High-Efficiency Screen-Printed Low-Medium Concentrator Silicon Solar Cells with Direct-Printed 50um-Wide Fingers 928**
Chia-Wei Chen[1], Xudong Chen[2], Kenneth Church[2], Haixin Yang[3], Keith Tate[1], Ian B. Cooper[1], Ajeet Rohatgi[4]
[1]University Center of Excellence for Photovoltaic Research and Education, School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA, [2]nScrypt, Inc., Orlando, FL, USA, [3]DuPont Microcircuit Materials, North Carolina, NC, USA, [4]Suniva Inc., Norcross, GA, USA

H23 260 **Fabrication of Lattice-Mismatched Multijunction Cells by 3-D Integration Concepts 932**
Jose L. Cruz-Campa[1], Gregory N. Nielson[1], Anlthony L. Lentine[1], Anton A. Filatov[2], Paul J. Resnick[1], Carlos A. Sanchez[1], Adam M. Rowen[1], Murat Okandan[1], Vipin P. Gupta[1], Jeffrey S. Nelson[1]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Colorado School of Mines, Golden, CO, USA

H25 261 **Enhanced Performance of Small GaAs Solar Cells via Edge and Surface Passivation with Trioctylphosphine Sulfide 937**
Carissa N. Eisler, Matthew T. Sheldon, Harry A. Atwater
CalTech, Pasadena, CA, USA

H27 262 **Evaluation of the Stability Improvement in Power Generation of a Concentration Photovoltaic Module with Supercapacitors 941**
Yu-Pei Huang, Ko-Wei Weng, Peng-Fei Tsai
Department of Electronic Engineering, Nation Quemoy University, Kinmen County, Taiwan

I1 263 **Fabrication of Two-Terminal Metal-Interconnected Multijunction III-V Solar Cells 944**
Chieh-Ting Lin[1], W.E. McMahon[2], J.S. Ward[2], J.F. Geisz[2], M.W. Wanlass[2], J.J. Carapella[2], W. Olavarria[2], M. Young[2], M.A. Steiner[2], R.M. France[2], A.E. Kibbler[2], A. Duda[2], J.M. Olson[2], E.E. Perl[1], D.J. Friedman[2], J.E. Bowers[1]
[1]University of California at Santa Barbara, Santa Barbara, CA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

I3 264 **Development of Tunnel Junctions with High Peak Tunneling Currents for InP-Based Multijunction Solar Cells 949**
Matthew P. Lumb[1,2], Michael Yakes[2], Maria Gonzalez[3,2], Raymond Hoheisel[1,2], Woojun Yoon[2], Robert J. Walters[2]
[1]The George Washington University, Washington, DC, USA, [2]US Naval Research Laboratory, Washington, DC, USA, [3]Sotera Defense Solutions, Crofton, MD, USA

I5 265 **Study on the Device Structure of GaInNAs(Sb)-Based Solar Cells for Use in 4-Junction Tandem Solar Cells 954**
Naoya Miyashita, Nazmul Ahsan, Muhammad Monirul Islam, Yoshitaka Okada
The University of Tokyo, Tokyo, Japan

I7 266 **Optimizing Wide Bandgap Subcells for Multijunction Solar Cells Using the Strain-Free AlGaAs/GaAs System N/A**
Kyle H. Montgomery, Xin Zhao, Jerry M. Woodall
School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA

I9 267 **"Gondola": Trackless LCPV Module for Si Cells with Low-Aspect Ratio and High Energy Rating 957**
Francesco Morichetti[1], Aldo Righetti[2], Giorgio Grasso[2], Maria C. Ubaldi[2], Silvia M. Pietralunga[3]
[1]Politecnico di Milano, Dip. Elettronica e Informazione, Milano, Italy, [2]CIFE, Milano, Italy, [3]CNR-IFN, Milano, Italy

I11 268 **Influence of Temperature Distribution on 25 Series-Connected 820X CPV Module Output During Outdoor Operation 961**
Yasuyuki Ota[1], Tsuyoshi Sueto[1], Hirokazu Nagai[2], Kenji Araki[2], Kensuke Nishioka[1]
[1]University of Miyazaki, Miyazaki, Japan, [2]Daido Steel, Nagoya, Japan

I13 269 **Growth and Characterization of Quaternary (GaInAsP-GaAs)-Graded Heterostructures 965**
Monika Rathi, Pavel Dutta, S. P. Ahrenkiel
South Dakota School of Mines and Technology, Rapid City, SD, USA

I15 270 **Preliminary Development and Analysis of Tandem III-V/SiGe Devices Grown on Si 968**
Ken Schmieder[1], Andrew Gerger[2], Martin Diaz[1], Ziggy Pulwin[3], Chris Ebert[3], Robert Opila[1], Anthony Lochtefeld[2], Allen Barnett[4]
[1]University of Delaware, Newark, DE, USA, [2]AmberWave Inc., Salem, NH, USA, [3]Veeco MOCVD, Somerset, NJ, USA, [4]The University of New South Wales, Sydney, Australia

I17 271 **High-Efficiency Thin-Film InGaP/(In)GaAs/Ge Multijunction Solar Cells Enabled by Controlled Spalling Technology 974**
Davood Shahrjerdi[1], Stephan Bedell[1], Chris Ebert[2], Can Bayram[1], Bahman Hekmatshoar[1], Keith Fogel[1], Paul Lauro[1], Michael Gaynes[1], John Ott[1], Tayfun Gokmen[1], Devendra Sadana[1]
[1]IBM T J Watson Research Center, Yorktown Heights, NY, USA, [2]Veeco Corporations, Somerset, NJ, USA

I19 272 **A GaAs Single-Junction Solar Cell with a Roughened Back Scattering Surface 978**
Weiquan Yang[1], Charles Allen[1], Jing-jing Li[1], Shi Liu[1], Ding Ding[1], Stuart Farrell[1], Zhaoyu He[1], Hua Li[1], Hank Dettlaff[1], Yong-hang Zhang[1], Hector Cotal[2], Chritopher Fetzer[2], Nasser Karam[2]
[1]Arizona State University, tempe, AZ, USA, [2]Boeing-Spectrolab Inc., Sylmar, CA, USA

I21 273 **The Effect of Offcut Angle on Electrical Conductivity of Wafer-Bonded n-GaAs/n-GaAs Structures for Wafer-Bonded Tandem Solar Cells 982**
King W. Yeung, Mark S. Goorsky
Department of Materials Science and Engineering, UCLA, Los Angeles, CA, USA

I23 274 **MBE Growth of ZnTe and ZnTeSe on GaSb N/A**
Jessica Chai, Kyoung K. Lee, Kevin Doyle, John H. Dinan, Thomas H. Myers
Texas State University - San Marcos, San Marcos, TX, USA

10:30 - 12:00 PM **EH4-D**

Area 4: Crystalline Silicon: Passivation and Advanced Devices (Posters)

Chair(s): Bart Geerligs

I25 275 **Process Optimization for High-Efficiency Heterojunction c-Si Solar Cells Fabrication Using Hot-Wire Chemical Vapor Deposition 988**
Yuming Ai, Hao-Chih Yuan, Matthew Page, William Nemeth, Lorenzo Roybal, Lynn Gedvilas, Qi Wang
National Renewable Energy Laboratory, Golden, CO, USA

J1 276 **Passivation of n-Type Silicon (111) Surfaces by the Attachment of Charged Molecules 992**
Nicholas P. Alderman[1], Lefteris Danos[1], Martin C. Grossel[2], Tom Markvart[1]
[1]Solar Energy Laboratory, Faculty of Engineering and the Environment, University of Southampton, Southampton, United Kingdom, [2]Faculty of Natural and Environmental Sciences, University of Southampton, Southampton, United Kingdom

J5 277 **Effect of Interface States (Dit) at the a-Si/c-Si Interface on the Performance of Thin-Film a-Si/c-Si/c-Si Heterojunction Solar Cells 996**
Aaesha Alnuaimi, Ammar Nayfeh
Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates

J9 278 **Thin Monocrystalline Silicon Solar Cell with 100μm Thickness and 156x156mm² N/A**
Tae-Hyun Baek[1], Kyeom Seon Do[2], Sung Jin Choi[3], Gi Hwan Kang[4], Gwon Jong Yu[4], Jeong Chul Lee[4], Hye Mi Hwang[4], Kee-Joe Lim [1], Hee-eun Song[4]
[1]Department of Electrical Engineering, Chungbuk National University, Chongju, South Korea, [2]Department of Material Science & Engineering, Yonsei University, Seoul, South Korea, [3]Green Graduate School, Korea University, Seoul, South Korea, [4]Solar Energy Research Center, Korea Institute of Energy Research, Daejeon, South Korea

J13 279 **Improved Performance of Uncapped Al_2O_3 and Local Firing-Through Al-BSF in Bifacial Solar Cells** **1000**
I. Cesar[1], A.A. Mewe[1], E. Granneman[2], P. Vermont[2], A.W. Weeber[2]
[1]ECN, Petten, Netherlands, [2]Levitech, Almere, Netherlands

J17 280 **Novel Dual-Layered Passivation Approach for 18.8% Efficiency Laser-Doped Selective-Emitter Cells** **1006**
Tseng-Jung Chang, Te-Yu Wei, Sean H.T. Chen, Li-Wei Cheng
Topcell Solar International CO., LTD, Taoyuan County, Taiwan

J21 281 **n-Type Aluminum-Alloyed Rear-Junction Silicon Solar Cells with Implanted Front Surface Field** **1010**
Naratip Chantarat, Shao-peng Su
Topcell Solar International Co., LTD., Guanyin Township, Taoyuan Country, R.O.C., Taiwan

J25 282 **Effect of Interface Trap States in Reduced-Base-Thickness a-Si/c-Si Heterojunction Solar Cells** **1014**
Raghu Vamsi K. Chavali, John Wilcox, Jeffery L. Gray
School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA

K1 283 **Structure Simulation of Screen-Printed Local Back Surface Field for Rear-Passivated Silicon Solar Cell** **1018**
Daming Chen, Zongcun Liang, Hui Shen, Yang Liu
Institute for Solar Energy System, School of Physics and Engineering, State Key Laboratory of Optoelectronic Materials and Technologies, Sun Yat-Sen University, Guangzhou, Christmas Island

K5 284 **Industrial Development of Silicon Hetero-junction Back Contact Solar Cells** **1023**
Jin-Ho Choi[1], Jong-Chul Lee[1], Sang-Kyun Kim[1], Hun Park[1], Ki-Hyun Kim[2], Won-Jae Lee[1]
[1]Hyundai Electro-Mechanical Research Institute(HEMRI), Hyundai Heavy Industries Co.,Ltd, Yong-In, Korea, [2]Green Energy Business Division, Hyundai Heavy Industries Co.,Ltd, Eum-Seong, Korea

K9 285 **The Electrical Properties with Various Pre-Deposition Times During Doping Process in Monocrystalline Silicon Solar Cell** **N/A**
Sung Jin Choi[1], Gwon Jong Yu[2], Gi Hwan Kang[2], Jeong Chul Lee[2], Donghwan Kim[1], Hee-eun Song[2]
[1]Green Graduate School, Korea University, Seoul, South Korea, [2]Solar Energy Research Center, Korea Institute of Energy Research, Daejeon, South Korea

K13 286 **Excellent Low-Temperature Passivation Scheme with Reduced Optical Absorption for Back Amorphous-Crystalline Silicon Heterojunction (BACH) Photovoltaic Device 1026**
Zahidur R. Chowdhury[1], Dmitri Stepanov[2], Davit Yeghikyan[1], Nazir P. Kherani[1,2]
[1]Department of Electrical and Computer Engineering, University of Toronto, Toronto, ON, Canada, [2]Department of Material Science and Engineering, University of Toronto, Toronto, ON, Canada

K17 287 **Full-Area Laser-Doped Boron-Emitter Silicon Solar Cells 1029**
Morris Dahlinger, Sebastian J. Eisele, Patrick C. Lill, Jürgen R. Köhler, Jürgen H. Werner
Institute of Photovoltaics, University of Stuttgart, Stuttgart, Germany

K21 288 **Optical Modeling of the Internal Back Reflectance of Various Dielectric Stacks Featuring Al_2O_3, TiO_2, and SiO_2 1032**
Kristopher O. Davis[1,2], Matthew Weed[2], Hubert P. Seigneur[1,2], Kaiyun Jiang[3], Carsten Demberger[3], Heiko Zunft[3], Helge Haverkamp[3], Dirk Habermann[3], Winston V. Schoenfeld[1,2]
[1]Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA, [2]College of Optics and Photonics, University of Central Florida, Orlando, FL, USA, [3]Gebr. Schmid GmbH & Co., Freudenstadt, Germany

K25 289 **State-of-the-Art Surface Passivation of Boron Emitters on *n*-Type *c*-Si using In-Line PECVD AlO_x/SiN_x Stacks for Industrial High-Efficiency Solar Cells 1036**
Shubham Duttagupta[1, 2], Fen Lin[1], Marshall Wilson[3], Fa-Jun Ma[1], Jiaji Lin[1], Armin G. Aberle[1,2], Bram Hoex[1]
[1]Solar Energy Research Institute of Singapore (SERIS), Singapore, Singapore, [2]Department of Electrical and Computer Engineering, National University of Singapore, Singapore, Singapore, [3]Semilab SDI LLC, Tampa, FL, USA

K28 290 **Thin Macroporous Heterojunction Silicon Solar Cells 1040**
Marco Ernst[1], Rolf Brendel[1,2], Rafel Ferré[1], Nils-Peter Harder[1,3]
[1]Institute for Solar Energy Research Hamelin (ISFH), Emmerthal, Germany, [2]Department Solar Energy, Institute of Solid-State Physics, Leibniz Universität Hannover, Hannover, Germany, [3]Institute of Electronic Materials and Devices, Leibniz Universität Hannover, Hannover, Germany

L3 291 **Experimental and Theoretical Verification of the Presence of Inversion Region in a-Si/c-Si Heterojunction Solar Cells with an Intrinsic Layer 1046**
Kunal Ghosh, Clarence Tracy, Stuart Bowden
Arizona State University, Tempe, AZ, USA

L6
292 **Blister Formation Mechanisms in Spatial ALD Al_2O_3 for Silicon Surface Passivation 1049**
Luuk Hennen[1,2], Ernst Granneman[1], Erwin Kessels[2]
[1]Levitech BV, Almere, Netherlands, [2]Department of Applied Physics, Eindhoven University of Technology, Eindhoven, Netherlands

L9
293 **Reassessment of Classic Recombination Mechanisms in Silicon Point Contact Concentrator Solar Cell 1055**
Stanislau Herasimenka[1], Pietro Altermatt[2], Stuart Bowden[1], Christiana Honsberg[1]
[1]Arizona State University, Tempe, AZ, USA, [2]Leibniz University of Hannover, Hannover, Germany

L12
294 **Self-Doping Laser Transferred Contacts for c-Si Solar Cells 1059**
Erik Hoffmann, Tobias Röder, Jürgen Köhler
Institute for Photovoltaics, Stuttgart, Germany

L15
295 **Improvement of Short Wavelength Optical Response by Applying Double SiN_x:H Layers on Monocrystalline Silicon Solar Cells 1063**
Kihyun Kim, Hoon Oh, Jongbin Lim, Jongkyu Heo, Sumi Yang, Younghyun Oh, Myungick Hwang, Eunchel Cho
Hyundai Heavy Industries Co., Ltd, Eumseong, Chungcheongbuk-Do, Korea

L18
296 **Fabrication of Large-Area n-Type Silicon Solar Cells with Al-doped p^+ Rear Emitter and Analysis of Rear Metal Contact Properties for Rear Passivated Solar Cells N/A**
Young Do Kim, Kyung Dong Lee, Seongtak Kim, Hyunho Kim, Soohyun Bae, Hyomin Park, Sungeun Park, Sung Ju Tark, Donghwan Kim
Korea University, Seoul, South Korea

L21
297 **Excellent Passivation and Low-Reflectivity Al_2O_3/TiO_2 Bilayer Coatings for n-Wafer Silicon Solar Cells 1066**
Benjamin G. Lee[1], Jarmo Skarp[2], Ville Malinen[2], Shuo Li[2], Howard M. Branz[1]
[1]National Center for Photovoltaics, National Renewable Energy Lab, Golden, CO, USA, [2]Beneq Oy, Vantaa, Finland

L24
298 **Thermal Stable a-Si:H/SiN_x Stack Passivating System and the Application in Rear-Localized Contact Solar Cells on CZ p-Type Crystalline Silicon 1069**
Hua Li, Stuart Wenham
Photovoltaics Centre of Excellence, the University of New South Wales, Sydney, Australia

L27
299 **Boron Diffused Emitter Etch Back and Passivation 1073**
Xiaoqiang Li, Longzhong Tao, Zhengyue Xia, Zhuojian Yang, Jingbing Dong, Wentao Song, Guoqiang Xing
Hareon Solar Technology Co., Ltd., Huangtang Industrial Park, Jiangyin, China

M2
300 **Research on Ultra-Small Textured Surface of Multicrystalline Silicon Solar Cell N/A**
Haofeng Li[1], Rui Jia[1,2], Bingfei Dou[1], Chen Chen[1], Xinyu Liu[1], Tianchun Ye[1]
[1]Institute of Microelectronics, Chinese Academy of Sciences, Beijing, China, [2]Research Center of Advanced Solar Cells, Shanghai, China

M5
301 **A Novel Low-Cost ~25µm-Thin Monocrystalline Silicon Bifacial Solar Cell Technology with Flexible and Rigid Form-Factor and Electroplated Contacts N/A**
Leo Mathew[1], Rajesh Rao[1], Dabraj Sarkar[3], Sanjay Banerjee[2], Darmesh Jawarani[1], Jerry Fossum[3], Rico Garcia[1], Scott Smith[1], Dewei Xu[2], Moses Ainom[1], Emmanuel Oneygam[2], Rachel Stout[1], Sayan Saha[1], Aarium Gurmu[1]
[1]AstroWatt Inc., Austin, TX, USA, [2]Univ. of Texas, Austin, TX, USA, [3]Univ. of Florida, Gainesville, FL, USA

M8
302 **Electrical Characterization of Al_2O_3 Passivation Layers for p-Type CZ-Si PERC Solar Cells 1077**
Alessandro Morato[1], Bart Vermang[2,3], Hans Goverde[4], Gaudenzio Meneghesso[1], Joachim John[2], Jef Poortmans[2,3], Robert Mertens[2,3]
[1]Department of Information Engineering, University of Padova, Padova, Italy, [2]IMEC, Leuven, Belgium, [3]Katholieke Universiteit Leuven (K.U.Leuven), Leuven, Belgium, [4]Eindhoven University of Technology (TU/e), Eindhoven, Netherlands

M11
303 **Plasma Immersion Ion Implantation for Shallow Junction of Silicon Solar Cells N/A**
Hyomin Park, Jong-Han Lee, Doowon Lee, Soomin Kim, Sungeun Park, Young Do Kim, Sung Ju Tark, Donghwan Kim
Korea University, Seoul, South Korea

M14
304 **Impact of Surface Preparation Prior to AlO_x Deposition for i-PERC Cells 1083**
Julien Penaud[1], Périne Jaffrennou[1], Aude Rothschild[2], Benoit Lombardet[1]
[1]TOTAL, Paris, France, [2]imec, Leuven, Belgium

M17
305 **Oxidation Enhanced Diffusion for Screen-Printed Silicon Solar Cells 1089**
Victor Prajapati[1,2], Jorg Horzel[1], Patrick Choulat[1], Tom Janssens[1], Jef Poortmans[1,2], Robert Mertens[1,2]
[1]imec, Leuven, Belgium, [2]Katholiek Universiteit Leuven, Leuven, Belgium

M19
306 **Charge Trapping and Charge Storage in SiN_x Thin Films Deposited with Oxford PlasmaLab 100 System 1094**
Yongling Ren[1], Klaus J. Weber[1], Fouad Karouta[2], Kaushal Vora[2], Wensheng Liang[1]
[1]Centre for Sustainable Energy Systems, College of Engineering and Computer Science, The Australian National University, Canberra, Australia, [2]Department of Electronic Materials Engineering, Research School of Physics & Engineering, The Australian National University, Canberra, Australia

M21 307 **Crystalline Silicon Solar Cells with Segmented Selective Emitter by Ultraviolet Laser Doping 1098**
John S Renshaw[1,2], Ajay Upadhyaya[2], Vijay Upadhyaya[2], Ajeet Rohatgi[2,3]
[1]Department of Physics, Georgia Institute of Technology, Atlanta, GA, USA, [2]University Center of Excellence for Photovoltaics, Georgia Institute of Technology, Atlanta, GA, USA, [3]Suniva, Norcross, GA, USA

M23 308 **Optimization of ICP-CVD Silicon Nitride for Si Solar Cell Passivation 1102**
Sandeep S. S.[1,2], Ketan Warikoo[1], Anil Kottantharayil[1,2]
[1]National Centre for Photovoltaic Research and Education, Mumbai, India, [2]Department of Electrical Engineering, IIT Bombay, Mumbai, India

M25 309 **Distinctive Aspects of the Centaurus Solar Cell Technology N/A**
J. Schöne[1], K. A. Münzer[1], M. Hein[1], A. Teppe[1], M. Hanke[1], R. E. Schlosser[1], K. Varner[1], H. Mäckel[1], J. Maier[1], A. Yodyunyong[1], S. Keller[1], P. Fath[2]
[1]Centrotherm Cell & Module GmbH, Konstanz, Germany, [2]Centrotherm Photovoltaics AG, Blaubeuren, Germany

M27 310 **Characterization and Modeling of Low-Temperature Surface Passivation for Interdigitated Back-Contact Silicon Heterojunction Solar Cell 1105**
Brent Shu[1,2], Ujjwal Das[1], Steven Hegedus[1], Robert Birkmire[1,2]
[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Physics and Astronomy, University of Delaware, Newark, DE, USA

N1 311 **Self-Aligned Hydrogenated Selective Emitter for n-Type Solar Cells 1110**
Seth D. Shumate[1,2], Douglas A. Hutchings[2], Mohammed K. Hafeezuddin[2], Genevra Beilke[1,2], Benjamin S. Newton[1], Matthew Young[1], Husam H. Abu-Safe[3,4], Shui-Qing Yu[3], Hameed A. Naseem[3]
[1]Microelectronics-Photonics, University of Arkansas, Fayetteville, AR, USA, [2]Silicon Solar Solutions LLC, Fayetteville, AR, USA, [3]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA, [4]Natural Science Division, Lebanese American University, Byblos, Lebanon

N3 312 **Understanding Light-Induced Degradation of c-Si Solar Cells 1115**
Bhushan Sopori[1], Prakash Basnyat[1,2], Sudhakar Shet[1,2], Vishal Mehta[1,2], Srinivas Devayajanam[1,2], Jeff Binns[3], Jesse Appel[3]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]New Jersey Institute of Technology, Newark, NJ, USA, [3]MEMC Electronic Materials, St Peters, MO, USA

N5 313 **Improved Uniformity for Thin Oxides when Using Wet Thermal Oxidation 1121**
Jeffrey Spiegelman
RASIRC, San Diego, CA, USA

N7 314 **Industrially Feasible Casting: Monocrystalline Solar Cells with PECVD AlO_x/SiN_x Rear Passivation Stack Towards 19.6% Efficiency** 1125
Baoming Sun, Jian Sheng, Shengzhao Yuan, Chun Zhang, Zhiqiang Feng, Qiang Huang
State Key Laboratory of PV Science and Technology, Trina solar Limited Company, Changzhou, China

N9 315 **Halogen-Doped Al_2O_3 Thin Films with Excellent Passivation Layer for High-Efficiency Solar Cell Application** N/A
Wen-Ching Sun, Terry Tai-Jui Wang, Sheng-Min Yu, Yi-Fan Chen, Chia-Liang Sun, Tzer-Shen Lin
Material & Chemical Research Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan

N11 316 **Fabrication of Nanoporous Black Silicon Surface for Solar Cells in One Step Via a Modified Etching Solution** N/A
Yehua Tang[1,2], Wenjing Wang[1], Chunlan Zhou[1], Su Zhou[1,2], Yan Zhao[1,2], Jingwei Chen[1,2], Baojun Yan[1,2], Xiangxin Liu[1], Jianming Fei[3], Hongbin Cao[3]
[1]Institute of Electrical Engineering, Key Laboratory of Solar Thermal Energy and Photovoltaic System, Chinese Academy of Sciences, Beijing, China, [2]Graduate University of the Chinese Academy of Sciences, Beijing, China, [3]Eoplly New Energy Technology Co., Ltd., Nantong, Jiangsu, Nantong, China

N13 317 **Crystalline Silicon Interconnected Strips (XIS): Introduction to a New, Integrated Device and Module Concept** 1129
John van Roosmalen, Paula Bronsveld, Arthur Weeber
ECN Solar Energy, Petten, Netherlands

N15 318 **A Study of Blister Formation in Al_2O_3 grown on Silicon** 1135
Bart Vermang[1,2], Hans Goverde[3], Emanuele Cornagliotti[2], Victor Prajapati[1,2], Eddy Simoen[2], Alessandro Morato[4], Anne Lorenz[2], Loic Tous[1,2], Angel Uruena[1,2], Patrick Choulat[2], Aude Rothschild[2], Joachim John[2], Jorg Horzel[2], Jef Poortmans[1,2], Robert Mertens[1,2]
[1]University of Leuven, Leuven, Belgium, [2]Imec, Leuven, Belgium, [3]University of Eindhoven, Eindhoven, Netherlands, [4]University of Padova, Padova, Italy

N17 319 **Characterisation of Mechanical Stress in PECVD Silicon Nitride and Implications to Silicon Surface Passivation** 1139
Yimao Wan[1], Keith R. McIntosh[2], Andrew F. Thomson[1]
[1]Research School of Engineering, Australian National University (ANU), Canberra ACT, Australia, [2]PV Lighthouse, Coledale NSW, Australia

N19 320 **Silicon Grain Boundary Passivation for Photovoltaics: A Novel Approach with Small Polar Molecules 1144**
Wentao Wang[1], Lei Wang[1], Fude Liu[1], Fei Yan[2], Steve Johnston[2], Mowafak Al-Jassim[2]
[1]The University of Hong Kong, Hong Kong, Hong Kong, [2]National Renewable Energy Laboratory, Golden, CO, USA

N21 321 **18.82%-Efficient Laser-Doped Semiconductor Fingers Screen-Printed Silicon Solar Cell with Light-Induced Plating 1149**
Kee Soon Wang, Dong Lin, Ly Mai, Xin Rui An, Emily Mitchell, Stuart Ross Wenham
University of New South Wales, Sydney, NSW 2052, Australia

N23 322 **Effect of TCO Work Function on the Back Contact Carrier Transport of Heterojunction Solar Cells N/A**
Wangping Wang, Qiang Huang
State Key Laboratory of PV Science and Technology, Trina Solar Limited Company, Changzhou, Jisuang, China

N24 323 **20.3% Efficiency Rear-Passivated Silicon Solar Cells with Local Back Contact Using Commercial P-Cz Wafers 1154**
Zhenjiao Wang[1], Peiyu Han[1], Qinglei Meng[1], Hongqiang Qian[1], Jiaqi Wu[1], Yongfei Jiang[1], Ning Tang[1], Hongyan Lu[1], Haidong Zhu[1], Rulong Chen[1], Peter Yang[1], Jingjia Ji[1], Zhengrong Shi[1], Adeline Sugianto[1,2], Stuart Wenham[1,2]
[1]Suntech Power Holdings Co.,Ltd, Wuxi, China, [2]Centre of Excellence for Advanced Silicon Photovoltaics and Photonics University of New South Wales, Sydney, Australia

N25 324 **Development of High-Efficiency Mono-Silicon Solar Cells: Optimization of Rear Point Contacts Formation on Dielectrically Passivated Surfaces 1158**
Kapila Wijekoon, Prabhat Kumar, Jeff Franklin, Mukul Agrawal, Hemant Mungekar, Kalyan Rapolu, Michael Stewart, Yi Zheng, Lin Zhang, David Tanner, Hari Ponnekanti
Applied Materials, Santa Clara, CA, USA

N26 325 **Comparison Between Passivation Properties of Thermal ALD Al_2O_3 Deposited with TMS+ O_3 and TMA+ H_2O 1163**
Zhengyue Xia, Changrui Ren, Longzhong Tao, Xiaoqiang Li, Zhuojian Yang, Jingbing Dong, Wentao Song, Guoqiang Xing, Bin Zhang
Hareon Solar Technology Co., Ltd, Jiangyin, China

N27 326 **Optical Transparency and Surface Recombination Considerations for High Sheet Resistance Emitter Passivation 1166**
Satoshi Yamanaka, Maciej Dybiec, Bradley Kopp, Nicholas Gurnon, Ethan A. Good
SolarWorld Industries America, Hillsboro, OR, USA

N28 327 **The Effect of Rear Surface Passivation Layer Thickness on High-Efficiency Solar Cells with Planar and Scattering Metal Reflectors 1172**
Yang Yang, Hamid Mehrvarz, Supriya Pillai, Henner Kampwerth, Anita Ho-Baillie, Martin Green
Photovoltaics Centre of Excellence, University of New South Wales, Sydney, Australia

O1 328 **Low-Cost Spraying Halogen-Doped Al_2O_3 Thin Film for Passivated Emitter and Rear Cells N/A**
S.M. Yu, W.C. Sun, Terry T.J. Wang, Y.F. Chen, C.L. Sun, T.S. Lin
Material & Chemical Research Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan

O2 329 **Impact of Back-Surface Patterning Process on FF in Interdigitated Back Contact Silicon Heterojunction (IBC-SHJ) Solar Cell 1177**
Lulu Zhang[1,2], Brent Shu[1,2], Robert W Birkmire[1,2], Steve S Hegedus[1], Ujjwal K Das[1]
[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Physics and Astronomy, University of Delaware, Newark, DE, USA

10:30 - 12:00 PM **EH4-E**

Area 5: Thin-Film Silicon: Solar Cells, Novel Concepts, Thin Crystalline Silicon Film, Solar Cells and Modules (Posters)

Chair(s): Jimmy Melskens, Remi Biron

O4 330 **Towards Light-Trapping Free Amorphous-Si-Only Multijunction Solar Cells 1182**
Seung Jae Baik[1], Koeng Su Lim[1], Jeong Chul Lee[2]
[1]KAIST, Daejeon, Korea, [2]KIER, Daejeon, Korea

O6 331 **Epitaxial n-ZnO on p-Si with Native SiO_x Reduced by Al Overlayer 1187**
Chun-Fu Chang[1], Quark Y. Chen[1,2], Jin-Jie Lin[1], Guo-Sin Huang[1], Jun-Hau Wang[1], Paritosh V. Wadekar[1], Chih-Hsiung Liao[3], Hua-Hsien Liao[4], Hui-Chun Huang[5], Dharshana Wijesundera[2], Wei-Kan Chu[2], Li-Wei Tu[1], New-Jin Ho[5]
[1]Physics and Center for Nanoscience and Nanotechnology, National Sun Yat-Sen University, Kaohsiung, Taiwan, [2]Physics and Texas Center for Super Conductivity, University of Houston, Houston, TX, USA, [3]Physics, R.O.C. Military Academy, Kaohsiung, Taiwan, [4]Enli Technology Co., Ltd., Kaohsiung, Taiwan, [5]Materials and Optoelectronic Science, National Sun Yat-Sen University, Kaohsiung, Taiwan

O8
332 **High Efficiency Multijunction Solar Cells and TPV Using SiGeSn Materials 1189**
Benjamin R. Conley[1], Hameed Naseem[2], Greg Sun[3], Paul Sharps[4], Shui-Qing Yu[2]
[1]microElectronics-Photonics, University of Arkansas, Fayetteville, AR, USA, [2]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA, [3]Department of Physics, University of Massachusetts, Boston, MA, USA, [4]Emcore Photovoltaics, Albuquerque, NM, USA

O10
333 **Improved Internal Quantum Efficiency in High-Quality $BaSi_2$ Films Grown by Molecular Beam Epitaxy 1193**
Weijie Du[1], Mitsushi Suzuno[1], Khan Muhammad Ajmal[1], Katsuaki Toh[1], Masakazu Baba[1], Kotaro Nakamura[1], Kaoru Toko[1], Noritaka Usami[2,3], Takashi Suemasu[1,3]
[1]Institute of Applied Physics, University of Tsukuba, Tsukuba, Japan, [2]Institute of Materials Science, Tohoku University, Sendai, Japan, [3]JST-CREST, Tokyo, Japan

O12
334 **Investigation of Intrinsic Minority-Carrier Lifetime in Barium Disilicide Epitaxial Films 1197**
Kosuke O. Hara[1,2], Noritaka Usami[1,2], Katsuaki Toh[3], Masakazu Baba[3], Kaoru Toko[3], Takashi Suemasu[2,3]
[1]Tohoku University, Sendai, Japan, [2]JST-CREST, Tokyo, Japan, [3]University of Tsukuba, Tsukuba, Japan

O14
335 **Low-Cost High-Efficiency High-Density-Plasma Silicon-Based Thin-Film Solar Cells with High Light-Soaking Stability 1201**
Tzu-Hsuan Hsiao[1], Jia-Min Shieh[2], Peichen Yu[1], Chang-Houng Shen[2], Ming-Hsuan Kao[1], Uio-Pu Chiou[1], Wei-Hsiang Shieh[2]
[1]National Chiao Tung University, Hsinchu, Taiwan, [2]National Nano Device Laboratories, Hsinchu, Taiwan

O16
336 **Novel Process Flow and Cell Architecture for 10μm-Thick Membrane Single-Crystalline Silicon Solar Cells 1205**
Erik W. Janssen, Rafael N. Kleiman
McMaster University, Hamilton, ON, Canada

O18
337 **Development of Thin-Film Solar Cells Using Solar Spectrum Splitting Technique 1209**
Sinae Kim[1], Fuminori Takahashi[1], Shunsuke Kasashima[1], Yoshiaki Hirai[1], Sichanugrist Porponth[1], Akira Yamada[1,2], Makoto Konagai[1,2]
[1]Tokyo Institute of Technology, Tokyo, Japan, [2]Photovoltaic Research Center (PVREC), Tokyo Institute of Technology, Tokyo, Japan

O20
338 **Si Thin-Film Solar Cell with Asymmetric p-n Junction 1212**
Myung-Dong Ko[1], Chang-Ki Baek[2], Taiuk Rim[1], Sooyoung Park[1], Yoon-Ha Jeong[1,2,3]
[1]POSTECH, Department of Electrical Engineering, Pohang, Korea, [2]POSTECH, Creative IT Excellence Engineering, Pohang, Korea, [3]POSTECH, Division of IT Convergence Engineering, Pohang, Korea

O22 339 **Thin-Film ZnO/Si Heterojunction Solar Cells: Design and Implementation 1217**
Eric Kozarsky, Juhyung Yun, Chong Tong, Xueli Hao, Jun Wang, Wayne A. Anderson
University at Buffalo, Buffalo, NY, USA

O24 340 **Fabrication of Site-Specific Amorphous/ Nanocrystalline Silicon Composite Thin Film for Solar Cells 1220**
Benjamin S. Newton[1], Husam Abu-Safe[2,3], Mourad Benamara[4], Shui -Qing Yu[3], Hameed Naseem[3]
[1]Microelectronics Photonics Program, Fayetteville, AR, USA, [2]Natural Science Division, Beirut, Lebanon, [3]Department of Electrical Engineering, Fayetteville, AR, USA, [4]Institute of Nanoscale Material Science and Engineering, Fayetteville, AR, USA

O26 341 **Formation of Polycrystalline Silicon Films with μm-Order-Long Grains Through Liquid-Phase Explosive Crystallization by Flash Lamp Annealing 1225**
Keisuke Ohdaira[1,2], Sergey Varlamov[3], Noritaka Usami[4], Hideki Matsumura[1]
[1]Japan Advanced Institute of Science and Technology, Nomi, Japan, [2]PRESTO, Japan Science and Technology Agency, Kawaguchi, Japan, [3]University of New South Wales, Sydney, Australia, [4]Institute for Materials Research, Tohoku University, Sendai, Japan

O28 342 **Amorphous InZnO Transparent Conductors for c-Si/a-Si Heterojunction PV 1229**
J.D. Perkins, T. Gennett, S. Grover, D.L. Young, D.S. Ginley, C.W. Teplin
National Renewable Energy Laboratory, Golden, CO, USA

P2 343 **A Si-Rich Si_xC_{1-x}-Based p-n Junction Photovoltaic Solar Cells 1232**
Ling-Hsuan Tsai, Chiao-Ti Lee, Yung-Hsiang Lin, Gong-Ru Lin
Graduate Institute of Photonics and Optoelectronics, and Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan

P4 344 **Improving Tunnel Junction in Micromorph Tandem Cells by Inserting p-Type Nanocrystalline Silicon Layer N/A**
Wenjie Yao, Xiangbo Zeng, Xiaobing Xie, Ping Yang, Hao Li, Jingyan Li, Xianbo Liao, Qiming Wang
State Key Laboratory on Integrated Optoelectronics, Institute of Semiconductors, CAS, Beijing, China

P5
345 **a-Si:H/c-Si Nanocomposite Material for Solar Cells Fabricated from PECVD 1236**
Matthew G Young[1,4], Mourad Benamara[2], Husam Abu-Safe[1,3], Shui-Qing Yu[1], Hameed A Naseem[1]
[1]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA, [2]Institute of Nanoscale Material Science and Engineering, University of Arkansas, Fayetteville, AR, USA, [3]Natural Science Division, Lebanese American University, Beiruit, Lebanon, [4]Microelectronics-Photonics Program, University of Arkansas, Fayetteville, AR, USA

10:30 - 12:00 PM **EH4-F**

Area 8: PV Characterization: Session 2 (Posters)

Chair(s): Yoshihiro Hishikawa, Manuel Romero, Gerald Siefer

Q21
346 **Effect of Shunt Resistance on the Performance of mc-Silicon Solar Cells: A Combined Electro-Optical and Thermal Investigation 1241**
Marco Barbato[1], Matteo Meneghini[1], Valentina Giliberto[1], Daniele Giaffreda[2,3], Paolo Magnone[2,3], Raffaele De Rose[2,3], Claudio Fiegna[2,3], Gaudenzio Meneghesso[1,3]
[1]University of Padova, Padova, Italy, [2]University of Bologna, Bologna, Italy, [3]IUNET, Bologna, Italy

Q23
347 **European Pre-Standardization for Building-Integrated Photovoltaic Applications in Nearly-Zero-Energy Buildings N/A**
J.J. Bloem[1], C. Lodi[2]
[1]Joint Research Centre, Institute for Energy and Transport, Renewable Energies Unit, Ispra, Italy, [2]Applied Physics Section of the Environmental Science Department, University of Lleida, Lleida, Spain

R1
348 **Irradiance-Dependent Current-Limiting Behavior of Multijunction Solar Cells 1246**
Avi Braun[1], Eugen A. Katz[1], Klaus Schwarzburg[2], Thomas Hannappel[2], Jeffrey M. Gordon[1]
[1]Department of Solar Energy and Environmental Physics, Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Sede Boqer Campus, Israel, [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

R3
349 **Photovoltaic Module Performance and Degradation as Compared in Distinct Climatic Regions 1250**
Jesse A. Campbell
Solon Corporation, Tucson, AZ, USA

R5 350 **Thermal Effusion Measurements: Probing Hydrogen in Surface Passivation Schemes 1256**
Gijs Dingemans[1], Wolfhard Beyer[2], Erwin Kessels[1]
[1]Eindhoven University of Technology, Eindhoven, Netherlands, [2]Forschungszentrum Juelich, Juelich, Germany

R7 351 **Lifetime Measurements on III-V Solar Cell Relevant Materials in the Presence and Absence of Electrical Fields N/A**
Anja Dobrich[1], Klaus Schwarzburg[1], Elias Martinez Moreno[1], Marinus Kunst[1], Thomas Hannappel[1,2,3]
[1]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, [2]Ilmenau University of Technology, Ilmenau, Germany, [3]CiS Research Institute, Erfurt, Germany

R9 352 **Light-Soaking Measurements of Commercially Available CIGS PV Modules 1260**
Lawrence Dunn, Michael Gostein
Atonometrics, Inc., Austin, TX, USA

R11 353 **A Study of Thermal, Voltage, and Photoinduced Effects on the External Quantum Efficiency of CuInGaSe$_2$ (CIGS) Photovoltaic Devices 1266**
Rebekah K. Feist, Michael Mills, R. Kirk Thompson, Narayan Ramesh
The Dow Chemical Company, Midland, MI, USA

R13 354 **Photothermal Spectroscopy on Multicrystalline Silicon Solar Cell Materials by Dual Sampling Method in Atomic Force Microscopy 1271**
Kenji Hara[1], Takuji Takahashi[1,2]
[1]Institute of Industrial Science, The University of Tokyo, Tokyo, Japan, [2]Institute for Nano Quantum Information Electronics, The University of Tokyo, Tokyo, Japan

R15 355 **Insolation-Dependent Solar Module Performance Evaluation from PV Monitoring Data 1274**
Volker Herbort[1], Reinhold von Schwerin[2], Ben Compton[4], Leo Brecht[5], Henrik te Heesen[1]
[1]meteocontrol GmbH, Augsburg, Germany, [2]University of Applied Sciences, Ulm, Germany, [3]Ulm University, Ulm, Germany, [4]meteocontrol North America, Alameda, CA, USA

R17 356 **The Effect of Back-Surface Reflectance on the Interpretation of Internal Quantum Efficiency Data N/A**
Gregory S. Horner[1], Maciej Dybiec[2], John Schmidt[3], Timothy J. Coutts[4], Ethan A. Good[2], Leonid A. Vasilyev[1], Kyle Lu[1], James E. Hudson[1]
[1]Tau Science Corporation, Beaverton, OR, USA, [2]Solarworld Industries America, Hillsboro, OR, USA, [3]Tau Science Corporation, Mountain View, CA, USA, [4]Timothy J. Coutts Consulting, Golden, CO, USA

R19 357 **Fast Characterization of Tandem Solar Cells 1278**
Juan Jimeno[1], Carmen Ikaran[1], Joseba Ezquerra[1], Ignacio Ruiz[2]
[1]UPV/EHU, Zamudio, Spain, [2]Agilent Technologies, Getxo, Spain

R21 358 **A Cost-Effective Method for PV Module Field Test Using an Electronic Load 1282**
Ahn Jin-Ho, Cho Eun-Chel, Hwang Myung-Ick, Shin Seung-Min, Kim Hyun-Il
Hyundai Heavy Industries, Eumseong-Kun, South Korea

R23 359 **Investigation of Defects in n^+-CdS/p-CdTe Solar Cells 1286**
P.R. Kharangarh[1], D. Misra[2], G.E. Georgiou[1], A.E. Delahoy[1], Z. Cheng[1], G. Liu[1], H. Opyrchal[1], T. Gessert[3], K.K. Chin[1]
[1]Dept. of Physics and Apollo CdTe Solar Energy Center, NJIT, University Heights, NJ, USA, [2]Dept. of Electrical and Computer Engineering, NJIT, University Heights, NJ, USA, [3]NREL, Golden, CO, USA

S1 360 **Algorithm for Building a Simulator Spectrum for NREL One-Sun Multi-Source Simulator 1291**
Tom Moriarty[1], Joe Jablonski[2], Keith Emery[1]
[1]National Renewable Energy Lab, Golden, CO, USA, [2]Labsphere, Inc., North Sutton, NJ, USA

S3 361 **Comparative Study of a Directly-Cooled PV Water Heating System to a Naturally-Cooled Module in South Africa 1296**
Busiso Mtunzi, Edson L. Meyer
University of Fort Hare, Institute of Technology, Alice, Eastern Cape, South Africa

S5 362 **Steady State Photoconductance: A new parameter to predict solar cell performance N/A**
Bijaya B Paudyal[1], Steve Johnston[2], David House[1]
[1]MKS Instruments Inc., San Jose, CA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

S7 363 **Method for Estimating the Power Conversion Output in Photovoltaic Systems with More than One Maximum Power Point Tracking Device 1300**
Stephen G. Pisklak[1], Michael E. Mills[1], Conor Quinn[2]
[1]Dow Chemical, Midland, MI, USA, [2]Emerson Network Power, Eden Prarie, MN, USA

S9 364 **Indoor-Outdoor Measurement Inter-Comparison of c-Si CPV Cells at 1X to 300X: Spectral and Capacitive Effects 1306**
Mauro Pravettoni[1], Raffaele Fucci[2], Matthew Norton[3]
[1]University of Applied Sciences and Arts of Southern Switzerland (SUPSI-ISAAC), Canobbio, Switzerland, [2]Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Portici, Italy, [3]University of Cyprus, Department of Electrical and Computer Engineering, PV Technology, Nicosia, Cyprus

S11 365 **PV Fire Safety: Examining the Conductivity of Water Jets and Nozzles at a Simulated PV Solar Array of 1kV N/A**
Florian Reil[1], Ferdi Gülenc[1], Willi Vaassen[1], Annett Sepanski[1], Bettina van Heeckeren[1], Horst Thiem[2]
[1]TÜV Rheinland Energie und Umwelt GmbH, Cologne, Germany, [2]Fire Department, Munich, Germany

S13 366 **Characterization of Diffuse Anisotropic Illumination Effects to the Output of Bifacial and Holographic Planar Concentrating Photovoltaic Panel Configurations 1312**
Juan M. Russo[1], Deming Zhang[1], Michael Gordon[2], Shelby Vorndran[2], Jose Castillo[3], Adria Brooks[4], Vincent Lonij[4], Alex Cronin[4], Raymond K. Kostuk[1]
[1]The University of Arizona Department of Electrical and Computer Engineering, Tucson, AZ, USA, [2]The University of Arizona College of Optical Sciences, Tucson, AZ, USA, [3]Prism Solar Technologies, Inc., Tucson, AZ, USA, [4]The University of Arizona Department of Physics, Tucson, AZ, USA

S15 367 **A Newton-Raphson Method Approach to Adjusting Multi-Source Solar Simulators 1318**
David B. Snyder, David S. Wolford
NASA Glenn Research Center, Cleveland, OH, USA

S17 368 **Sub-Hourly Irradiance Models on the Plane of Array for Photovoltaic Energy Forecasting Applications 1321**
Giuseppe Marco Tina[1], Sebastiano De Fiore[2], Ventura Cristina[1]
[1]University of Catania, Catania, Italy, [2]Softeco Sismat SpA, Genoa, Italy

S19 369 **Analysis of Solar Cell Quality Using Voltage Metrics 1327**
Eric S. Toberer[1], Adele C. Tamboli[1], Myles Steiner[2], Sarah Kurtz[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

S21 370 **Evaluating TCO Long-Term Performance by Electrochemical Corrosion Test and Residual Film Stress Analysis 1332**
Mei Wen, Pierre Ricou
Arkema Inc., King of Prussia, PA, USA

S23 371 **A Multi-Purpose Wafer Scanning System for PV Inspection 1336**
Chris Yang[1], Steven Danyluk[2]
[1]Manufacturing Research Center, Georgia Institute of Technology, Atlanta, GA, USA, [2]G.W.W School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA

T1 372 **Diagnosis Photovoltaic Failure by Simple Function Method to Acquire *I-V* Curve of Photovoltaic Modules String 1340**
Hirata Youichi, Noro Shouta, Aoki Takumi, Miyazawa Satoru
Tokyo University of Science, Suwa, Nagano, Japan

T3
373 **Temperature and Reverse Voltage on Shaded PV Cell Under Hot Spot Test Condition 1344**
Qi Zhang
Solaria, Fremont, CA, USA

10:30 - 12:00 PM **EH4-G**

Area 9: Modules and Systems: Inverters, Balance-of-System Devices, and Module Shading (Posters)

Chair(s): Mike Ropp, Rob Sorensen, Chris Deline

T9
374 **Development of a Low-Cost Induction Motor Drive System Using a PVM, Boost Converter and Three-Phase Inverter 1348**
Nelson M. Méndez-Gómez, Orlando Bousoño, Ricardo Castañeyra, Eduardo I. Ortiz-Rivera
University of Puerto Rico - Mayagüez, Mayagüez, PR, USA

T13
375 **Decision-Making Framework for Solar Photovoltaic Power Conditioning Unit Topologies Using Six Sigma 1352**
Harish S. Krishnamoorthy, Poornima Mazumdar, Ilaval Manickam, Robert S. Balog, Prasad N. Enjeti
Texas A&M University, College Station, TX, USA

T17
376 **Differential Power Processing for Efficiency and Performance Leaps in Utility-Scale Photovoltaics 1357**
Pradeep Shenoy[1], Philip T. Krein[1], Patrick L. Chapman[2]
[1]University of Illinois, Urbana, IL, USA, [2]SolarBridge Technologies, Austin, TX, USA

T21
377 **Implementation of Advanced Inverter Interoperability and Functionality 1362**
Sigifredo Gonzalez[1], Frank Hoffmann[2], Michael Mills-Price[3], Mark Ralph[1], Abraham Ellis[1]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Princeton Power Systems, Princeton, NJ, USA, [3]Advanced Energy, Bend, OR, USA

U1
378 **Determination of Parasitic Parameters in a High Frequency Magnetic to Improve the Manufacturability, Performance, and Efficiency of a PV Inverter 1368**
Mohammad B. Shadmand, Robert S. Balog
Texas A&M University, College Station, TX, USA

U5
379 **Optimum Core Dimension for Minimizing Proximity Effect Losses of an AC Inductor for a Galvanically Isolated PV Inverter 1373**
Abozar Alabakhshizadeh[1,3], Ole-Morten Midtgård[1,2]
[1]University of Agder, Grimstad, Norway, [2]Norwegian University of Science and Technology, Trondheim, Norway, [3]Eltek, Kristiansand, Norway

U9 380 **PV Arc-Fault Detector Algorithm Evaluation Method Utilizing Prerecorded Arcing Signatures 1378**
Jack Kang[1], Jay Johnson[2]
[1]Sensata Technologies, Attleboro, MA, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA

U13 381 **Cross-Talk Nuisance Trip Testing of Photovoltaic DC Arc-Fault Detectors 1383**
Jay Johnson[1], Chris Oberhauser[2], Sigifredo Gonzalez[1], Armando Fresquez[1], Michael Montoya [1], Ash Patel [2]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Texas Instruments, Santa Clara, CA, USA

U17 382 **Module Mismatch Loss and Recoverable Power in Unshaded PV Installations 1388**
Sara MacAlpine[1], Chris Deline[2], Michael Brandemuehl[1], Robert Erickson[1]
[1]University of Colorado, Boulder, CO, USA, [2]National Renewable Energy Laboratory (NREL), Golden, CO, USA

U21 383 **A Survey of Maximum PPT Techniques of PV Systems N/A**
Mohamed Saied
Abu Qir Fertilizers & Chemical Industries Company (AFC), Alexandria, Egypt

V1 384 **Impact of PV Module Mismatch on the PV Array Energy Yield and Comparison of Module, String and Central MPPT 1393**
Panagiotis Bakas, Antonis Marinopoulos, Bengt Stridh
ABB Corporate Research, Västerås, Sweden

V5 385 **In-situ measurements applied to large PV grid-connected inverters (100 kW- 1 MW) N/A**
Vicente Salas
Universidad Carlos III de Madrid, Leganes, Spain

V9 386 **A Control Strategy to Reduce the Effect of Intermittent Solar Radiation and Wind Velocity in the Hybrid Photovoltaic/Wind SCIG System Without Losing MPPT 1399**
Rupesh G. Wandhare, Vivek Agarwal
Indian Institute of Technology- Bombay, Mumbai, India

V13 387 **Novel Three-Phase Single Power Stage Photovoltaic Inverter Topology with MPPT 1405**
Moumita Das, Vivek Agarwal
IIT Bombay, Mumbai, India

V17 388 **Exact Maximum Power Point Tracking for Partially-Shaded PV Strings Based on Current Equalization Concept 1411**
Pooja Sharma[1], Pradeep K. Peter[2], Vivek Agarwal[1]
[1]Indian Institute of Technology Bombay, Mumbai, India, [2]Indian Space Research Organization, Banglore, India

V21 389 **Run-Time Partially Reconfigurable FPGA Applications in PV-Fed Systems N/A**
Sajeesh Kumar, Vivek Agarwal
Dept. of Electrical Engineering, IIT Bombay, Mumbai, India

W1 390 **Development of a Field Programmable Gate Array (FPGA)-Based Photovoltaic Panel Emulator Based on a DC/DC Converter 1417**
Hayrettin Can, Koray Sener Parlak, Damla Ickilli
Firat University, Elazig, Turkey

W5 391 **Switched Capacitor DC-DC Converter-Based Current Equalization Scheme for Maximum Power Extraction from Partially-Shaded PV Modules Without Bypass Diodes 1422**
Pradeep Peter[1], Pooja Sharma[2], Vivek Agarwal[2]
[1]Indian Space Research Organization, Bangalore, India, [2]Indian Institute of Technology-Bombay, Mumbai, India

W9 392 **High-Gain, High-Efficiency DC-DC Converter with Soft Switching Feature 1428**
Vivek Agarwal[2], Sachin Jain[1]
[1]IIT-Bombay,Mumbai, Bombay, India, [2]Schneider-Electric, Bangalore, India

W13 393 **Maximum Power Point Tracking Method Under Partial Shading Conditions 1434**
Chee Lim Nge[1,2], Ole-Morten Midtgard[2], Lars Norum[1]
[1]Norwegian University of Science and Technology, Trondheim, Norway, [2]University of Agder, Grimstad, Norway

W17 394 **Analysis of Photovoltaic Array with Reconfigurable Modules Under Partial Shading 1437**
Priyanka O. Singh[1], Srinivasa R. Vemuru[2], Mohammad Niamt[1]
[1]Department of EECS, The University of Toledo, Toledo, OH, USA, [2]Department of ECE, Ohio Northern University, Ada, OH, USA

W21 395 **Switch-Based Reconfigurable Photovoltaic Array for Power Maximization N/A**
Kalpesh C. Chheladiya[1], Paresh N. Chavada[1], Hetal G. Bhatt[2], Rajesh A. Thakker[1]
[1]Electronics and Communication Department, VGEC, Gandhinagar, India, [2]Electronics and Communication Department, S.P.C.E., Visnagar, India

W24 396 **Controlled-Partial-Shading Evaluation of PV Arrays During Realistic Operation N/A**
Abraham K. Ishihara
Carnegie Mellon University, Moffett Field, CA, USA

X3
397 **String-Level (Kw-Scale) IV Curves from Different Types Of Modules Under Partial Shade 1442**
Patricia L. Hidalgo-Gonzalez[1,2], Adria E. Brooks[2,3], Emily S. Kopp[4], Vincent P. Lonij[2], Alexander D. Cronin[2,3,4]
[1]Pontificia Universidad Catolica de Chile, Santiago, Chile, [2]University of Arizona, Department of Physics, Tucson, AZ, USA, [3]Arizona Research Institute for Solar Energy, Tucson, AZ, USA, [4]University of Arizona, College of Optical Sciences, Tucson, AZ, USA

X6
398 **Architecture of a Smart Photovoltaic Module N/A**
Peter Mark Jansson[1,2], Carlos Barreiro[2,3], John L. Schmalzel[2,4]
[1]Bucknell University, Lewisburg, PA, USA, [2]Center for Sustainable Design, Glassboro, NJ, USA, [3]Alencon Systems, Inc, Plymouth Meeting, PA, USA, [4]Rowan University, Glassboro, NJ, USA

X9
399 **Evaluation of Economical Benefit of Cleaning of Soiling and Snow in PV Plants at Three Selected Locations in Europe 1448**
Bengt Stridh
ABB Corporate Research, Västerås, Sweden

X12
400 **Output Performance and Payback Analysis of a Residential Photovoltaic System in Colorado 1452**
Steven W. Johnston
National Renewable Energy Laboratory, Golden, CO, USA

10:30 - 12:00 PM **19B**

Area 10: PV Velocity Forum: PV Executive Forum

Chair(s): Dave Parrillo

401 **PV Executive Forum N/A**
Danielle Merfeld
GE Global Research

402 **PV Executive Forum N/A**
Zhengrong Shi
Suntech

403 **PV Executive Forum N/A**
Cai Steger
Energy Analyst, NRDC

404 **PV Executive Forum N/A**
Frank Mierlo
1366 Technologies

405 **PV Executive Forum N/A**
Yanev Suissa
New Enterprise Associates, Washington, DC, USA

1:30 - 3:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Quantum Well Solar Cells (Orals)

Chair(s): Ryne P. Raffaelle, Martha Symko-Davies, Greg Wilson

1:30
406

Best Student Presentation Award Finalist

High-Aspect-Ratio Structures for Efficient Light Absorption and Carrier Transport in InGaAs/GaAsP Multiple Quantum Well Solar Cells N/A

Hiromasa Fujii[1], Yunpeng Wang[2], Kentaroh Watanabe[2], Masakazu Sugiyama[1], Yoshiaki Nakano[2]

[1]Department of Electrical Engineering and Information Systems, the University of Tokyo, Tokyo, Japan, [2]Research Center for Advanced Science and Technology, Tokyo, Japan

2:00
407

The Optimization of High Phosphorus Content InGaAs/GaAsP Strained Layer Superlattices for Use in Multijunction Solar Cells 1456

Conrad Z. Carlin[1], Joshua P. Samberg[2], Geoffrey K. Bradshaw[1], Nadia A. El-Masry[2], Peter C. Colter[1], Salah M. Bedair[1]

[1]Department of Electrical and Computer Engineering, North Carolina State University, Raleigh, NC, USA, [2]Department of Materials Science and Engineering, North Carolina State University, Raleigh, NC, USA

2:15
408

Best Student Presentation Award Finalist

Multijunction Solar Cell with Dilute Nitride Cascaded Quantum Wells Design 1461

Gopi K Vijaya, Akhil Mehrotra, Andenet Alemu, Alexandre Freundlich

University of Houston, Houston, TX, USA

2:30
409

Effect of GaAs Step Layer Thickness in InGaAs/GaAsP Stepped Quantum Well Solar Cell N/A

Yu Wen[1], Yunpeng Wang[1], Kentaroh Watanabe[1], Masakazu Sugiyama[2], Yoshiaki Nakano[1]

[1]Research Center for Advanced Science and Technology, the, University of Tokyo, Tokyo, Japan, [2]Department of Electrical Engineering and Information Systems, School of Engineering, the University of Tokyo, Tokyo, Japan

2:45
410

Optimization of MOCVD-Grown MQW Structures for Triple-Junction Solar Cells 1465

Chris W. Ebert[1], C.L. Reynolds Jr.[2], Davood Shahrjerdi[3], T.A. Rawdanowicz[2], Ziggy Pulwin[1], Frank Lu[1], Devon Dyer[1]

[1]Veeco Instrumnets, Somerset, NJ, USA, [2]North Carolina State University, Raleigh, NC, USA, [3]IBM T.J. Watsion Research Center, Yorktown Heights, NY, USA

1:30 - 3:00 PM **18CD**

Area 2: Polycrystalline Thin Films: Absorber and Device Modeling (Orals)

Chair(s): Susanne Siebentritt, Jim Sites

1:30
411 **Characterization and Understanding of Performance Losses in a Highly-Efficient Solution-Processed CZTSSe Thin-Film Solar Cell 1471**
Kaushik Roy Choudhury, Yanyan Cao, Jonathan V. Caspar, William E. Farneth, Qijie Guo, Alex S. Ionkin, Lynda K. Johnson, Meijun Lu, Irina Malajovich, Daniela Radu, H David Rosenfeld, Wei Wu
The DuPont Company, Central Research and Development, Experimental Station, Wilmington, DE, USA

1:45
412 **Best Student Presentation Award Finalist**
Influence of Ge Doping on the Defect Distributions of $Cu_2Zn(Sn_xGe_{1-x})(S_ySe_{1-y})$ Fabricated by Nanocrystal Ink Deposition with Selenization 1475
James Moore[1], Charles Hages[2], Mark Lundstrom[1], Rakesh Agrawal[2]
[1]Department of Electrical and Computer Engineering, Purdue University, Lafayette, IN, USA, [2]Department of Chemical Engineering, Purdue University, Lafayette, IN, USA

2:00
413 **2-D Finite Element Model of a CIGS Module 1481**
Gaby J.M. Janssen, Lenneke H. Slooff, Evert E. Bende
ECN Solar Energy, Petten, Netherlands

2:15
414 **Determination of Grain-Boundary Charging in $Cu(In,Ga)Se_2$ Thin Films 1486**
Chun-Sheng Jiang, Miguel A. Contreras, Ingrid Repins, Helio R. Moutinho, Rommel Noufi, Mowafak M. Al-Jassim
National Renewable Energy Laboratory, Golden, CO, USA

2:30
415 **Modeling the Effects of Na Incorporation on CIGS Solar Cells N/A**
Elif S. Mungan, Xufeng Wang, Muhammad A. Alam
Purdue University, West Lafayette, IN, USA

2:45
416 **Toward Ultrathin CIGS Solar Cells 1492**
Sylvain Marsillac[1], Vikash Ranjan[1], Krishna Aryal[1], Scott Little[2], Yunus Erkaya[1], Grace Rajan[1], Patrick Boland[1], Dinesh Attygalle[2], Puruswottam Aryal[2], Puja Pradhan[2], Robert W. Collins[2]
[1]Old Dominion University, Norfolk, VA, USA, [2]The University of Toledo, Toledo, OH, USA

1:30 - 3:00 PM **Blrm G**

Area 4: Crystalline Silicon: Fundamentals (Orals)

Chair(s): Mariana Bertoni, Gianluca Coletti

1:30 417 **Diffusion Gettering of Metal Impurities in Crystalline Silicon** **1495**
Hele I. Savin
Aalto University, Espoo, Finland

2:15 418 **Quantification of Atomic-Scale Defects in Poly Si PV Devices Using Atom Probe Tomography** **1498**
Brian P. Gorman[1], Harvey L. Guthrey[1, 2], Mowafak Al-Jassim[2], David R. Diercks[1]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

2:30 419 **Effect of Dislocation-Impurity Interaction on Dislocation Annihilation in Solar-Grade Silicon** **N/A**
Hyunjoo Choi, Mariana Bertoni, Jasmin Hofstetter, David Fenning, Sergio Castellanos, Douglas Powell, Tonio Buonassisi
Massachusetts Institute of Technology, Cambridge, MA, USA

2:45 420 **Impurity-Related Limitations of Next-Generation Industrial Silicon Solar Cells** **N/A**
Jan Schmidt[1,2], Bianca Lim[1], Karsten Bothe[1], Sebastian Gatz[1], Thorsten Dullweber[1], Pietro P. Altermatt[2]
[1]Institute for Solar Energy Research Hamelin (ISFH), Emmerthal, Germany, [2]Institute of Solid-State Physics, Leibniz Univerity of Hanover, Hanover, Germany

1:30 - 3:00 PM **19A**

Area 5: Thin-Film Silicon: Solar Cells and Modules (Orals)

Chair(s): Christophe Ballif, Arno Smets

1:30 421 **Towards High-Efficiency Thin n-i-p Micromorph Solar Cells on Plastic** **N/A**
Rémi Biron, Grégory Bugnon, Escarré Jordi, Franz-Josef Haug, Christophe Ballif
Ecole Polytechnique Fédérale de Lausanne (EPFL), Institute of Microengineering (IMT), Photovoltaics and Thin Film Electronics Laboratory, Neuchâtel, Switzerland

2:00 422 **Deposition of High-Efficiency Microcrystalline Silicon Solar Cells Using $SiF_4/H_2/Ar$ Mixtures** **N/A**
Jean-Christophe Dornstetter[1,2], Samir Kasouit[1], Pere Roca i Cabarrocas[2]
[1]TOTAL S.A. Gas & Power, Paris La defense, France, [2]LPICM-CNRS, Palaiseau, France

2:15 423 **Best Student Presentation Award Finalist**
On the Interplay Between Material Quality and Interfaces in High-Efficiency Microcrystalline Silicon Solar Cells **N/A**
Simon Hänni, Mathieu Boccard, Laura Ding, Corsin Battaglia, Grégory Bugnon, Peter Cuony, Jordi Escarré, Gaetano Parascandolo, Sylvain Nicolay, Matthieu Despeisse, Fanny Meillaud, Ballif Christophe
Institute of Microengineering (IMT), Ecole Polytechnique Fédérale de Lausanne (EPFL), Laboratory of Photovoltaics and Thin Film Electronics, Neuchâtel, Switzerland

2:30 424 **Progress in Research and Mass Production of Large-Scale Thin-Film Si Solar Cells** **1501**
Xinwei Niu, Minghua Wang, Xin Zhu, Cao Yu, Guijun Li, Bing Cheng, Junmei Rong, Zhen Chen, Jian Ding, Liyou Yang
Chint Solar (Zhejiang) Co. Ltd., Hangzhou, China

2:45 425 **Correlations Between Mapping Spectroscopic Ellipsometry Results and Solar Cell Performance for Evaluations of Non-Uniformity in Thin-Film Silicon Photovoltaics** **N/A**
Lila Dahal[1], Zhiquan Huang[1], Dinesh Attygalle[1], Carl Salupo[1], S. Marsillac[2], N.J. Podraza[1], R.W. Collins[1]
[1]Center for Photovoltaics Innovation and Commercialization, University of Toledo, Toledo, OH, USA, [2]Department of Electrical and Computer Engineering, Old Dominion University, Norfolk, VA, USA

1:30 - 3:00 PM **17A**

Area 8: PV Characterization: Challenges in Characterization of Multijunction Devices (Orals)

Chair(s): Keith Emery, Gerald Siefer

1:30
426
Electro- and Photoluminescence Characterization of Multijunction Solar Cells **N/A**
Helmut Nesswetter[1], Paolo Lugli[2], Claus G. Zimmermann[1]
[1]EADS Astrium GmbH, Munich, Germany, [2]Institute for Nanoelectronics, Technical University of Munich, Munich, Germany

2:00
427
Best Student Presentation Award Finalist
Elimination of Measurement Artifacts of External Quantum Efficiency of Multijunction Solar Cells Using a Pulse Light Bias **N/A**
Jing-Jing Li, Yong-Hang Zhang
Arizona State University, Tempe, AZ, USA

2:15
428
Spatial Characterization Techniques for Dye-Sensitized Solar Cells **1507**
Matevz Bokalic, Ursa Opara Krasovec, Mateja Hocevar, Marko Topic
University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia

2:30
429
A Low-Cost Weather-Balloon Borne Solar Cell Calibration Payload **1512**
David B. Snyder, David S. Wolford
NASA Glenn Research Center, Cleveland, OH, USA

2:45
430
Best Student Presentation Award Finalist
Characterization of a TS-Space Quad-Source Solar Simulator **1517**
Kyle H. Montgomery[1,2], David M. Wilt[1], Alex Howard[1], Bill Williams, Sr.[3], Bill Williams, Jr.[3]
[1]Air Force Research Laboratory Space Vehicles Directorate, Kirtland AFB, NM, USA, [2]School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, [3]TS-Space Systems, Marlow, United Kingdom

1:30 - 3:00 PM **16AB**

Area 9: Modules and Systems: Systems Design, Control, and Performance (Orals)

Chair(s): Greg Ball, Angele Reinders

1:30 431 **PV Output Smoothing with Energy Storage** **1523**
Abraham Ellis, David Schoenwald
Sandia National Laboratories, Albuquerque, NM, USA

1:45 432 **New Approaches for Characterizing Photovoltaic System Performance** **1529**
Owen W. Westbrook, Beth H. Copanas, Forrest D. Collins
Juwi solar, Inc., Boulder, CO, USA

2:00 433 **Photovoltaic Prognostics and Heath Management Using Learning Algorithms** **1535**
Daniel Riley, Jay Johnson
Sandia National Laboratories, Albuquerque, NM, USA

2:15 434 **Best Student Presentation Award Finalist**
A Modified Control Strategy for Centralized PV – Grid Systems for Assisting Dynamic Stability to Overcome Penetration Issues **1540**
Rupesh G. Wandhare, Vivek Agarwal
Indian Institute of Technology - Bombay, Mumbai, India

2:30 435 **Interconnection Wiring Considerations in Evaluating Large Photovoltaic System Designs** **1545**
Jumie N. Yuventi
Electrical Engineering, Stanford University, Stanford, CA, USA

2:45 436 **System Performance Analysis and Estimations of Degradation Rates Based on 500 Years of Monitoring Data** **1551**
Nils Reich, Alexander Goebel, Daniela Dirnberger, Christian Reise, Klaus Kiefer
Fraunhofer ISE, Freiburg, Germany

1:30 - 3:10 PM **19B**

Area 10: PV Velocity Forum: National Programs (Orals)

Chair(s): Elaine Ulrich

1:50 437 **Overview of Korean PV programs** **N/A**
Donghwan Kim
Korea University, Seoul, Korea

2:10 438 **Importance of PV and Overview of Japanese PV Programs** **N/A**
Sadao Wasaka
NEDO

2:30 439 **Overview of Chinese PV Programs** **N/A**

2:50 440 **US Department of Energy SunShot Initiative** **N/A**
Ramamoorthy Ramesh
US Dept of Energy

3:00 - 3:30 PM **Exhibit Hall 4**

Coffee Break

3:30 - 5:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Light Concentration and Light Trapping 1 (Orals)

Chair(s): Ryne P. Raffaelle, Seth Hubbard

3:30
441 **The Opto-Electronic Physics That Broke the Efficiency Limit in Solar Cells 1556**
Eli Yablonovitch[1,2], Owen D. Miller[1,2], Sarah R. Kurtz[3]
[1]Material Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA, [2]University of California, Berkeley, Dept. of Electrical Engineering & Computer Science, Berkeley, CA, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA

4:00
442 **Two-Photon Excitation in a Dilute Nitride Intermediate-Band Solar Cell N/A**
Nazmul Ahsan[1], Naoya Miyashita[1], Muhammad Monirul Islam[1], Kin Man Yu[2], Wladek Walukiewicz[2], Yoshitaka Okada[1]
[1]The University of Tokyo, Tokyo, Japan, [2]Lawrence Berkeley National Laboratory, Berkeley, CA, USA

4:15
443 **Mid-IR Photovoltaic Devices Based on Interband Cascade Structures 1560**
Zhaobing Tian[1], Robert T. Hinkey[1,2], Rui Q. Yang[1], John F. Klem[3], Matthew B. Johnson[2]
[1]School of Electrical and Computer Engineering, University of Oklahoma, Norman, OK, USA, [2]Homer L. Dodge Department of Physics and Astronomy, Norman, OK, USA, [3]Sandia National Laboratories, Albuquerque, NM, USA

4:30
444 **Performance Benefits for Thin-Film Solar Cells Incorporating Semiconductor Heterostructures and Light Trapping 1566**
Claiborne O McPheeters[1], Dongzhi Hu[2], Xiaohan Li[1], Daniel M Schaadt[2], Edward T Yu[1]
[1]Microelectronics Research Center, Department of Electrical and Computer Engineering, The University of Texas at Austin, Austin, TX, USA, [2]Institute of Energy Research and Physical Technologies/Energy Research Center of Lower Saxony, Clausthal University of Technology, Goslar, Germany

4:45
445 **Best Student Presentation Award Finalist**
Inverse Electromagnetic Design for Subwavelength Light Trapping 1572
Vidya Ganapati[1,2], Owen D. Miller[1,2], Eli Yablonovitch[1,2]
[1]University of California, Berkeley, Berkeley, CA, USA, [2]Lawrence Berkeley National Laboratory, Berkeley, CA, USA

3:30 - 5:00 PM **18CD**

Area 2: Polycrystalline Thin Films: Junctions and Device Stability (Orals)

Chair(s): Rommel Noufi, Marcus Bär

3:30
446 **Buffer and Transparent Conducting Oxide Layers for CIGS-Based Thin-Film Solar Cells** **N/A**
Tokio Nakada
Aoyama Gakuin University, Kanagawa, Japan

4:00
447 **Buffer-Less Cu(In,Ga)Se_2 Solar Cells with New Transparent Electrode for Band Offset Control** **1577**
Takashi Minemoto, Jasmeen Julayhi
Ritsumeikan University, Kusatsu, Japan

4:15
448 **Optical Properties of Zn(O,S) Thin Films Deposited by RF Sputtering, Atomic Layer Deposition, and Chemical Bath Deposition** **1580**
Jian Li[1,2], Stephen Glynn[1], Steven Christensen[1], Jonathan Mann[1], Bobby To[1], Kannan Ramanathan[1], Rommel Noufi[1], Thomas E. Furtak[2], Dean Levi[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Department of Physics, Colorado School of Mines, Golden, CO, USA

4:30
449 **Accelerated Aging and Contact Degradation of CIGS Solar Cells** **N/A**
Thomas Ott[1], Thomas Walter[1], Dimitrios Hariskos[2], Oliver Kiowski[2], Raymund Schäffler[3]
[1]University of Applied Sciences, Ulm, Germany, [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden Württemberg, Stuttgart, Germany, [3]Manz CIGS Technology GmbH, Schwäbisch Hall, Germany

4:45
450 **The Effects of Device Geometry and TCO/ Buffer Layers on Damp Heat Accelerated Lifetime Testing of Cu(In,Ga)Se_2 Solar Cells** **N/A**
Christopher P. Thompson[1], Steven S. Hegedus[1], Peter F. Carcia[2], R. Scott McLean[2]
[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]DuPont Research and Development, Experimental Station, Wilmington, DE, USA

3:30 - 5:00 PM **Blrm G**

Area 4: Crystalline Silicon: Advanced Devices (Orals)

Chair(s): Dave Carlson, Tonio Buonassisi

3:30
451 **Rear-Surface Passivation Technology for Large-Scale Manufacturing of High-Efficiency Crystalline Silicon Solar Cells N/A**
A. Metz, Y. Gassenbauer, J. D. Moschner, M. Fiedler, K. Dressler, E. Brower, B. Bethmann, M. Feldhaus, N. Lenck
SCHOTT Solar AG, Alzenau, Germany

3:45
452 **Effects of Process Conditions for the n^+-Emitter Formation in Crystalline Silicon 1584**
Amir Dastgheib-Shirazi[1], Hannes Wagner[2], Michael Steyer[1], Giso Hahn[1]
[1]Div. Photovoltaics, Dep. of Physics, University of Konstanz, Konstanz, Germany, [2]Dep. Solar Energy, Inst. Solid-State Physics, Leibniz University of Hannover, Hannover, Germany

4:00
453 **High-Efficiency Heterojunction Solar Cells on Crystalline Silicon and Germanium Substrates Enabled by Low-Temperature Epitaxial Growth of Silicon 1590**
Bahman Hekmatshoar, Davood Shahrjerdi, Stephen W. Bedell, Devendra K. Sadana
IBM T.J. Watson Research Center, Yorktown Heights, NY, USA

4:15
454 **Generation III High-Efficiency Lower-Cost Technology: Transition to Full-Scale Manufacturing 1594**
David D. Smith, Peter J. Cousins, Asnat Masad, Staffan Westerberg, Michael Johnson, Xiuwen Tu, Tim Dennis, Gabriel Harley, Genevieve Solomon, Seung Rim, Michael Shepherd, Scott Herrington, Michael Defensor, Arjelene Leygo, Princess Tomada, Junbo Wu
SunPower Corp., San Jose, CA, USA

4:30
455 **Stack-Junction Approach to Overcome Silicon Single-Junction Limit 1598**
Dongkyun Kim, Youngmoon Choi, Eun Cheol Do, Chulki Kim, Yeonil Lee, Yun Gi Kim
Energy Lab, Samsung Advanced Institute of Technology, Yongin-si, Korea

4:45
456 **SLASH Concept: A Novel Approach for Simplified Interdigitated Back Contact Solar Cells Fabrication 1602**
Thibaut Desrues, Sylvain De Vecchi, Florent Souche, Delfina Munoz, Pierre-Jean Ribeyron
CEA-INES, Le Bourget du Lac, France

3:30 - 5:00 PM **19A**

Area 5: Thin-Film Silicon: Novel Concepts: Hybrid, Plasmonics and Diagnostic Tools (Orals)

Chair(s): Hitoshi Sai, Yasushi Sobajima

3:30
457
Ultra Light-Trapping Filters with Broadband Reflection Volume Holograms N/A
Deming Zhang[1], Shelby Vorndran[2], Juan M. Russo[1], Michael Gordon[2], Raymond K. Kostuk[1]
[1]University of Arizona Electrical and Computer Engineering Department, Tucson, AZ, USA, [2]University of Arizona College of Optical Sciences, Tucson, AZ, USA

3:45
458
Novel Hybrid Amorphous Si/Organic Solar Cell N/A
Vikram Dalal, Sambit Pattnaik, Teng Xiao, Ruth Shinar, Joseph Shinar
Iowa State University, Ames, IA, USA

4:00
459
Best Student Presentation Award Finalist
Nanoparticles-Based Plasmonic Back Reflector for High-Efficiency Thin-Film Silicon Solar Cells N/A
Hairen Tan, Rudi Santbergen, Guangtao Yang, Miro Zeman, Arno Smets
Photovoltaic Materials and Devices Laboratory, Delft University of Technology, Deflt, Netherlands

4:15
460
Coupled Optical and Electrical Design of Plasmonic and Nanophotonic Thin-Film Amorphous Silicon Solar Cells N/A
Michael G. Deceglie[1], Vivian E. Ferry[2], A. Paul Alivisatos[2], Harry A. Atwater[1]
[1]Thomas J. Watson Laboratories of Applied Physics, California Institute of Technology, Pasadena, CA, USA, [2]Materials Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

4:30
461
Light Trapping for Thin Silicon Solar Cells by Femtosecond Laser Texturing 1606
Benjamin G. Lee[1], Yu-Ting Lin[2], Meng-Ju Sher[3], Eric Mazur[2,3], Howard M. Branz[1]
[1]National Center for Photovoltaics, National Renewable Energy Lab, Golden, CO, USA, [2]School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA, [3]Department of Physics, Harvard University, Cambridge, MA, USA

4:45
462
In Situ Determination of Silane Gas Utilization and Deposition Rate for Different Deposition Regimes of µc-Si:H Using FTIR and OES In Situ 1609
A.J. Flikweert, J. Woerdenweber, A. Gordijn
IEK-5 Photovoltaik, Forschungszentrum Juelich GmbH, Juelich, Germany

3:30 - 5:00 PM **17A**

Area 8: PV Characterization: Defects in PV Materials and Solar Cells (Orals)

Chair(s): Manuel Romero, Martin Schubert

3:30
463
Nanoprobe-XRF and Micro-Raman Studies of Metal Impurity Decoration Around Dislocations **1613**
Mariana I. Bertoni[1], David P. Fenning[1], George Sarau[2], Markus Rinio[3], Volker Rose[4], Jorg Maser[5], Tonio Buonassisi[1]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Max Planck Institute for the Science of Light, Erlangen, Germany, [3]Fraunhofer ISE, Laboratory and Servicecenter, Gelsenkirchen, Germany, [4]Advanced Photon Source, Argonne National Laboratory, Argonne, IL, USA, [5]Center for Nanoscale Materials, Argonne National Laboratory, Argonne, IL, USA

4:00
464
Best Student Presentation Award Finalist
Non-Destructive Defect Characterization of Saw-Damage-Etched Multicrystalline Silicon Wafers Using Scanning Electron Acoustic Microscopy **N/A**
Lei Meng[1,4], Satyavolu S. Papa Rao[2], Charanjit S. Bhatia[1,4], Steven E. Steen[2], Alan G. Street[3], Jacob C.H. Phang[1,3]
[1]Centre for Integrated Circuit Failure Analysis and Reliability (CICFAR), Department of Electrical and Computer Engineering, National University of Singapore, Singapore, Singapore, [2]IBM, Thomas J. Watson Research Center, Yorktown Heights, NY, USA, [3]Inscope Labs Pte. Ltd., Singapore, Singapore, [4]Solar Energy Research Institute of Singapore (SERIS), National University of Singapore, Singapore, Singapore

4:15
465
A Model for Electron-Beam-Induced Current Analysis of mc-Si Addressing Defect Contrast Behavior in Heavily Contaminated PV Material **1617**
Harvey L. Guthrey[1,2], Brian P. Gorman[1], Gianluca Coletti[3], Mowafak M. Al-Jassim[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]ECN Solar Energy, Petten, Netherlands

4:30
466
Large-Area Plan-View Transmission Electron Microscopy Sample Preparation for Multijunction Metamorphic Solar Cell Devices **1620**
M. Jackson[1], B. Jackson[1], N. Bodzin[1], A. Zakaria[2], X.-Q. Liu[2], R. King[2], M.S. Goorsky[1]
[1]UCLA Department of Materials Science and Engineering, Los Angeles, CA, USA, [2]Spectrolab, Inc., Slymar, CA, USA

4:45
467
A Comparison of Photoluminescence Imaging and Confocal Photoluminescence Microscopy in the Study of Diffusion near Isolated Extended Defects in GaAs **1624**
Timothy H. Gfroerer[1], Yong Zhang[2], Mark W. Wanlass[3]
[1]Davidson College, Davidson, NC, USA, [2]University of North Carolina at Charlotte, Charlotte, NC, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA

3:30 - 5:00 PM **16AB**

Area 9: Modules and Systems: Inverters and Balance-of-System Devices (Orals)

Chair(s): Mike Fife, Sigifredo Gonzalez

3:30 468 **Thermal Study of Inverter Components N/A**
N. Robert Sorensen[1], Edward V. Thomas[1], Michael A. Quintana[1], Steven Barkaszi[2], Andrew Rosenthal[3]
[1]Sandia National Labs, Albuquerque, NM, USA, [2]Florida Solar Energy Center, Cocoa, FL, USA, [3]New Mexico State University, Las Cruces, NM, USA

3:45 469 **A High Power Density DC-DC Converter for Distributed PV Architectures N/A**
Mohammed Agamy, Yan Jiang, Maja Harfman Todorovic, Ahmed Elasser, Fengfeng Tao, Song Chi, Lei Wang
GE Global Research Center, Niskayuna, NY, USA

4:00 470 **Partial-Shade Evaluation of Distributed Power Electronics for Photovoltaic Systems 1627**
Chris Deline[1], Jenya Meydbray[2], Matt Donovan[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]PV Evolution Labs, Davis, CA, USA

4:15 471 **Light-Generated Effect on Power Switches Used in a Planar PV Power System with Monolithically-Embedded Power Converters N/A**
Abusaleh M. Imtiaz, Faisal H. Khan
University of Utah, Salt Lake City, UT, USA

4:30 472 **A New Model-Based Method for Hot Spot Suppression in Photovoltaic Modules N/A**
Sorin Spanoche[1], David Stewart[1], Shiloh Hawley[1], Ion Opris[2]
[1]ArrayPower Inc., Sunnyvale, CA, USA, [2]Opris Consluting, San Jose, CA, USA

4:45 473 **Dynamic Loss Comparison Between Fixed-State and Reconfigurable Solar Photovoltaic Array 1633**
Bhawani Patnaik, Jyotsna Mohod, Siddhartha P. Duttagupta
Indian Institute of Technology Bombay, Mumbai, India

3:30 - 5:00 PM **19B**

Area 10: PV Velocity Forum: Markets and Scalability (Orals)

Chair(s): Martha Symko-Davies

3:30 474 **PV Manufacturing Cost Analysis N/A**
Alan Goodrich
NREL, Golden, CO, USA

3:45 475 **Best Practices in Manufacturing: Photovoltaics 1639**
Amy Galland
As You Sow, San Francisco, CA, USA

4:00 476 **Increasing Predictability and Investor Confidence in PV Power Plants Through Latent Defect Screening 1643**
Alex C. Mayer, Jenya Meydbray
PV Evolution Labs, Berkeley, CA, USA

4:15 477 **The History of Photovoltaic Industry Pricing and Future Direction in a Low Incentive Environment N/A**
Paula J. Mints
Navigant, Palo Alto, CA, USA

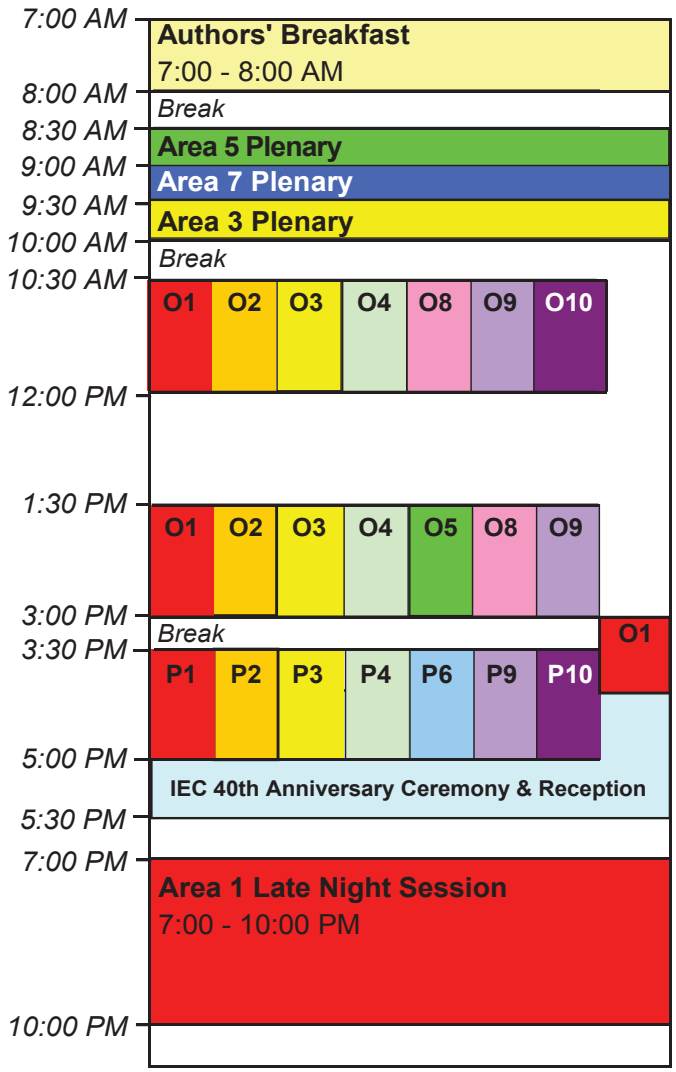
4:30 478 **The Impact of a Rapidly Changing Global PV Market on the PV Manufacturing Supply Chain 1648**
Ray E Morgan[1], Bettina Weiss[1], Joseph Berwind[3], Stephan Raithel[2]
[1]SEMI PV Group, San Jose, CA, USA, [2]SEMI PV Group, Berlin, Germany, [3]AEI Research, Summit, NJ, USA

4:45 479 **Strategic Innovation for Accelerated Grid Penetration and Competitive Domestic Manufacturing N/A**
Douglas M. Powell, Mark T. Winkler, Hyunjoo Choi, Christie B. Simmons, David Berney Needleman, Tonio Buonassisi
Massachusetts Institute of Technology, Cambridge, MA, USA

6:30 - 8:30 PM **Hilton Austin, Salon ABC**

Cherry Reception

WEDNESDAY PROGRAM SUMMARY



AREA LEGEND

- Area 1: Fundamentals and New Concepts for Future Technologies
- Area 2: Thin Film Polycrystalline Photovoltaics
- 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 Terrestrial Systems
- Area 10: PV Velocity Forum

O = Oral Session P = Poster Session

8:00 - 8:30 AM **4th Floor Foyer**

Coffee Break

8:30 - 9:00 AM **Blrm D**

Area 5: Thin-Film Silicon: Plenary

Chair(s): Arno Smets

8:30
480 **Thin-Film Silicon Solar Cells Based on Amorphous and Microcrystalline Silicon and Silicon Alloys: New Approaches for High-Efficiency Devices and Perspectives for the Terawatt Solar Society** **N/A**
Christophe Ballif
Ecole Polytechnique Fédérale de Lausanne (EPFL), Institute of Microengineering (IMT), Photovoltaics and Thin-Film Electronics Laboratory (PV-Lab), Neuchâtel, Switzerland

9:00 - 9:30 AM **Blrm D**

Area 7: Space Technologies: Plenary

Chair(s): David Wilt, Steve Taylor, Mitsuru Imaizumi

9:00
481 **NASA Space Technology Program Plans for Advanced Space Power** **N/A**
James Reuther
NASA Headquarters

9:30 - 10:00 AM **Blrm D**

Area 3: III-V's and Concentrators: Plenary

Chair(s): Mark Stan

9:30
482 **Low-Cost Reliable Highly-Concentrating Photovoltaics: A Reality** **1651**
Andreas Gombert
Soitec Solar GmbH, Freiburg, Germany

10:00 - 10:30 AM **Exhibit Hall 4**

Coffee Break

10:30 - 12:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Simulation and Modeling of Advanced Concept Solar Cells (Orals)

Chair(s): Ryne P. Raffaelle, Seth Hubbard

10:30 483 **Simulation of Carrier Relaxation in Hot-Carrier Solar Cells 1657**
Stephen Goodnick, Christiana Honsberg
Arizona State University, Tempe, AZ, USA

11:00 484 **The Shockley-Queisser Limit and Practical Limits of Nanostructured Photovoltaics 1663**
Robert F. McCarthy[1], Hugh W. Hillhouse[2]
[1]Purdue University, West Lafayette, IN, USA, [2]University of Washington, Seattle, WA, USA

11:15 485 **A New Methodology for Calculating the Efficiency of Multijunction Solar Cells N/A**
Zeev R. Abrams
University of California, Berkeley, Berkeley, CA, USA

11:30 486 **Device Simulation of Intermediate-Band Solar Cells: Dependence on Number of Intermediate-Band Layers 1669**
Katsuhisa Yoshida[1,2], Yoshitaka Okada[1,2], Nobuyuki Sano[3]
[1]School of Engineering, The University of Tokyo, Tokyo, Japan, [2]Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan, [3]Institute of Applied Physics, University of Tsukuba, Ibaraki, Japan

11:45 487 **The Effect of Photonic Bandgap Materials on the Shockley-Queisser Limit N/A**
Jeremy N. Munday[1,2]
[1]Department of Electrical and Computer Engineering, University of Maryland, College Park, MD, USA, [2]Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD, USA

10:30 - 12:00 PM **18CD**

Area 2: Polycrystalline Thin Films: Window Layers and Flexible Devices (Orals)

Chair(s): Tokio Nakada, Joel Duenow

10:30 488 **Review of Progress Towards 20%-Efficiency Flexible CIGS Solar Cells and Manufacturing Issues of Solar Modules N/A**
Adrian Chirila, Patrick Bloesch, Shiro Nishiwaki, Stephan Buecheler, Ayodhya Tiwari
EMPA, Dubendorf, Switzerland

11:00 489 **Using Amorphous Zinc-Tin Oxide Alloys in the Emitter Structure of CIGS PV Devices 1673**
Peter A. Hersh[1], Maikel van Hest[2], Vincent Bollinger[2], Joseph J. Berry[2], David S. Ginley[2], Billy J. Stanbery[1]
[1]HelioVolt Corporation, Austin, TX, USA, [2]National Renewable Energy Labarotory, Golden, CO, USA

11:15 490 **Comparison in Cell Performance of ZnS(O,OH)/CIGS Solar Cells Using MOCVD-ZnO:B and Sputter-Deposited ZnO:Al Window Layers N/A**
Taizo Kobayashi, Kotaro Yamauchi, Tokio Nakada
Aoyama Gakuin University, Sagamihara, Japan

11:30 491 **A Comparative Study of ZnS Buffer Layer CIGS Solar Cells Fabricated by CBD, ALD and Sputtering 1677**
Kannan Ramanathan, Jonathan Mann, Steve Glynn, Steve Christensen, Jian Li, John Scharf, Miguel Contreras, Lorelle Mansfield, Rommel Noufi
NREL, Golden, CO, USA

11:45 492 **Cu(In,Ga)Se_2 Thin-Film Solar Cell Absorbers on Flexible Polyimide: Effect of Na on the Chemical and Electronic Surface and Interface Structure 1682**
Regan G. Wilks[1], Xin Song[1], Raquel Caballero[1,2], Roberto Félix[1], Dominic Gerlach[1], Christian A. Kaufmann[1], Hans-Werner Schock[1], Marcus Bär[1,3]
[1]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany, [2]Universidad Autónoma de Madrid, Madrid, Spain, [3]Brandenburgische Technische Universität Cottbus, Cottbus, Germany

10:30 - 12:00 PM **17B**

Area 3: III-V's and Concentrators: Cells (Orals)

Chair(s): Mark Stan, Scott Burroughs

10:30
493
Metal Pillar Interconnection Topology for Bonded Two-Terminal Multijunction III-V Solar Cells N/A
W.E. McMahon[1], C.-T. Lin[2], J.S. Ward[1], J.F. Geisz[1], M.W. Wanlass[1], J.J. Carapella[1], W. Olavarría[1], M. Young[1], M.A. Steiner[1], R.M. France[1], A.E. Kibbler[1], A. Duda[1], J.M. Olson[1], E.E. Perl[2], D.J. Friedman[1], J.E. Bowers[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University of California at Santa Barbara, Santa Barbara, CA, USA

10:48
494
Temperature Coefficients of Concentrator Solar Cells up to Ultrahigh Irradiance 1688
Avi Braun, Baruch Hirsch, Alexis Vossier, Eugene A. Katz, Jeffrey M. Gordon
Department of Solar Energy and Environmental Physics, Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Sede Boqer Campus, Israel

11:06
495
Demonstration of Multiple Substrate Reuses for Inverted Metamorphic Solar Cells N/A
Jessica G.J. Adams, Victor C. Elarde, Alexander Hains, Christopher Stender, Francis Tuminello, Christopher T. Youtsey, Andree Wibowo, Mark Osowski
MicroLink Devices, Inc., Niles, IL, USA

11:24
496
Best Student Presentation Award Finalist
Metamorphic GaAsP Solar Cells on GaP Grown by Molecular Beam Epitaxy 1692
Stephanie Tomasulo, Kevin Nay Yaung, John Simon, Minjoo L. Lee
Yale University, New Haven, CT, USA

11:42
497
Best Student Presentation Award Finalist
Epitaxial Liftoff of GaAs Thin-Film Solar Cells Followed by Substrate Reuse 1698
Kyusang Lee[1], Jeramy D. Zimmerman[1], Yifan Zhang[2], Stephen R. Forrest[1,2,3]
[1]Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA, [2]Department of Physics, University of Michigan, Ann Arbor, MI, USA, [3]Department of Material Science and Engineering, University of Michigan, Ann Arbor, MI, USA

10:30 - 12:00 PM **Blrm G**

Area 4: Crystalline Silicon: Passivation (Orals)

Chair(s): Ron Sinton, Stefan Glunz

10:30
498
Progress in n-Type Si Solar Cell and Module for High Efficiency and Low Cost 1701
Dengyuan Song, Jingfeng Xiong, Zhiyan Hu, Gaofei Li, Hongfang Wang
Yingli Green Energy Holding Co., TLD, Baoding, China

11:00
499
a-Si:H/c-Si Heterojunctions: A Future Mainstream Technology for High-Efficiency Crystalline Silicon Solar Cells? 1705
Christophe Ballif, Loris Barraud, Antoine Descoeudres, Zachary Holman, Sophie Morel, Stefaan De Wolf
Ecole Polytechnique Fédérale de Lausanne (EPFL), Institute of Microengineering (IMT), Photovoltaics and Thin-Film Electronics Laboratory, Neuchâtel, Switzerland

11:15
500
Design Considerations for Industrial Rear-Passivated Solar Cells 1710
Thomas Lauermann, Benjamin Fröhlich, Giso Hahn, Barbara Terheiden
University of Konstanz, Konstanz, Germany

11:30
501
Best Student Presentation Award Finalist
Process Control of Reactive Sputter Deposition of AlOx and Improved Surface Passivation of Crystalline Silicon N/A
Xinyu Zhang, Andres Cuevas, Andrew Thomson
Research School of Engineering, The Australian National University, Canberra, Australia

11:45
502
Multifunctional Dielectrics: Dopant Source, Passivation and Optics N/A
Johannes Seiffe, Florian Pillath, Daniel Trogus, Andreas Brand, Christian Savio, Marc Hofmann, Jochen Rentsch, Ralf Preu
Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany

10:30 - 12:00 PM **17A**

Area 8: PV Characterization: Characterization of Thin Films (Orals)

Chair(s): Chun-Sheng Jiang, Yanfa Yan

10:30
503

Best Student Presentation Award Finalist

Identification and Analysis of Distinct Features in Imaging Thin-film Solar Cells **1716**

Katherine N. Zaunbrecher[1,2], Steve W. Johnston[1], James R. Sites[2]

[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado State University, Fort Collins, CO, USA

10:45
504

Best Student Presentation Award Finalist

Large-Area Compositional Mapping of $Cu(In_{1-x}Ga_x)Se_2$ Materials and Devices with Spectroscopic Ellipsometry **N/A**

Puruswottam Aryal[1], Dinesh Attygalle[1], Nikolas J. Podraza[1], Sylvain X. Marsillac[1], Robert W. Collins[2]

[1]Center for Photovoltaics Innovation & Commercialization and Department of Physics & Astronomy, University of Toledo, Toledo, OH, USA, [2]Department of Electrical and Computer Engineering, Old Dominion University, Norfolk, VA, USA

11:00
505

Optical-Fiber-Based Time-Resolved Photoluminescence Spectrometer for Rapid Thin-Film Absorber Characterization and Analysis of TRPL Data for CdS/CdTe **1721**

Darius Kuciauskas, Joel N. Duenow, Ana Kanevce, Jian V. Li, Dean H. Levi

NREL, Golden, CO, USA

11:15
506

Analysis of $CuIn_xGa_{1-x}Se_2$ Solar Cells Using Admittance Spectroscopy Under Light Bias **1727**

Angus A Rockett[1], D. Westley Miller[2], J. David Cohen[2]

[1]University of Illinois, Urbana, IL, USA, [2]University of Oregon, Eugene, OR, USA

11:30
507

Optoelectronic Methods for Characterizing Uniformity in CIGS Thin-Film Solar Cells **1732**

Thomas D. Boone, David Soltz, Anika A. Kinkhabwala, Geordie Zapalac, Mustafa Pinarbasi

SoloPower Inc., San Jose, CA, USA

11:45
508

Photovoltage Decay Measurements on $Cu(In,Ga)Se_2$ Solar Cells by Photo-Assisted Kelvin Probe Force Microscopy **1736**

Yu Nakajima[1], Masaki Takihara[1], Takashi Minemoto[3], Takuji Takahashi[1,2]

[1]Institute of Industrial Science, The University of Tokyo, Tokyo, Japan, [2]Institute for Nano Quantum Information Electronics, The University of Tokyo, Tokyo, Japan, [3]Department of Photonics, Ritsumeikan University, Shiga, Japan

10:30 - 12:00 PM **16AB**

Area 9: Modules and Systems: PV Reliability (Orals)

Chair(s): Mike Fife, Tassos Golnas

10:30 509 **Design for Reliability: A Low Concentration PV Case Study 1739**
Jennifer E. Granata[1], Neil R. Sorensen[1], Zachary S. Judkins[2], Sy Olson[2]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]SunPower Corporation, San Jose, CA, USA

10:45 510 **PVLife: An Integrated Model for Predicting PV Performance Degradation over 25+ Years 1744**
Mark Mikofski, David F.J. Kavulak, David Okawa, Yu-Chen Shen, Akira Terao, Michael Anderson, Wendell Caldwell, Doug Kim, Nicholas Boitnott, Junrhey Castro, Laurice Ann Laurio-Smith, Ryan Lacerda, Ernest F. Hasselbrink, Jr.
SunPower Corp., San Jose, CA, USA

11:00 511 **Testing and Analysis for Lifetime Prediction of Crystalline Silicon PV Modules Undergoing Degradation by System Voltage Stress 1750**
P. Hacke, R. Smith, K. Terwilliger, S. Glick, D. Jordan, S. Johnston, M. Kempe, S. Kurtz
NREL, Golden, CO, USA

11:15 512 **Reliability of a PV Module-Integrated Inverter (PV-MII): A Usage Model Approach 1756**
Souhib Harb, Robert S. Balog
Texas A&M University, College Station, TX, USA

11:30 513 **PV Inverter Performance and Reliability: What is the Role of the Bus Capacitor? N/A**
Jack D. Flicker, Matthew Marinella, Robert Kaplar, Jennifer Granata
Sandia National Laboratories, Albuquerque, NM, USA

11:45 514 **PV Reliability Session: Questions for Discussion N/A**
Jennifer E. Granata
Sandia National Laboratories, Albuquerque, NM, USA

10:30 - 12:00 PM **19B**

Area 10: PV Velocity Forum: Models and Markets (Orals)

Chair(s): Ardeth Banrhart

10:30 515 **Quantifying Non-Hardware Balance of System Costs for Photovoltaic Installations in the United States Using a Combined Annual Expenditure-Labor Hour Productivity Approach 1762**
Kristen Ardani[1], Galen Barbose[2], David Feldman[1], Robert Margolis[1], Sean Ong[3]
[1]National Renewable Energy Laboratory, Washington, DC, USA, [2]Lawerence Berkeley National Laboratory, Berkeley, CA, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA

10:45 516 **Updating Interconnection Screens for PV Integration 1768**
Michael H. Coddington[1], Benjamin D. Kroposki[1], Barry A. Mather[1], Kevin Lynn[2], Abraham Ellis[3]
[1]NREL, Golden, CO, USA, [2]DOE, Washington, DC, USA, [3]Sandia National Laboratories, Albuquerque, NM, USA

11:00 517 **Modeling the Grid Impacts of High Penetration of Solar Photovoltaics N/A**
Paul Denholm[1], Greg Brinkman[1], Easan Drury[1], Robert Margolis[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]National Renewable Energy Laboratory, Washington, DC, USA

11:15 518 **Solar Installation Labor Market Analysis and New NREL Models for PV Jobs and Economic Impacts Analysis N/A**
Barry C. Friedman
NREL, Golden, CO, USA

11:30 519 **Do PV Systems Increase Residential Selling Prices? If So, How Can Practitioners Estimate This Increase? 1774**
Ben Hoen[1], Ryan Wiser[1], Mark Thayer[2], Peter Cappers[1]
[1]Lawrence Berkeley National Laboratory, Berkeley, CA, USA, [2]San Diego State University, San Diego, CA, USA

11:45 520 **IEA PVPS Task8: Study on Very-Large-Scale Photovoltaic (VLS-PV) Systems 1778**
Keiichi Komoto[1], Edwin Cunow[2], Christian Breyer[3], David Faiman[4], Karim Megherbi[5], Peter van der Vleuten[6]
[1]Mizuho Information & Research Institute, Inc., Tokyo, Japan, [2]LSPV Consulting, Groebenzell, Germany, [3]Reiner Lemoine Institut gGmbH, Berlin, Germany, [4]Ben Gurion University of the Negev, Be'er Sheva, Israel, [5]Helios Energie, Paris, France, [6]Free Energy Consulting, Eindhoven, Netherlands

1:30 - 3:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Quantum Dot Solar Cells (Orals)

Chair(s): Ryne P. Raffaelle, Cory Cress, Annick Anctil

1:30 521 **Carrier Dynamics in Intermediate States of InAs/GaAs Quantum Dots Embedded in Photonic Cavity Structure** **N/A**
Takashi Kita, Tsuyoshi Maeda, Yukihiro Harada
Kobe University, Kobe, Japan

2:00 522 **Growth and Characterization of $In_xGa_{1-x}As$ Quantum Dots on Metamorphic $GaAs_yP_{1-y}$ Templates by Molecular Beam Epitaxy** **1783**
J. Grandal[1], T.J. Grassman[1], A.M. Carlin[1], M.R. Brenner[1], L. Yang[2], M.J. Mills[2], S.A. Ringel[1]
[1]Dept. of Electrical & Computer Engineering, The Ohio State University, Columbus, OH, USA, [2]Dept. of Materials Science & Engineering, The Ohio State University, Columbus, OH, USA

2:15 523 **Optimization of Growth and Device Performance for InAs Quantum Dot Solar Cells** **1788**
Seth M. Hubbard, Adam Podell, Chelsea Mackos, Stephen Polly, David Forbes
Rochester Institure of Technology, Rochester, NY, USA

2:30 524 **Real Time During Growth Metrology and Assessment of Growth Kinetics of Epitaxial Quantum Dots by Rheed** **1794**
Manori V Gunasekera, Alexandre Freundlich
University of Houston, Houston, TX, USA

2:45 525 **Correlation Between Quantum Dot Morphology and Photovoltaic Performance** **1798**
David V. Forbes[1], Christopher G. Bailey[2], Stephen Polly[1], Chris Kerestes[1], Michael Slocum[1], Zachary S. Bittner[1], Seth M. Hubbard[1]
[1]Rochester Institute of Technology, Rochester, NY, USA, [2]U.S. Naval Research Laboratory, Washington, DC, USA

1:30 - 3:00 PM **18CD**

Area 2: Polycrystalline Thin Films: Thin-Film Manufacturing (Orals)

Chair(s): Harin Ullal, Bernhard Dimmler

1:30 526 **Advancing the Manufacturing of CdTe Modules N/A**
Kevin Walters, Hiroshi Sakurai, W.S. Sampath
NSF I/UCRC for Next Generation Photovoltaics, Colorado State University, Fort Collins, CO, USA

2:00 527 **Electrical Characterization of Cu Composition Effects in CdS/CdTe Thin-Film Solar Cells with a ZnTe:Cu Back Contact N/A**
Jian V. Li, Joel N. Duenow, Darius Kuciauskas, Ana Kanevce, Ramesh G. Dhere, Dean H. Levi
National Renewable Energy Laboratory, Golden, CO, USA

2:15 528 **Effect of Annealing Atmosphere and Temperature on the Properties of Cd_2SnO_4 Thin Films 1803**
Tiejun Meng, Brian E. McCandless, Wayne A. Buchanan, Robert W. Birkmire
Institute of Energy Conversion, University of Delaware, Newark, DE, USA

2:30 529 **Achievement of 17.5% Efficiency with $30x30cm^2$-Sized $Cu(InGa)(SeS)^2$ Submodules 1807**
Motoshi Nakamura, Yoshiyuki Chiba, Kyouhei Horiguchi, Yoshihiko Yanagisawa, Yuko Sawai, Hideki Hakuma
Showa Shell Sekiyu K. K., Atsugi, Japan

2:45 530 **Development of High-Efficiency Cu_2ZnSnS_4 Submodule with Cd-Free Buffer Layer 1811**
Homare Hiroi, Noriyuki Sakai, Satoshi Muraoka, Takuya Katou, Hiroki Sugimoto
Solar Frontier K.K., Atsugi, Japan

1:30 - 3:00 PM **17B**

Area 3: III-V's and Concentrators: Modules and Systems (Orals)

Chair(s): Carlos Algora, Kenji Araki

1:30 531 **System Performance Considerations for Low-Concentration Linear-Focus Silicon-Based Photovoltaic Modules N/A**
Raphael V. Varieras, David L. King, Jusong Wang
Solaria Corporation, Fremont, CA, USA

1:48 532 **Advancing Efficiency and Scale in CPV Arrays N/A**
Geoffrey S. Kinsey, Mingguo Liu, William Bagienski, Aditya Nayak, Vahan Garboushian
Amonix, Inc., Seal Beach, CA, USA

2:06 533 **Experiences After Four Years of Operation of the CPV Plants in ISFOC N/A**
Francisca T. Rubio, Maria C. Martinez, Daniel Sanchez, Pablo J. Trujillos
ISFOS, Puertollano, Spain

2:24 534 **Design and Development of 35%-Efficient and 1000X CPV Module with Sufficient Optical Alignment Tolerance 1815**
Kenji Araki[1], Pablo Zamora[2], Hirokazu Nagai[1], Pablo Benítez[2], Kenji Hobo[1], Juan C. Miñano[2], Masayoshi Futo[1], Gabriel Sala[2], Kazuyuki Tamura[1], Isao Kumagai[1]
[1]Daido Steel, Nagoya, Japan, [2]Universidad Politecnica de Madrid, Madrid, Spain

2:42 535 **On the Effect of Ramp Rate in Damage Accumulation of the CPV Die-Attach 1820**
Nick S. Bosco, Timothy J. Silverman, Sarah R. Kurtz
National Renewable Energy Laboratory, Golden, CO, USA

1:30 - 3:00 PM **Blrm G**

Area 4: Crystalline Silicon: Crystallization and Wafering (Orals)

Chair(s): Jinggang Lu, Paul Von Dollen

1:30 536 **Status of Mono^{2}™ Gen5 Casting at IdealCast Solar N/A**
Roger Clark[1], Christian Lehnert[2]
[1]AMG IdealCast Solar Corp., Frederick, MD, USA, [2]ALD Vacuum Technologies, GmbH, Hanau, Germany

1:45 537 **Integration and Reliability of Ultrathin Silicon Solar Cells and Modules Fabricated using SOM Technology N/A**
Dharmesh Jawarani[1], Dewei Xu[2], Scott Smith[1], Rajesh Rao[1], Leo Mathew[1], Sayan Saha[1], Dabraj Sarkar[3], Curt Vass[1], Sanjay Banerjee[2], Paul S. Ho[2]
[1]AstroWatt, Inc., Austin, TX, USA, [2]The University of Texas at Austin, Austin, TX, USA, [3]The University of Florida, Gainesville, FL, USA

2:15 538 **Laser Wafering 1826**
Stuart Bowden, James Lebeau
Arizona State University, Tempe, AZ, USA

2:30 539 **Structural Analysis of Longitudinal Si-C-N Precipitates in Multicrystalline Silicon: Towards Intrinsic Growth of Current-Conducting and Current-Collecting Channels N/A**
Stefan Köstner[1], Angelika Hähnel[1], Horst Blumtritt[1], Rajmund Mokso[2], Jan Bauer[1], Peter Werner[1], Otto Breitenstein[1]
[1]Max Planck Institute of Microstructure Physics, Halle, Germany, [2]Paul Scherrer Institute, Villigen, Switzerland

2:45 540 **Growth of Multicrystalline Si Ingots for Solar Cells Using Noncontact Crucible Method Without Touching the Crucible Wall 1830**
Kazuo Nakajima[1], Ryota Murai[1], Kohei Morishita[1], Kentaro Kutsukake[2], Noritaka Usami[2]
[1]Kyoto University, Kyoto, Japan, [2]Tohoku University, Sendai, Japan

1:30 - 3:00 PM **19A**

Area 5: Thin-Film Silicon: Thin-Crystalline Silicon Technology (Orals)

Chair(s): Ivan Gordon, Vikram Dalal

1:30
541 **High-Quality Epitaxial Foils, Obtained by a Layer Transfer Process, for Integration in Back Contacted Solar Cells Processed on Glass** **1833**
Kris Van Nieuwenhuysen, Frederic Dross, Valerie Depauw, Roberto Martini, Barry O'Sullivan, Twan Bearda, Jonathan Govaerts, Riet Labie, Maarten Debucquoy, Hariharsudan Sivaramakrishnan, Ivan Gordon, Jozef Poortmans
IMEC, v.z.w., Leuven, Belgium

2:00
542 **Device Physics of Heteroepitaxial Film c-Si Heterojunction Solar Cells** **N/A**
Sachit Grover[1], Charles W. Teplin[1], Jian V. Li[1], David Bobela[2], Jon Bornstein[2], Paul Schroeter[2], Steve Johnston[1], Harvey Guthrey[1], Howard M. Branz[1], David Young[1]
[1]National Renewable Energy Lab., Golden, CO, USA, [2]Ampulse Corporation, Golden, CO, USA

2:15
543 **A Low-Cost Kerfless Thin Exfoliated Si Solar Cell Technology** **1837**
Rajesh Rao[1], Leo Mathew[1], Dabraj Sarkar[2], Scott Smith[1], Sayan Saha[1], Ricardo Garcia[1], Rachel Stout[1], Ariam Gurmu[1], Moses Ainom[1], Emmanuel Onyegam[3], Dewei Xu[1], Dharmesh Jawarani[1], Ujjwal Das[4], Sanjay Banerjee[3], Jerry Fossum[2]
[1]AstroWatt, Austin, TX, USA, [2]University of Florida, Gainesville, FL, USA, [3]University of Texas, Austin, TX, USA, [4]Institute of Energy Conversion, Newark, DE, USA

2:30
544 **Best Student Presentation Award Finalist**
Remote Plasma Chemical Vapor Deposition for High-Efficiency Ultra-Thin ~25-Microns Crystalline Si Solar Cells **N/A**
Dabraj Sarkar[1], Emmanuel U. Onyegam[2], Sayan Saha[3], Leo Mathew[3], Rajesh A. Rao[3], Mohamed H. Hilali[2], Ryan S. Smith[3], Dewei Xu[2], Dharmesh Jawarani[3], Ricardo Garcia[2], Rachel Stout[3], Ariam Gurmu[3], Moses Ainom[3], Jerry G. Fossum[1], Sanjay K. Banerjee[2]
[1]University of Florida, Gainesville, FL, USA, [2]University of Texas, Austin, TX, USA, [3]AstroWatt Inc., Austin, TX, USA

2:45
545 **Characterization of Epitaxial Film Silicon Solar Cells Grown on Seeded Display Glass** **1841**
David L. Young[1], Sachit Grover[1], Charles Teplin[1], Pauls Stradins[1], Vincenzo LaSalvia[2], Ta-Ko Chuang[2], J. Greg Couillard[2], Howard M. Branz[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Corning Incorporated, Corning, NY, USA

1:30 - 3:00 PM **17A**

Area 8: PV Characterization: Advanced Characterization Methods and Instruments (Orals)

Chair(s): Yoshihiro Hishikawa, Jan Schmidt

1:30 546 **Novel Free Carrier Pump-Probe Analysis of Carrier Recombination Lifetime in Semiconductors N/A**
Richard K. Ahrenkiel[1], Ari Feldman[1,2], John Lehman[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Institute of Standards and Technology, Boulder, CO, USA

1:45 547 **Multimodal System for the Characterization of Photovoltaic Structures N/A**
Razvan Ciocan[1], Behrang Hamadani[2], Domenic Assalone[1], Zhuoyun Li[1], Tom Moriarty [3], Keith Emery[3], Mike Carroll[4], Shahram Seyedmohammadi[5], Eugenia Ciocan[6], Mantu Hudait[7], Michael Slocum[8], Aymeric Maros[8], Chris Kerestes[8], Seth Hubbard[8]
[1]Oriel Instruments, Newport Corporation, Stratford, CT, USA, [2]National Institute of Standards and Technology, Gaithersburg, MD, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA, [4]RFMD, Greensboro, NC, USA, [5]Ferro Corp, Vista, CA, USA, [6]Wentworth Institute of Technology, Boston, MA, USA, [7]Virginia Tech, Blacksburg, VA, USA, [8]Rochester Institute of Technology, Rochester, NY, USA

2:00 548 **A Novel Solar Simulator Based on a Super-Continuum Laser 1845**
Tasshi Dennis[1], John B. Schlager[1], Hao-Chih Yuan[2], Qi Wang[2], Daniel Friedman[2]
[1]National Institute of Standards and Technology, Boulder, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

2:15 549 **Characterization of Three-Dimensional Structures in Silicon Solar Cells by Spatially-Resolved Illuminated Lock-in Thermography 1849**
Tobias M. Pletzer, Markus Lenz, Horst Windgassen, Joachim Knoch
RWTH Aachen University, Aachen, Germany

2:30 550 **Spatially-Resolved Luminescence Imaging of All Essential Silicon Solar Cell Parameters 1855**
C Shen, H Kampwerth, M.A Green
UNSW, Sydney, Australia

2:45 551 **Unified Lifetime Measurement for Silicon PV 1860**
Marshall Wilson[1], Jacek Lagowski[1], Andrew Findlay[1], Sara Olibet[2], Valentin Mihailetchi[2]
[1]Semilab SDI, Tampa, FL, USA, [2]ISC Konstanz, Konstanz, Germany

1:30 - 3:00 PM **16AB**

Area 9: Modules and Systems: Module Materials, Durability, and Performance 1 (Orals)

Chair(s): Peter Hacke, Govindasamy Tamizhmani

1:30 552 **Damp Heat Versus Field Reliability for Crystalline Silicon 1864**
Kent L. Whitfield[1], Asher Salomon[1], Michael D. Kempe[2], Tsuyoshi Shioda[3]
[1]Solaria, Fremont, CA, USA, [2]NREL, Golden, CO, USA, [3]Mitsui Chemicals, Nagaura, Japan

2:00 553 **A Field Evaluation of the Potential for Creep in Thermoplastic Encapsulant Materials 1871**
Michael D. Kempe[1], David C. Miller[1], John H. Wohlgemuth[1], Sarah R. Kurtz[1], John M. Moseley[1], Qurat Shah[4], Govindasamy Tamizhmani[4], Keiichiro Sakurai[2], Masanao Inoue[3], Takuya Doi[3], Atsushi Masuda[3]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan, [3]National Institute of Advanced Industrial Science and Technology, Tosu, Japan, [4]Arizona State University Polytechnic Campus, Mesa, AZ, USA

2:15 554 **Performance of Thermoplastic Ionomer Encapsulant Material with Advanced Emitter Solar Cells 1877**
Michael Z. Burrows[1], Andreas Meisel[1], Francesco Lemmi[1], Homer Antoniadis[1], Silvia Schreiber[2], Lucie Garreau-Iles[2], Philip Boydell[2], Alison M.A. Bennett[3], Rebecca L. Smith[4]
[1]Innovalight, Inc., Sunnyvale, CA, USA, [2]DuPont de Nemours Int. SARL, Geneva, Switzerland, [3]E. I. DuPont de Nemours & Co., Wilmington, DE, USA, [4]E. I. DuPont de Nemours & Co., Parkersburg, WV, USA

2:30 555 **Soiling Test Methods and Their Use in Predicting Performance of Photovoltaic Modules in Soiling Environments 1881**
Kathy Brown, Tim Narum, Naiyong Jing
3M Company, St. Paul, MN, USA

2:45 556 **Best Student Presentation Award Finalist**
The Effect of Dust Deposition on Photovoltaic Modules 1886
Reinhart H. Appels[1], Buvaneshwari Muthirayan[1], Alexander Beerten[1], Robin Paesen[1], Johan Driesen[1], Jozef Poortmans[2]
[1]ESAT/ELECTA, KU Leuven, Heverlee, Belgium, [2]IMEC vzm, Heverlee, Belgium

3:00 - 4:00 PM **19B**

SCREAM Workshop

3:00 - 3:30 PM **Exhibit Hall 4**

Coffee Break

3:30 - 5:00 PM **EH4-A**

Area 1: Fundamentals and New Concepts: Session 3 (Posters)

Chair(s): Annick Anctil, Chris Bailey, Seth Hubbard

A3 557 **Synthesis and Characterization of PECVD-Grown, Silane-Terminated Silicon Quantum Dots** **1890**
Ingrid E. Anderson[1], Rebecca A. Shircliff[1], Brian Simonds[1], Matt Bergren[1], Pauls Stradins[2], Reuben T. Collins[1]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

A7 558 **Realization of an Intermediate-Band Solar Cell: The InAs/GaAsSb Quantum Dot System as a Candidate** **N/A**
Stephen P. Bremner[1], Keun Yong Ban[2], Christiana B. Honsberg[2]
[1]University of New South Wales, Sydney, Australia, [2]Arizona State University, Tempe, AZ, USA

A11 559 **Investigation of Carrier Escape Mechanism in InAs/GaAs Quantum Dot Solar Cells** **N/A**
Yushuai Dai[1], Chris Bailey[2], Chris Kerestes[1], David Forbes[1], Seth Hubbard[1]
[1]Nanopower Research Laboratory, Rochester Institute of Technology, Rochester, NY, USA, [2]Naval Research Lab, Washington, DC, USA

A15 560 **Epitaxy of High Aspect Ratio and Wetting-Layer-Free InAs Quantum Dots on (Al)GaAs** **1895**
Alex Freundlich[1], Manori Gunasekera[1], Chandani Rajapaksha[1], Irena Rusakova[2]
[1]Center for Advanced Materials and Physics Department, University of Houston, Houston, TX, USA, [2]Texas Center for Superconductivity and Physics Department, Houston, TX, USA

A19
561 **Numerical Modeling of Axial Junction Compositionally Graded $In_xGa_{1-x}N$ Nanorod Solar Cells 1898**

Jian-Wei Ho[1], Andrew A. O. Tay[2], Soo-Jin Chua[3]
[1]NUS Graduate School of Integrative Sciences & Engineering, National University of Singapore, Singapore, Singapore, [2]Department of Mechanical Engineering, National University of Singapore, Singapore, Singapore, [3]Singapore-MIT Alliance, National University of Singapore, Singapore, Singapore

A23
562 **Nanohole Structure as Efficient Antireflection Layer for Silicon Solar Cell Fabricated by Maskless Laser Annealing 1904**

Lei Hong[1,2], Rusli Rusli[1], Fei Wang[1], Lining He[1], Xincai Wang[2], Hongyu Zheng[2], Hao Wang[1], Hongyu Yu[3]
[1]Nanyang Technological University, Singapore, Singapore, [2]Singapore Institute of Manufacturing Technology, Singapore, Singapore, [3]South University of Science and Technology of China, Shenzhen, China

A27
563 **Photoelectrochemical Study of GaAs Nanowires for Tandem III-V/Si Solar Cells N/A**

Shu Hu[1, 3], Chun-Yung Chi[2], Maoqing Yao[2], Chongwu Zhou[2], P. Daniel Dapkus[2], Nathan S. Lewis[1, 3]
[1]Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, CA, USA, [2]Ming Hsieh Department of Electrical Engineering, University of Southern California, Los Angeles, CA, USA, [3]Joint Center for Artificial Photosynthesis, Pasadena, CA, USA

B3
564 **The Relation Between Photovoltaic Performance and Film Thickness in PbS Quantum Dot Solar Cells N/A**

Junhee Kim[1], Cholong Jung[2], Yongseok Jun[2], Donghwan Kim[1]
[1]Korea University, Seoul, South Korea, [2]UNIST, Ulsan, South Korea

B7
565 **Best Student Presentation Award Finalist**
InGaAs/GaAsP Asymmetric Quantum Wells for Enhancing Carrier Escape Through Resonant Tunneling 1908

ShaoJun Ma[1], Hassanet Sodabanlu[2], YunPeng Wang[2], Kentaroh Watanabe[2], Masakazu Sugiyama[1], Yoshiaki Nakano[1,2]
[1]Department of Electrical Engineering and Information Systems, School of Engineering, The University of Tokyo, Tokyo, Japan, [2]Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan

B11
566 **Silicon Nanowires Development for Solar Cell Devices 1911**

Gopal G. Pethuraja[1,2], Manisha V. Rane-Fondacaro[1], Harry Efstathiadis[1], Ashok K. Sood[2], Pradeep Haldar[1]
[1]Energy and Environmental Applications Center (E2TAC), College of Nanoscale Science and Engineering, University at Albany, State University of New York, Albany, NY, USA, [2]Magnolia Solar Inc., Albany, NY, USA

B15 567 **Numerical Study of GaAs-Based Dual-Junction Intermediate-Band Solar Cells 1917**
Ching-Yu Shih[1], Ming-hsuan Tan[1], Lung-Hsing Hsu[1], Che-Pin Tsai[1], Chien-chung Lin[1], Hao-Chung Kuo[2], K.Y. Chuang[3], T.S. Lay[3]
[1]Institute of Photonic System, National Chiao Tung University, Tainan, Taiwan, [2]Department of Photonic & Institute of Electro-Optical Engineering, National Chiao Tung University, Hsin-chu, Taiwan, [3]Department of Photonics, National SunYat-Sen University, Kaohsiung, Taiwan

B19 568 **Carrier Sweep-Out Time in InGaAs/GaAsP Multiple Quantum Well Solar Cells by Time-Resolved Photoluminescence: Effects of Well Depth and Barrier Thickness 1922**
Hassanet Sodabanlu[1], Shaojun Ma[2], Kentaroh Watanabe[1], Masakazu Sugiyama[2,3], Yoshiaki Nakano[1,2]
[1]Research Center for Advanced Science and Technology, the University of Tokyo, Tokyo, Japan, [2]School of Engineering, the University of Tokyo, Tokyo, Japan, [3]Institute of Engineering Innovation, the University of Tokyo, Tokyo, Japan

B23 569 **Highly-Ordered Silicon Nanowire Arrays on Heterojunction Solar Cells 1926**
Hong-Jhang Syu[1], Yung-Jr Hung[2], Shu-Chia Shiu[1], San-Liang Lee[2], Ching-Fuh Lin[1,3,4]
[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [2]Department of Electronics Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan, [3]Graduate Institute of Electronic Engineering, National Taiwan University, Taipei, Taiwan, [4]Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan

B27 570 **High-Efficiency InAs/GaAs Quantum Dot Solar Cells by MOCVD 1929**
Katsuaki Tanabe, Denis Guimard, Damien Bordel, Ryo Morihara, Masao Nishioka, Yasuhiko Arakawa
University of Tokyo, Tokyo, Japan

C3 571 **Investigations of the Optical Properties of ZnO-Metal Oxide Core-Shell Nanowire Arrays for Use in Advanced Optoelectronics 1931**
M. Allan Thomas, Jingbiao Cui
University of Arkansas at Little Rock, Little Rock, AR, USA

C7 572 **Growth and Characterization of III-Nitride-Based Multiple Quantum Wells for Photovoltaic Devices 1937**
P.V Wadekar[1], C.W Chang[1], T.W. Dung[1], Y.T. Lin[1], Q.Y. Chen[1,2], M.C. Chou[3], S.W. Feng[4], H.C. Huang[3], N.J. Ho[3], L.W. Tu[1], D. Wijesundera[2], W.K. Chu[2]
[1]Department of Physics and Center for Nanoscience and Nanotechnology, National Sun Yat Sen University, Kaohsiung, Taiwan, [2]Department of Physics and Texas Center for Superconductivity, University of Houston, Houston, TX, USA, [3]Department of Materials and Opto-electronic Science, National Sun Yat Sen University, Kaohsiung, Taiwan, [4]Department of Applied Physics, National University of Kaohsiung, Kaohsiung, Taiwan

C11 573 **A Multi-Step Superlattice Solar Cell with Enhanced Sub-Band Absorption and Open Circuit Voltage 1940**
YunPeng Wang[1], ShaoJun Ma[1], Hassanet Sodabanlu[1], Hiromasa Fujii[1], Kentaroh Watanabe[1], Masakazu Sugiyama[2], Yoshiaki Nakano[1]
[1]Research Center for Advanced Science and Technology, the University of Tokyo, Tokyo, Japan, [2]Department of Electrical Engineering and Information Systems, School of Engineering, the University of Tokyo, Tokyo, Japan

C15 574 **Macroporous Silicon Solar Cell on Upgraded Metallurgical-Grade Silicon Wafer N/A**
Lei Zhao, Zhaochen Li, Hongwei Diao, Hailing Li, Chunlan Zhou, Wenjing Wang
Institute of Electrical Engineering, The Chinese Academy of Sciences, Beijing, China

C19 575 **Photovoltaic Measurements in Carbon Nanotube - Amorphous Silicon Core/Shell Nanowire 1944**
Hang Zhou[1,2], Georgis Lentaris[2], Pritesh Hiralal[2], Tim Butler[2], Emrah Unalan[2], Gehan Amaratunga[2], Alan Colli[3]
[1]Peking University Shen Zhen Graduate School, Shen Zhen, China, [2]University of Cambridge, Cambridge, United Kingdom, [3]Nokia Research Center, Cambridge, United Kingdom

C22 576 **Evaluating Photovoltaic Performance Indoors 1948**
Yasmin Afsar[1], John Sarik[2], Maria Gorlatova[2], Gil Zussman[2], Ioannis Kymissis[2]
[1]Princeton University, Princeton, NJ, USA, [2]Columbia University, New York, NY, USA

C25 577 **Simulation-Guided Design of Flexible Photovoltaic Laminates 1952**
Siddharth Ram Athreya, Rahul Sharma, Keith Kauffmann, Leo Lopez, Jie Feng
The Dow Chemical Company, Midland, MI, USA

C28 578 **The Pathway to Achieve More than 5% PbS Quantum Dot Solar Cells N/A**
Jianbo Gao[1], Octavi Semonin[2], Joseph Luther[1], Randy Ellingson[3], Arthur Nozik[1], Matthew Beard[1]
[1]NREL, Golden, CO, USA, [2]University of Colorado, Boulder, CO, USA, [3]University of Toledo, Toledo, CO, USA

D3 579 **Novel Modeling and Simulation of a-Si/c-$Si_{1-x}Ge_x$/c-Si Hetrostructure Thin-Film Solar Cells 1958**
Muhammad Khizar, Md. Amimul Ehsan, Christina Keller, Dongming Mei
Department of Physics, University of South Dakota, Vermillion, SD, USA

D6 580 **Development of Zinc Phosphide as a p-Type Absorber 1963**
Parag S. Vasekar, Siva P. Adusumilli, Daniel Vanhart, Tara Dhakal
Center for Autonomous Solar Power, The State University of New York at Binghamton, Binghamton, NY, USA

D9 581 **Crystal Phase-Controlled Synthesis of Cu_2FeSnS_4 Nanocrystals with Band Gap around 1.5 eV 1967**
Xiaoyan Zhang[1,2], Ningzhong Bao[3], Karthik Ramasamy[1], Yu-Hsiang A. Wang[1], Yifeng Wang[3], Baoping Lin[2], Arunava Gupta[1]
[1]University of Alabama, Tuscaloosa, AL, USA, [2]Southeast University, Nanjing, China, [3]Nanjing University of Technology, Nanjing, China

3:30 - 5:00 PM **EH4-B**

Area 2: Polycrystalline Thin Films: Alternate Substrates, Back Contact Materials, Buffer Compounds, TCOs, Manufacturing, Metrology, Process Control, and Reliability (Posters)

Chair(s): Ayodhya Tiwari, Katsumi Kushiya

E8 582 **Device Degradation Studies of CIGS Solar Cells Using *In Situ* High-Temperature X-Ray Diffraction 1970**
Rangarajan Krishnan[1], Tim Anderson[1], Ryan Kaczynski[2], Urs Schoop[2], Andrew Payzant[3], Woo Kyoung Kim[4]
[1]University of Florida, Gainesville, FL, USA, [2]Global Solar Inc, Tucson, AZ, USA, [3]Oak Ridge National Laboratory, Oak Ridge, TN, USA, [4]Yeungnam University, Dae-Dong, South Korea

E12
583 **Optical Monitoring and Control of Three-Stage Co-Evaporated $Cu(In_{1-x}Ga_x)Se_2$ by Real Time Spectroscopic Ellipsometry N/A**

Dinesh Attygalle[1], Vikash Ranjan[2], Puruswottam Aryal[1], Puja Pradhan[1], S Marsillac[2], N. J Podraza[1], R. W. Collins[1]

[1]Center for Photovoltaics Innovation and Commercialization, University of Toledo, Toledo, OH, USA, [2]Department of Electrical and Computer Engineering, Old Dominion University, Norfolk, VA, USA

E16
584 **Metrology and Process Optimization for Large-Area Monolithically-lintegrated $Cu(In,Ga)Se_2$ Modules 1974**

Dingyuan Lu, Eric P. Christiansen, Colm W. Walsh, Joseph F. Chase, Roy M. Miller, Michael F. Miller, B.J. Stanbery

HelioVolt Corporation, Austin, TX, USA

E20
585 **First-Ever Full-Size CdTe Luminescent Down-Shifting Module 1978**

David Ross[1], Diego Alonso Álvarez[1], Jochen Fritsche[2], Michael Bauer[2], Bryce S. Richards[1]

[1]Heriot-Watt University, Edinburgh, United Kingdom, [2]Calyxo GmbH, Bitterfeld-Wolfen, Germany

E24
586 **Investigation of Post-Deposition and In Situ Cl Treatments for Fully-Sputtered CdTe/CdS Thin-Film Solar Cells 1983**

R. E. Treharne[1], K. Durose[1], L. Bowen[2], B. G. Mendis[2]

[1]University of Liverpool, Liverpool, United Kingdom, [2]University of Durham, Durham, United Kingdom

E28
587 **$In(O,OH)S/AgInS_2$ Absorbent-Layer/Buffer-Layer System for Thin-Film Solar Cells 1988**

Carlos A. Arredondo[1], William A. Vallejo[2], Johann Hernandez[3], Gerardo Gordillo[4]

[1]Universidad Antonio Nariño, Bogota, Columbia, [2]Universidad de America, Bogota, Columbia, [3]Universidad Distrital Francisco Jose de Caldas, Bogota, Columbia, [4]Universidad Nacional de Colombia, Bogota, Columbia

F4
588 **Two-Stage Chemical-Bath Deposition for Well-Covered and Stoichiometric ZnS Thin Films 1992**

Po-Chuan Tsai[1], Ian Pai[1], Han-Ping D. Shieh[2]

[1]Department of Photonics & Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Department of Photonics & Display Institute, National Chiao Tung University, Hsinchu, Taiwan

F8
589 **Influence of $Cu(In,Ga)Se_2$ Grain Orientation on Solution Growth of Zn(O,S) and CdS 1995**

Wolfram Witte[1], Daniel Abou-Ras[2], Dimitrios Hariskos[1]

[1]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Stuttgart, Germany, [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

F12 590 **Mo Effect on One-Step Sputtering Chalcopyrite CIGS Thin Films 1999**
Tzu-Ying Lin[1], Chia-Hsiang Chen[1], Chih-Huang Lai[1,2]
[1]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan, [2]Low Carbon Energy Research Center, Tsing Hua University, Hsinchu, Taiwan

F16 591 **Metallic Grids for Low-Resistive Transparent Conductors: Modeling and Experiments 2003**
Joop van Deelen, Henk Rendering, Hero het Mannetje, Lennaert Klerk, Arjan Hovestad
TNO, Eindhoven, Netherlands

F20 592 *In Situ* **Real Time Spectroscopic Ellipsometry Analysis of Ag Nanoparticle Layers for Back Contact Reflector Applications 2006**
Scott Little[1], Vikash Ranjan[2], Thomas Begou[2], Robert W. Collins[1], Sylvain Marsillac[2]
[1]University of Toledo, Toledo, OH, USA, [2]Old Dominion University, Norfolk, VA, USA

F24 593 **High Quality Indium Tin Oxide (ITO) Film Growth by Controlling Deposition Pressure in RF Magnetron Sputtering 2009**
M. Mannir Aliyu[1], M. Sharafat Hossain[1], Jamilah Husna[1], Nripen Dhar[2], M. Qamarul Huda[2], Kamaruzzaman Sopian[2], Nowshad Amin[1,2]
[1]Department of Electrical, Electronics and System Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia, [2]Solar Energy Research Institute (SERI), Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

F28 594 **Atmospheric Pressure Deposition of SnO_2 and ZnO 2014**
Joop van Deelen, Bas Kniknie, Frank Grob, Ioanna Volintiru, Fred Roozeboom, Paul Poodt, Andrea Illiberi
TNO, Eindhoven, Netherlands

G4 595 **Characterization of TCO Deposition for CIGS Solar Cells 2018**
Krishna Aryal[1], Grace Rajan[1], Yunus Erkaya[1], Nitin Hegde[1], Patrick Boland[1], Vikash Ranjan[1], Robert W. Collins[2], Sylvain Marsillac[1]
[1]Old Dominion University, Norfolk, VA, USA, [2]The University of Toledo, Toledo, OH, USA

G8 596 **The ZnO-Reflectance Effect on the Heterojunction ITO/ZnO/CdS/CdTe 2021**
Juan Luis Peña, Victor Rejón, Oscar Arés, Juan M. Camacho, Araceli Rios-Flores
Applied Physics Department, CINVESTAV-IPN, Mérida, Yucatán, Mexico

G12 597 **Low-Resistivity and High-Transparency ZnO Thin Films on PET Substrate Grown by Atmospheric Spray Pyrolysis N/A**
Kenji Yoshino[1], Naomi Kamiya[1], Minoru Oshima[1], Akiko Ide[1], Yumi Yamamoto[1], Yujin Takemoto[2], Kouji Toyota[2], Koichiro Inaba[2], Ken-ichi Haga[2], Kouichi Tokudome[2]
[1]University of Miyazaki, Miyazaki, Japan, [2]Tosoh Finechem Corporation, Syunan, Japan

G16 598 **Transparent Conductors for Full Spectrum Photovoltaics 2024**

Kin Man Yu[1], Marie M. Mayer[1,2], Derrick T. Speaks[1,2], Hongcai He[3,4], Ruying Zhao[1,2], Leon Hsu[5], Samuel S. Mao[3], Eugene E. Haller[1,2], Wladek Walukiewicz[1]
[1]Lawrence Berkeley National Laboratory, Materials Sciences Division, Berkeley, CA, USA, [2]University of California, Berkeley, Department of Materials Science and Engineering, Berkeley, CA, USA, [3]Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, Berkeley, CA, USA, [4]University of Electronic Science and Technology of China, State Key Laboratory of Electronic Thin Films and Integrated Devices, Chengdu, China, [5]University of Minnesota, Minneapolis, MN, USA

G20 599 **Reflection Optimization for Alternative Thin-Film Photovoltaics N/A**

Jonathan R. Mann, Jian Li, Ingrid L. Repins, Kannan V. Ramanathan, Stephen C. Glynn, Clay M. DeHart, Rommel Noufi
National Renewable Energy Laboratory, Golden, CO, USA

G24 600 **Green Electrodeposition of ZnO as a TCO in Terawatt Solar Cells 2030**

Bin Zhou[1], Xiaofei Han[1], Qing Feng[2], Meng Tao[1]
[1]School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA, [2]Department of Chemistry and Biochemistry, University of Texas at Arlington, Arlington, TX, USA

G28 601 **Development of a Microreactor Assisted Solution Deposition Process for Fabrication of a PV Thin Film N/A**

Michael O'Halloran[1], Sudhir Ramprasad[2], Dan Palo[2], Clayton Hires[3], Brian K. Paul[3], Yu-Wei Su[4], Chih-hung Chang[4]
[1]CH2M HILL, Portland, OR, USA, [2]Microproducts Breakthrough Institute, Pacific Northwest National Laboratory, Corvallis, OR, USA, [3]School of Mechanical, Industrial and Manufacturing Engineering, Oregon State University, Corvallis, OR, USA, [4]School of Chemical, Biological & Environmental Engineering, Oregon State University, Corvallis, OR, USA

H3 602 **Flexible and Cd-free CIGS Solar Cell Yielding 13.37% Efficiency Produced by Non-Vacuum Process 2034**

Wei-Tse Hsu, Chien-Chih Chiang, Tsung-Yeh Chuang, Lung-Teng Cheng, Lih-Ping Wang, Sheng-Wen Cha, Ke-Yu Lai, Wei-Chien Chen, Hsien-Te Cheng, Chou-Cheng Li, Jen-Chuan Chang, Yan-Ying Tsai, Song-Yeu Tsai
Green Energy & Environment Research Laboratories (GEL), Industrial Technology Research Institute, Hsinchu, Taiwan

3:30 - 5:00 PM **EH4-C**

Area 3: III-V's and Concentrators: Cells, Modules, and Systems 2 (Posters)

Chair(s): Daniel Derkacs

H10 603 **Absorption Performance of the Micro-Concentrating Photovoltaic with Multimode Waveguide and Slanted Micro-Hole Cell 2038**
Md. Mosaddek Hossain Adib[1], Arshad M. Chowdhury [1,2], Gee-Kung Chang[2], Nowshad Amin[3]
[1]Department of Electrical Engineering and Computer Science, North South University, Dhaka, Bangladesh, [2]School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA, [3]Department of Electrical, Electronic & Systems Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

H12 604 **Study of Wind Convection Coefficient Correlations for CPV Module Cooling N/A**
Deborah A. Adkins, Yuying Y. Yan
University of Nottingham, Nottingham, United Kingdom

H14 605 **Improvement of CPV System Performance by NGCPV Collaboration N/A**
Kenji Araki[1], César Domínguez[2], Hirokazu Nagai[1], Ignacio Luque-Heredia[3], Kensuke Nishioka[4], Kenji Hobo[1], Ignacio Anton[2], Masayoshi Futo[1], Gabriel Sala[2], Kazuyuki Tamura[1], Isao Kumagai[1]
[1]Daido Steel, Nagoya, Japan, [2]Universidad Politecnica de Madrid, Madrid, Spain, [3]BSQ Solar, Madrid, Spain, [4]University of Miyazaki, Miyazaki, Japan

H16 606 **Design of Semiconductor-Based Back Reflectors for High-V_{oc} Monolithic Multijunction Solar Cells 2042**
Ivan Garcia, John Geisz, Myles Steiner, Jerry Olson, Daniel Friedman, Sarah Kurtz
National Renewable Energy Laboratory, Golden, CO, USA

H18 607 **Trackless LCPV Modules: A Competitive Solution? 2048**
Giorgio Grasso[1], Francesco Morichetti[2], Aldo Righetti[1], Silvia M. Pietralunga[3], Maria C. Ubaldi[1]
[1]CIFE, Milano, Italy, [2]Politecnico di Milano, Dip. Elettronica e Informazione, Milano, Italy, [3]CNR-IFN, Milano, Italy

H20 608 **Numerical Modeling of $In_xGa_{1-x}N$/Silicon Multijunction Tandem Solar Cell 2052**
Ming-Han Hsieh, Yuh-Renn Wu
National Taiwan University, Tapei, Taiwan

H22 609 **Design of Metamorphic Dual-Junction InGaP/ GaAs Solar Cell on Si with Efficiency Greater than 29% Using Finite Element Analysis 2056**
Nikhil Jain, Mantu K Hudait
Virginia Tech, Blacksburg, VA, USA

H24 610 **High-Bandgap Solar Cells for Underwater Photovoltaic Applications 2061**
Phillip P. Jenkins[1], Scott R. Messenger[1], Kelly M. Trautz[1], Sergey Maximenko[2], David Goldstein[1], David A. Scheiman[1], Robert J. Walters[1]
[1]Naval Research Laboratory, Washington, DC, USA, [2]Soltera, Alexandria, VA, USA

H26 611 **Analysis of Energy Production of Spectrolab Multijunction Solar Cells in Field Conditions 2065**
R. K. Jones, R. R. King, C. M. Fetzer, J. H. Ermer, K. M. Edmondson, P. Hebert
Spectrolab, Inc., Sylmar, CA, USA

H28 612 **Device Modeling of an Optimized Monolithic All Lattice-Matched 3-Junction Solar Cell with Efficiency > 50% 2071**
Marina S. Leite[1,2,3], Harry A. Atwater[1]
[1]Thomas Watson Laboratories in Applied Physics, CALTECH, Pasadena, CA, USA, [2]CNST, National Institute for Standards and Technology, Gaithersburg, MD, USA, [3]Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD, USA

I2 613 **Mirror-Augmented Photovoltaic Designs and Performances 2076**
Wei-Chun Lin[1], Dave Hollingshead[2], Roger French[1], Kara Shell[2], Joseph Karas[1]
[1]Case Western Reserve University, Cleveland, OH, USA, [2]Replex Plastics, Mount Vernon, OH, USA

I4 614 **Efficiency Enhancement of GaAs Single-Junction Solar Cells via Improved Optical Designs 2082**
Shi Liu, Ding Ding, Shane R. Johnson, Yong-Hang Zhang
Center for Photonics Innovation and School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ, USA

I6 615 **An Examination of 1-D Solar Cell Model Limitations Using 3-D SPICE Modeling 2088**
William E. McMahon, Jerry M. Olson, John F. Geisz, Daniel J. Friedman
National Renewable Energy Laboratory, Golden, CO, USA

I8 616 **An Alternative Arrangement to Triple-Junction Devices for Reduced Temperature Effects and Enhanced Spectrum Exploitation N/A**
Alaeddine Mokri, Mahieddine Emziane
Masdar Institute of Science and Technology, Masdar City, United Arab Emirates

I10 617 **Annual Energy Yield: A Comparison Between Various Monolithic and Mechanically Stacked Multijunction Solar Cells 2092**
Yves Mols[1], Lu Zhao[1,2], Giovanni Flamand[1], Marc Meuris[1], Jef Poortmans[1]
[1]Imec, Leuven, Belgium, [2]Du Pont Apollo Ltd., Shatin, N.T., Hong Kong

I12 618 **Modeling of InAs/GaSb Tunnel Junction 2096**
Pradyumna Muralidharan[1], Dragica Vasileska[1], Y.-H. Zhang[2]
[1]School of Electrical, Computer and Energy Engineering,Arizona State University, Tempe, AZ, USA, [2]Center for Photonics Innovation and School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA

I14 619 **Efficiency Simulations of Top Surface Light Management Structures for Concentrator Solar Cells Using RCWA and Detailed Balance Theory 2101**
Efrain Eduardo Tamayo Ruiz[1,2], Kentaroh Watanabe[1], Ryosuke Watanabe[1], Masakazu Sugiyama[1,2], Yoshitaka Okada[1,2], Kenjiro Miyano[1,2]
[1]Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Meguro-ku, Japan, [2]School of Engineering, The University of Tokyo, Bunkyo-ku, Japan

I16 620 **A CPV System Design Technique to Maximize Optical Concentration and Efficiency, Based on Site-Specific Irradiance Conditions 2105**
Shelby Vorndran[1], Juan Russo[2], Deming Zhang[2], Michael Gordon[1], Raymond Kostuk[2]
[1]The University of Arizona College of Optical Sciences, Tucson, AZ, USA, [2]The University of Arizona Department of Electrical and Computer Engineering, Tucson, AZ, USA

I18 621 **Optimizing the Design of 2-D Subwavelength ARC Gratings for Multijunction III-V Concentrator Cells 2111**
Wei Wang, Alex Freundlich
University of Houston, Houston, TX, USA

I20 622 **Approaching the Shockley-Queisser Limit in GaAs Solar Cells 2117**
Xufeng Wang, Mohammad Ryyan Khan, Muhammad A. Alam, Mark S. Lundstrom
Purdue University, West Lafayette, IN, USA

I22 623 **A Distributed Emitter Model for Solar Cells: Extracting a Temperature Dependent Lumped Series Resistance 2122**
John R. Wilcox, Jeffery L. Gray
Purdue, West Lafayette, IN, USA

3:30 - 5:00 PM **EH4-D**

Area 4: Crystalline Silicon: Industrial Cell Technology (Posters)

Chair(s): Bart Geerligs

I26 624 **Inline Thermal Anneal to Improve Efficiency of c-Si Solar Cells N/A**
Tianming Bao, Hui Tao, Frank Bottari
BTU International, Shanghai, China

J2 625 **Value of Thermal Oxide for Ion Implanted Silicon Solar Cells 2128**
Vikram Bhosle, Chris Dube, Nick Bateman
Applied Materials, Varian Semiconductor Equipment, Gloucester, MA, USA

J6 626 **Selective- and Homo-Emitter Junction Formation Using Precise Dopant Concentration Control by Ion Implantation and Microwave, Laser or Furnace Annealing Techniques 2132**
John O. Borland[1], Victor Moroz[2], Joanne Huang[2], John Chen[3], Yao-Jen Lee[4], Peter Oesterlin[5], Peter Venema[6], Henri Geerman[6], Peter Zhao[7], Larry Wang[7]
[1]J.O.B. Technologies, Aiea, HI, USA, [2]Synopsys, Mountain View, CA, USA, [3]Kingstone, Shanghai, China, [4]Nano Device Lab, Hsinchu, Taiwan, [5]Innovavent GmbH, Gottingen, Germany, [6]Tempress Systems, Vaassen, Netherlands, [7]Eavans Analytical Group, Sunnyvale, CA, USA

J10 627 **Metal Contact and Diffusion Optimization for Selective Emitter 2138**
Michael Z. Burrows, Andreas Meisel, Giuseppe Scardera, Francesco Lemmi, Homer Antoniadis
Innovalight, Inc., Sunnyvale, CA, USA

J14 628 **The Investigation on the Front Surface Oxidation for Aluminum Rear Emitter n-Type Solar Cells 2142**
Liping Chen, Xi Xi, Wenjuan Wu, Feng Gao, Jin Xu, Zhengxin Wang, Zhenqiu Yu, Qian Lu, Song Zhang, Haidong Zhu, Rulong Chen, Jian Yang, Jingjia Ji, Zhengrong Shi
Suntech Power Co., Ltd., Wuxi, China

J18 629 **Shinsung Solar Energy High-Efficiency Commercial-Crystalline Si Solar Cells 2145**
Kyeong-Yeon Cho[1], Jisoo Kim[1], Eun-Joo Lee[1], Keun-kee Hong[1], Hyun-Woo Lee[1], Ji-Myung Shim[1], Dong-Joon Oh[1], Jeong-Eun Shin[1], Ji-Sun Kim[1], Jae-Keun Seo[1], Soo-hong Lee[2], Brett Hallam[3], Stuart Wenham[3], Hae-Seok Lee[1]
[1]R&D center, Solar cell division, Shinsung solar energy, Seongnam-Si, South Korea, [2]Department of Electronic Engineering, Sejong University, Seoul, South Korea, [3]School of Photovoltaic & Renewable Energy Engineering, University of New South Wales, Kensington NSW, Australia

J22 630 **Investigation of the Dependence of a Screen-Printed Solar Cell Open Circuit Voltage on the Al Paste Composition 2149**
Abasifreke U. Ebong[1], Ernest Addo[2]
[1]Department of Electrical and Computer Engineering, University of North Carolina at Charlotte, Charlotte, NC, USA, [2]PVCH, LLC, Newark, DE, USA

J26 631 **Method of Fabrication of a Backside Silicon Solar Cell by Electrothermal and Electrical Means N/A**
Boris Gilman
Coolsol R&C, Mountain View, CA, USA

K2 632 **Studies on the Effect of Gas Flow Rates in Optimizing Silicon Nitride Films for Multicrystalline Silicon Solar Cells N/A**
A. Guru Prasad, S. Saravanan, D.S. Murty, Dinesh Kumar, Prakash Suratkar
TATA BP Solar India Ltd, Bangalore, India

K6 633 **Ion Shower Doping for Emitter Fabrication in Crystalline Si Solar Cells 2153**
Hiroki Hashiguchi[1], Tomihisa Tachibana[1], Mari Aoki[2], Takuto Kojima[2], Yoshio Ohshita[2], Atsushi Ogura[1]
[1]Meiji University, Kawasaki, Japan, [2]Toyota Tech. Inst., Nagoya, Japan

K10 634 **Preferable Opening Area of Screen Mesh to Print Fine Finger Electrode with Uniform Surface 2158**
Hideaki Hayashi[1], Koji Honda[1], Isao Sumita[2], Uichi Itoh[3], Manabu Yoshida[3], Hideo Tokuhisa[3]
[1]Asada Mesh Co., LTD., Osaka, Japan, [2]Sumita Consulting, Yokohama, Japan, [3]National Institute of Advanced Industrial and Scientific Technology, Tsukuba, Japan

K14 635 **Comparison of Photoluminescence Imaging on Starting Multicrystalline Silicon Wafers to Finished Cell Performance 2161**
Steven W. Johnston[1], Fei Yan[1], David Dorn[2], Katherine Zaunbrecher[1,3], Mowafak Al-Jassim[1], Omar Sidelkheir[4], Kamel Ounadjela[4]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Specialized Imaging, Loveland, CO, USA, [3]Colorado State University, Fort Collins, CO, USA, [4]Calisolar, Sunnyvale, CA, USA

K18 636 **Screen-Printed Finger Electrode with High Aspect Ratio by Single Printing for Crystal Si Solar Cell Using Novel Screen Mask 2167**
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K22 637 **Advancements in Low-Silver Metallization Paste for Si Solar Cells 2171**
Lindsey A. Karpowich, Kristin E. Murphy, Weiming Zhang
Heraeus Precious Metals North America Conshohocken LLC, W. Conshohocken, PA, USA

K26 638 **Advanced Process Control of Chemical Concentration for Solar Cell Manufacturing 2175**
Ismail Kashkoush, Gim Chen, Dennis Nemeth, Jennifer Rieker
Akrion Systems, Allentown, PA, USA

L1 639 **The Effect of the Doping Methods for Laser-Doped Selective-Emitter Silicon Solar Cells 2178**
Jisoo Kim[1], Kyeong-Yeon Cho[1], Eun-Joo Lee[1], Keun-Kee Hong[1], Hyun-Woo Lee[1], Ji-Myung Shim[1], Dong-Joon Oh[1], Jeong-Eun Shin[1], Ji-Sun Kim[1], Jae-Keun Seo[1], Soo-hong Lee[2], Brett Hallam[3], Stuart Wenham[3], Hae-Seok Lee[1]
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L4 640 **Evaluation of Recombination in a Bifacial Si Solar Cell with Back Surface Field Formed by Ion Implantation N/A**
Lev Kreinin[1], Ninel Bordin[1], Naftali Eisenberg[1], Peter Grabitz [2], Gerhard Wahl[2]
[1]b-Solar Ltd., Jerusalem, Israel, [2]b-Solar GmbH, Heilbronn, Germany

L7 641 **Ultrafast Laser Direct Hard-Mask Writing for High Performance Inverted-Pyramidal Texturing of Silicon 2182**
Kitty Kumar, Kenneth C. Lee, Jun Nogami, Peter R. Herman, Nazir P. Kherani
University of Toronto, Toronto, ON, Canada

L10 642 **Progress in Production-Worthy Point Contact Solar Cells Process 2186**
Prabhat Kumar, Kapila Wijekoon, Mukul Agrawal, Kalyan Rapolu, Hemant Mungekar, Michael Stewart, Yi Zheng, Lin Zhang, David Tanner, Hari Ponnekanti
Applied Materials Inc., Santa Clara, CA, USA

L13 643 **Large-Area ~20%-Efficient Silicon Solar Cells Using Fine-Line Direct Printing 2192**
Jiun-Hong Lai[1], Ian B. Cooper[1], Xudong Chen[2], Kenneth Church[2], Haixin Yang[3], Chai-Wei Chen[1], Ajeet Rohatgi[4,5]
[1]University Center of Excellence for Photovoltaics, Georgia Institute of Technology, Atlanta, GA, USA, [2]nScrypt Inc, Orlando, FL, USA, [3]DuPont Microcircuit Materials, Triangle, NC, USA, [4]Regent's Professor, Georgia Institute of Technology, Atlanta, GA, USA, [5]Founder and CTO, Suniva Inc, Norcross, GA, Georgia

L16 644 **Microstructural Characterization of Front-Side Ag Contact of Crystalline Si Solar Cells with Lightly-Doped Emitter 2196**
Z. Li[1], K. Mikeska[1], L. Liang[1], D. Roach[1], L. Cheng[1], M. Lewittes[1], A. Carroll[2], A. Meisel[3], C. Jiang[4]
[1]DuPont Central Research and Development, Wilmington, DE, USA, [2]DuPont Electronic Technologies, Research Triangle Park, NC, USA, [3]DuPont Innovalight, Sunnyvale, CA, USA, [4]National Renewable Energy Laboratory, Golden, CO, USA

L19 645 **Improved Silver Paste Allows 19%-Efficient c-Si Solar Cell with Homogeneous High-Sheet-Resistance $POCl_3$ Emitter 2200**
Jong-Keun Lim[1], Junmo Seo[2], Kyumin Lee[1], Myung-Ick Hwang[2], Won-jae Lee[1], Eun-Chel Cho[2]
[1]Hyundai Electro-Mechanical Research Institute (HEMRI), Hyundai Heavy Industries, Co., Ltd., Yongin, Korea, [2]Green Energy Business Division, Hyundai Heavy Industries, Co., Ltd., Eumseong, Korea

L22 646 **Aluminum Local Back-Surface Field Solar Cells with Inkjet-Opened Rear Dielectric Films 2204**
Licheng Liu[1,2], Zheren Du[1,2], Fen Lin[1], Bram Hoex[1], Armin Gerhard Aberle[1,2]
[1]Solar Energy Research Institute of Singapore (SERIS), Singapore, Singapore, [2]Department of Electrical & Computer Engineering, Faculty of Engineering, National University of Singapore, Singapore, Singapore

L25 647 **Improved Contact Formation for Large-Area Solar Cells Using the Alternative Seed Layer (ASL) Process 2208**
Lynne M. Michaelson, Krystal Munoz, Jonathan C. Wang, Tom Tyson, Anthony Gallegos
Technic Inc., Cranston, RI, USA

L28 648 **Simulated Co-Optimization of Crystalline Silicon Solar Cell Throughput and Efficiency Using Continuously Ramping Phosphorus Diffusion Profiles 2213**
Ashley E. Morishige, David P. Fenning, Jasmin Hofstetter, Douglas M. Powell, Tonio Buonassisi
Massachusetts Institute of Technology, Cambridge, MA, USA

M3 649 **Towards Fabrication of Low-Cost High-Efficiency c-Si Solar Cell: Progress and Optimization Using TCAD Simulation Study 2218**
Karthick Murukesan, Narasimha Rao Mavilla, Brij Mohan Arora
NCPRE, Department of Electrical Engineering, IIT Bombay, Mumbai, India

M6 650 **Optimizing the Geometry of Local Aluminum-Alloyed Contacts to Fully Screen-Printed Silicon Solar Cells 2223**
Jens Müller[1], Sebastian Gatz[1], Karsten Bothe[1], Rolf Brendel[1,2]
[1]Institute for Solar Energy Research Hamelin, Emmerthal, Germany, [2]Institute of Solid-state Physics, University of Hanover, Hanover, Germany

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651 **Efficient Crystalline Si Solar Cell with Amorphous/Crystalline Silicon Heterojunction as Back Contact 2229**
Bill Nemeth[1], Qi Wang[1], Wei Shan[2]
[1]NREL, Golden, CO, USA, [2]JA Solar, Milpitas, CA, USA

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652 **Fabrication and Characterization Of Thin c-Si Solar Cells By Low-Cost Methods 2232**
Efrain Ochoa-Martinez[1], Mercedes Gabas[1], Jose R. Ramos-Barrado[1], Candido Vazquez[2], Itziar Hoces[3], Juan C. Jimeno[3], Bouchaib Hartiti[4]
[1]Dpto. de Física Aplicada I, Lab. de Materiales y Superficies, Universidad de Málaga, Malaga, Spain, [2]Isofotón S.A, Malaga, Spain, [3]Instituto de Tecnología Microelectrónica (TiM) UPV/EHU, Bilbao, Spain, [4]Laboratoire LPMAER, FST de Mohammédia, Université Hassan II, Mohammédia, Morocco

M15
653 **Thin (<100µm) Crystalline Silicon Solar Cell Fabrication Using Low-Cost Feedstock and Diamond Wire Slice Technologies 2237**
Yoshio Ohshita[1], Mari Aoki[1], Takuto Kojima[1], Tomohisa Tachibana[2], Atsushi Ogura[2]
[1]Toyota Technological Institute, Nagoya, Japan, [2]Meiji University, Kanagawa, Japan

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654 **Ion-Implanted and Screen-Printed Large-Area 19%-Efficient n-Type Bifacial Si Solar cells 2240**
Young-Woo Ok[1], Ajay D. Upadhyaya[1], Francesco Zimbardi[1], Steven Ning[1], Ajeet Rohatgi[1,2]
[1]Georgia Institute of Technology, Atlanta, GA, USA, [2]Suniva Inc., Atlanta, GA, USA

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655 **Non-Contact Printed Aluminum Metallization of Si Photovoltaic Devices 2244**
Heather A.S. Platt[1], Yunjun Li[2], James P. Novak[2], Maikel F.A.M. van Hest[1]
[1]National Renewable Energy Lab, Golden, CO, USA, [2]Applied Nanotech, Inc., Austin, TX, USA

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656 **Industrial Process and Materials for In-Line Boron Diffusion in n-Type Silicon N/A**
Paul Richter, Frank Bottari, David Wong
BTU International, Inc., North Billerica, MA, USA

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657 **High Efficiency n-Type Solar Cells with Screen-Printed Boron Emitters and Ion Implanted Back Surface Field 2247**
Kyungsun Ryu[1], Ajay Upadhyaya[1], Young-Woo Ok[1], Helen Xu[2], Lea Metin[2], Anil Bhanap[2], Ajeet Rohatgi[1,3]
[1]UCEP, Georgia Institute of Technology, Atlanta, GA, USA, [2]Honeywell International Inc., Sunnyvale, CA, USA, [3]Founder and CTO, Suniva Inc., Norcross, GA, USA

M26
658 **A Novel Non-Lithographic Patterning Method for Fabricating Solar Cells 2250**
Sayan Saha[1], Rajesh A. Rao[2], Leo Mathew[2], Moses Ainom[2], Sanjay K. Banerjee[1]
[1]University of Texas, Austin, TX, USA, [2]AstroWatt, Inc., Austin, TX, USA

M28 659 **Ion-Implant Doped Large-Area n-Type Czochralski High-Efficiency Industrial Solar Cells 2254**
Manav Sheoran, Matthew Emsley, Min Yuan, Deepak Ramappa, Paul Sullivan
Applied Materials, Varian Semiconductor Equipment, Santa Clara, CA, USA

N2 660 **Design of Antireflection Coating for Surface Textured Interdigitated Back Contact Silicon Heterojunction Solar Cell 2258**
Brent Shu[1, 2], Ujjwal Das[1], Lei Chen[1], Lulu Zhang[1], Steven Hegedus[1], Robert Birkmire[1, 2]
[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Physics and Astronomy, University of Delaware, Newark, DE, USA

N4 661 **The Investigation on Fast and Uniform Diffusion for Silicon Solar Cell Production 2263**
Ning Tang, Xi Xi, Zhengxin Wang, Hongqiang Qian, Feng Gao, Liping Chen, Wenjuan Wu, Cheng Huang, Yongfei Jiang, Haidong Zhu, Rulong Chen, Jian Yang, Jingjia Ji, Zhengrong Shi
Suntech Power Co., Ltd., Wuxi, China

N6 662 **Silver Ink Experiments for Silicon Solar Cell Metallization by Flexographic Process 2266**
Sébastien Thibert[1,2], Didier Chaussy[1], Beneventi Davide[1], Reverdy-Bruas Nadège[1], Johann Jourdan[2], Bernard Bechevet[2], Simon Mialon[2]
[1]Lgp2 Grenoble INP-Pagora, Saint-Martin-d'Hères, France, [2]MPO-Energy, Averton, France

N8 663 **High-Efficiency Lead-Free Silver Pastes for Crystalline Silicon Solar Cells 2271**
Paul D. VerNooy[1], Charlie C. Torardi[1], Zhigang Li[1], Mark E. Lewittes[1], Ross Getty[1], Kurt R. Mikeska[1], Alex S. Ionkin[1], Lapkin K. Cheng[1], Alex Wu[2], Brian J. Laughlin[3], Giovanna Laudisio[4]
[1]DuPont Central Research and Development, Wilmington, DE, USA, [2]DuPont Microcircuit Materials, Taoyuan, Taiwan, [3]DuPont Microcircuit Materials, Research Triangle Park, NC, USA, [4]DuPont Microcircuit Materials, Bristol, United Kingdom

N10 664 **The Fire-Through Processing of the Screen-Printed Ag Thick-Film Metal Contacts on Etched Porous Silicon ARC of the Si Solar Cells N/A**
P. Narayanan Vinod
Naval Physical and Oceanographic Laboratory, Thrikkakara P.O., Kochi, India

N12 665 **Electric-Arc Micro-Texturing of Silicon Surfaces for Photovoltaic Applications 2274**
Longteng Wang, Vikram V. Iyengar, Mool C. Gupta
Department of Electrical and Computer Engineering, University of Virginia, Charlottesville, VA, USA

N14 666 **The Investigation on the Quality of Aluminum Rear Emitter for n-Type Solar Cells 2278**
Wenjuan Wu, Xi Xi, Liping Chen, Feng Gao, Jin Xu, Zhengxin Wang, Zhenqiu Yu, Qian Lu, Song Zhang, Haidong Zhu, Rulong Chen, Jian Yang, Jingjia Ji, Zhengtong Shi
Suntech Power Co., Ltd., Wuxi, China

N16 667 **The Investigation on the Texture Differences Between p-Type and n-Type Crystalline Silicon Wafers 2281**
Wenjuan Wu, Jin Xu, Xi Xi, Liping Chen, Feng Gao, Zhengxin Wang, Zhenqiu Yu, Qian Lu, Song Zhang, Haidong Zhu, Rulong Chen, Jian Yang, Jingjia Ji, Zhengrong Shi
Suntech Power Co., Ltd., Wuxi, China

N18 668 **Development and Comparison of Small- and Large-Area Boron-Doped Solar Cells in Cz-Si n-Type and p-Type Substrates 2284**
Izete Zanesco, Adriano Moehlecke, Jaqueline Ludvig Pinto, Moussa Ly
PUCRS - Catholic University, Porto Alegre, Brazil

N20 669 **0.35% Absolute Efficiency Gain of Bifacial n-Type Si Solar Cells by Industrial Metal Wrap Through Technology 2289**
Wenchao Zhao[1], Jianming Wang[1], Yanlong Shen[1], Ziqian Wang[1], Yingle Chen[1], Zhiyan Hu[1], Gaofei Li[1], Jianhui Chen[1], Jingfeng Xiong[1], N. Guillevin[2], B.J.B. Heurtault[2], L.J. Geerligs[2], A.W. Weeber[2], J.H. Bultman[2]
[1]Yingli Green Energy Holding Co., Ltd, Baoding, China, [2]ECN Solar Energy, Alkmaar, Netherlands

N22 670 **The Effect of Emitter Profile on Laser-Doped Multicrystalline Silicon Selective-Emitter Cells 2292**
Chunlan Zhou, Su Zhou, Wenjing Wang
The Key Laboratory of Solar Thermal Energy and Photovoltaic System, Institute of Electrical Engineering, Beijing, China

3:30 - 5:00 PM **EH4-E**

Area 6: Organic Photovoltaics: Contacts and Dye Cells (Posters)

Chair(s): Ivgenny Katz, Dana Olson

P6 671 **Surface-Modified ZnO Nanorod Arrays for Hybrid Solar Cell Applications 2296**
Samir AbdulAlmosin, Jingbiao Cui
University of Arkansas at Little Rock, Little Rock, AR, USA

P8 672 **Improvement of Morphological and Electrical Properties in Poly (3-hexylthiophene-2, 5-diyl) Films Formed by Thermal Annealing in the Presence of Electric Field During the Solvent Drying Step 2301**

Anirban Bagui[1,3], S. Sundar Kumar Iyer[2,3]
[1]Department of Physics, Indian Institute of Technology Kanpur, Kanpur, India, [2]Department of Electrical Engineering, Indian Institute of Technology Kanpur, Kanpur, India, [3]Samtel Centre for Display Technologies, Indian Institute of Technology Kanpur, Kanpur, India

P10 673 **Atomistic Modeling of Titania Grown Using PVD Methods 2306**

Sabrina Blackwell[1], Roger Smith[1], Steven D. Kenny[1], John M. Walls[2]
[1]Department of Mathematical Sciences, Loughborough University, Loughborough, United Kingdom, [2]Department of Electronic and Electrical Engineering, Loughborough University, Loughborough, United Kingdom

P12 674 **Development and Demonstration of Flexible, Multi-Component Hybrid Sealing System for Encapsulating Organic Photovoltaics N/A**

Minjae Kim[1], Mike Clingerman[2], Alex Kawczak[2], Paul R. Berger[1,3]
[1]Department of Electrical and Computer Engineering, The Ohio State University, Columbus, OH, USA, [2]StrateNexus Technologies, LLC, Columbus, OH, USA, [3]Department of Physics, The Ohio State University, Columbus, OH, USA

P14 675 **Novel Non-Aggregated Hyperbranched Phthalocyanines for Efficient Dye-Sensitized Solar Cells 2311**

Yong Li[1,2], Peifen Lu[1], Xingzhong Yan[1], Zhonghua Peng[2]
[1]Department of Electrical Engineering and Computer Science, South Dakota State University, Brookings, SD, USA, [2]Department of Chemistry, University of Missouri-Kansas City, Kansas City, MO, USA

P16 676 **Electric and Optical Transport of MWNT/ Silicon Junctions 2315**

Muatez Z. Mohammed, Tar-pin Chen, Zhongrui Li, Jingbiao Cui
University of Arkansas at Little Rock & Arkansas GREEN Solar Cell Research Center, Little Rock, AR, USA

P18 677 **Module Construction of Dye-Sensitized Solar Cells by Using Chemical Etching N/A**

The-Vinh Nguyen[1], O-Bong Yang[2]
[1]Hochiminh City University of Technology, Hochiminh, Vietnam, [2]Chonbuk National University, Jeonju, South Korea

P20 678 **Enhancement of Indium-Based Organic Photovoltaics 2321**
Badr Omrane, Yindar Chuo, Jeyd Aristizabal, Clinton K. Landrock, David Fournier, Sasan V. Grayli, Siamack V. Grayli, Bozena Kaminska
Simon Fraser University, Burnaby, BC, Canada

P22 679 **Transparent Conductive Film Fabrication by Carbon Nanotube Ink Spray Coating and Ink-Jet Printing 2324**
Wei Zhou[1,2], Amare Benor Belay[1,2], Kris Davis[1,2], Nicoleta Sorloaica-Hic kman[1,2]
[1]Florida Solar Energy Center, University of Central Florida, Orlando, FL, USA, [2]College of Optics & Photonics, University of Central Florida, Orlando, FL, USA

P24 680 **Achieving Fill Factor Above 80% in Organic Solar Cells by Interface Engineering N/A**
Biswajit Ray, Muhammad Alam
Purdue University, West Lafayette, IN, USA

3:30 - 5:00 PM **EH4-F**

Area 9: Modules and Systems: Module Materials, Durability, and Performance (Posters)

Chair(s): Wilfried van Sark, Max Köntopp, Peter Hacke

T10 681 **Electrical Insulation Requirements for Combinations of Polymeric Film Components in PV Modules N/A**
Howard S. Creel, Nancy H. Phillips, William D. O'Brien, Brad L. Givot
3M, St. Paul, MN, USA

T14 682 **Improved Plastic Materials for Application in PV Modules 2328**
Dan M.J. Doble, Andrew Kodis, Rob deJong, Karen van der Wetering
Sabic IP, Pittsfield, MA, USA

T18 683 **Improving Long-Term Performance and Durability of Photovoltaic Modules by Incorporating an Edge Sealant with Optimized Properties and Application Design Flexibility 2331**
Samar Teli, Justin Bates, Dennis Booth, Tim O'Neil
Adco Products Inc., Michigan Center, MI, USA

T22 684 **Effect of Encapsulant Film Properties on PV Module Performance 2335**
Shaofu Wu[1], Nick Nichole[2], Bert Weaver[1], John Naumovitz[2], Neelkanth Dhere[3]
[1]The Dow Chemical Company, Freeport, TX, USA, [2]The Dow Chemical Company, Midland, MI, USA, [3]University of Central Florida, Cocoa, FL, USA

U2
685 **The Effect of Volume Resistance of EVA Encapsulant on the Insulation Performance of the PV Modules N/A**
Jiang Weina, Zhang Yan, Zhou Jian
ET-solar, Taizhou, China

U6
686 **Effect of Encapsulant on Cell-to-Module Power Loss in PV Modules with Ion Implant and $POCl_3$ Cells 2336**
Biao Li[1], Jennifer A. Segui[1], Cyril J. Fountain[1], Christopher E. Dube[2], Basil Tsefrekas[2]
[1]Fraunhofer Center for Sustainable Energy Systems CSE, Cambridge, MA, USA, [2]Applied Materials, Varian Semiconductor Equipment, Gloucester, MA, USA

U10
687 **Glass-Surface Morphology Effect of Antireflection-Coated Solar Glass in Crystalline Solar Module N/A**
Jong Dae Kim, BoJoong Kim, YongWoo Choi
Solar Biz. Division, LG Electronics, Seoul, Korea

U14
688 **Yield Strength Lowering of PV Interconnector Ribbon Using Control of Crystallographic Texture N/A**
Byungjun Kang[1], Won Wook Oh[1], Sung Ju Tark[1], Nochang Park[1,2], Young Do Kim[1], Chang-Sik Son[3], Donghwan Kim[1]
[1]Korea University, Seoul, South Korea, [2]Korea Electronics Technology Institute, Seongnam, South Korea, [3]Silla University, Busan, South Korea

U18
689 **Conductive Adhesive Based on Carbon Nanotubes for Solar Cells Interconnection 2342**
Yonas Zemen[1,2], Carolin Schulz[3], Helge Trommler[1,4], Samuel T. Buschhorn[4], Wolfgang Bauhofer[3], Karl Schulte[4]
[1]SOLON SE, Berlin, Germany, [2]SOLON Corporation, Tucson, AZ, USA, [3]Institute for Optical and Electronic Materials, Hamburg University of Technology (TUHH), Hamburg, Germany, [4]Institute for Polymer Composites, Hamburg University of Technology (TUHH), Hamburg, Germany

U22
690 **Temperature of Solder Contact in Back-Contact Si Solar Cells and Its Effect on Reliability of Modules Under Localized Shading Environments 2347**
Lewis Abra, Seung B. Rim, Doug Kim
SunPower Corp., San Jose, CA, USA

V2
691 **Comparative Study of Active Solder and Conventional Solder on Photovoltaic Cells 2351**
Christopher M. Darvell, Pritpal Singh
Villanova University, Villanova, PA, USA

V6 692 **Recycling of Materials from Silicon-Based Solar Cell Modules 2355**
Teng-Yu Wang[1], Jui-Chung Hsiao[1], Chen-Hsun Du[2]
[1]Green Energy and Environment Research Labs, Industrial Technology Research Institute, Hsinchu, Taiwan, [2]Institute of NanoEngineering and MicroSystems, National Tsing Hua University, Hsinchu, Taiwan

V10 693 **Superior Low-Light-Level Performance of Upgraded-Metallurgical-Grade Si Modules 2359**
Kamel Ounadjela[1], Jean-Patrice Rakotoniana[1], Omar Sidelkheir[1], Olivier Laparra[1], Martin Kaes[2], Ryan Smith[3], Steve Rummel[3], Mowafak Al-Jassim[3]
[1]Calisolar Inc., Sunnyvale, CA, USA, [2]Calisolar GmbH, Berlin, Germany, [3]NREL, Golden, CO, USA

V14 694 **PV Modules with Variable Ideality Factors 2362**
Georgi Hristov Yordanov[1,2], Ole-Morten Midtgård[1,2], Tor Oskar Saetre[1]
[1]University of Agder (UiA), Grimstad, Norway, [2]Norwegian University of Science and Technology (NTNU), Trondheim, Norway

V18 695 **Outdoor Performance of 10-Year-Old a-Si and Poly-Si Modules in Southern Norway Conditions 2368**
Deepak Verma[1], Muhammad Tayyib[1], Tor O. Sætre[1], Ole-Morten Midtgård[1]
[1]University of Agder, Faculty of Engineering and Science, Grimstad, Norway

V22 696 **Outdoor Performance of North-Facing Multicrystalline Modules in Southern Norway 2372**
Deepak Verma, Muhammad Tayyib, Tor O. Sætre, Ole-Morten Midtgård
University of Agder, Faculty of Engineering and Science, Grimstad, Norway

W2 697 **Comparative Study of the Performance of Field-Aged Photovoltaic Modules Located in a Hot and Humid Environment 2376**
Nicoleta Sorloaica-Hickman[1], Kris Davis[1], Sarah Kurtz[2], Dirk Jordan[2]
[1]Florida Solar Energy Center, University of Central Florida, Orlando, FL, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

W6 698 **Test of the European Joint Research Centre Performance Model for c-Si PV Modules 2382**
Georgi Hristov Yordanov[1,2], Muhammad Tayyib[1], Ole-Morten Midtgård[1,2], Jan-Ove Odden[3], Tor Oskar Saetre[1]
[1]University of Agder, Grimstad, Norway, [2]Norwegian University of Science and Technology, Trondheim, Norway, [3]Elkem Solar AS, Kristiansand, Norway

W10 699 **Analysis of Current Gain by Varying the Spacing Between Cells in a PV Module with Quantum Efficiency Measurement 2388**
Indeok Chung[1], Un-il Baek[1], In-Sik Moon[1], Keyman Bae[2], Sungyong Shin[2], Eun-Chel Cho[2], Ohjune Kwon[2], Seungmin Shin[2], Won-jae Lee[1]
[1]Hyundai Electro-Mechanical Research Institute, Hyundai Heavy Industries, Co., Ltd., Yongin, Korea, [2]Green Energy Business Division, Hyundai Heavy Industries, Co., Ltd., Eumseong, Korea

W14 700 **Stability of the Performance of Thin-Film Modules During One Year of Operation 2391**
Hans Georg Beyer, Georgi Yordanov
University of Agder, Grimstad, Norway

W18 701 **Initial Light-Induced Degradation Study of Multicrystalline Modules Made from Silicon Material Processed Through Different Manufacturing Routes 2395**
Muhammad Tayyib[1], Y. Harshavardhana[2], M. Ramanjaneyulu[2], T.S. Surendra[3], Jan Ove Odden[4], Tor Oskar Seatre[1]
[1]University of Agder, Grimstad, Norway, [2]Titan Energy Systems Ltd, Andhra Pradesh, India, [3]Padmasri Dr. B.V. Raju Inst. Of Techn, Narsapur, India, [4]Elkem Solar, Kristiansand, Norway

W22 702 **Comparison of the Performance Degradation Between Selective Emitter Solar Cells Recently Commercialized and Standard Solar Cells Under Encapsulation and Outdoor Exposure 2400**
Zongcun Liang, Fei Zeng, Shuquan Chen, Hui Shen
Institute for Solar Energy System, School of Physics and Engineering, State Key Laboratory of Optoelectronic Materials and Technologies, Sun Yat-Sen University, Guangzhou, China

X1 703 **Seasonal Variation of PV Module Performance in Tropical Regions 2406**
Jiaying Ye, Thomas Reindl, Joachim Luther
Solar Energy Research Institute of Singapore, Singapore, Singapore

X4 704 **Characterization of Field-Exposed Thin-Film Modules 2411**
John H. Wohlgemuth[1], Oruganti S. Sastry[2], Adam Stokes[1], Yogesh K. Singh[2], Mithilesh Kumar[2]
[1]NREL, Golden, CO, USA, [2]Solar Energy Centre, New Delhi, India

X7 705 **A Shade-Tolerant Panel Design for Thin-Film Photovoltaics 2416**
Sourabh Dongaonkar, Muhammad A. Alam
School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA

X10 706 **Statistical Analysis of Commercial c-Si PV Module Efficiency Distribution over 11-Years Period 2421**
Joseph M. Kuitche[1], Vivek Sharma[1], Jaewon Oh[1], Rong Pan[1], Govindasamy TamizhMani[1,2]
[1]Arizona State University, Tempe, AZ, USA, [2]TUV Rheinland PTL, Tempe, AZ, USA

X13 707 **Failure Rate Analysis of Module Design Qualification Testing - IV: 1997-2005 vs. 2005-2007 vs. 2007-2009 vs. 2009-2011 2426**
Govindasamy TamizhMani, Bo Li, Todd Arends, William Shisler, Arseniy Voropayev, Daniel Parker, Kamerine Kroner, Jameel Armstrong
TUV Rheinland PTL, Tempe, AZ, USA

X14 708 **Online Photovoltaic Array Hot-spot Bayesian Diagnostics from Streaming String-Level Electric Data 2432**
Stephen C Yang[2], Shahar Ben Menahem[1]
[1]1Carnegie Mellon University SV, Moffett Field, Mountain View, CA, USA, [2]Wattminder Inc., Sunnyvale, CA, USA

X15 709 **Potential Induced Degradation (PID) Study on Accelerated Stress-Tested PV Modules 2438**
Sandhya Goranti, Govindasamy TamizhMani
Arizona State University, Mesa, AZ, USA

X16 710 **Study of Potential Induced Degradation (PID) Mechanism in Commercial PV Module 2442**
Han-Chang Liu, Chung-Teng Huang, Wen-Kuei Lee
Industrial Technology Research Institute, Chutung Hsiuchu, Taiwan

X17 711 **High-Voltage Bias Testing of PV Modules in the Hot and Humid Climate Without Inducing Irreversible Instantaneous Degradation 2445**
Neelkanth Dhere, Ashwani Kaul, Eric Schneller, Narendra Shiradkar
Florida Solar Energy Center, Cocoa, FL, USA

X18 712 **A Decision-Making Framework for Solar Photovoltaic Module Technologies Using Six Sigma 2449**
Harish Krishnamoorthy, Poornima Mazumdar, Ilaval Manickam, Prasad Enjeti, Robert Balog
Texas A&M University, College Station, TX, USA

X19 713 **Analytical Thermal Stress Modeling in Design for Reliability (DfR) of Photovoltaic (PV) Assemblies N/A**
Ephraim Suhir[1], Dongkai Shangguan[2]
[1]University of California, Santa Cruz, CA, USA, [2]Flextronics, Santa Clara, CA, USA

X20 714 **Probabilistic Design-for-Reliability (PDfR) of Photovoltaic (PV) Modules N/A**
Ephraim Suhir[1], Dongkai Shangguan[2]
[1]University of California, Santa Cruz, CA, USA, [2]Flextronics, Santa Clara, CA, USA

3:30 - 5:00 PM **EH4-G**

Area 10: PV Velocity Forum: Session (Posters)

X21 715 **PV Programme In India: Present Status & Future Prospects N/A**
Bharat Bhargava
New Delhi, India

X22 716 **An Overview of the Bangladeshi Photovoltaic Market, Government Policies, and Deployment Challenges 2455**
Steven Limpert[1], Holly Battelle[2]
[1]Arizona State University, Tempe, AZ, USA, [2]Fulbright Scholar, Dhaka, Bangladesh

X23 717 **Deployment of PV Systems in Japan: The Opportunities and Challenges of New Feed-in Tariff Program 2458**
Izumi Kaizuka, Takashi Ohigashi, Hiroshi Matsukawa, Haruki Yamaya
RTS Corporation, Tokyo, Japan

X24 718 **Grid Parity Reached for Consumers in the Netherlands 2462**
Wilfried G. van Sark[1,2], Peter Muizebelt[3], Jadranka Cace[4], Arthur de Vries[1,5], Peer de Rijk[1,6]
[1]Stichting Monitoring Zonnestroom, Utrecht, Netherlands, [2]Utrecht University, Copernicus Institute, Utrecht, Netherlands, [3]New-Energy-Works, Utrecht, Netherlands, [4]Rencom, Ouderkerk a/d Amstel, Netherlands, [5]Holland Solar, Utrecht, Netherlands, [6]Organisatie voor Duurzame Energie, Utrecht, Netherlands

Y1 719 **Engineering Workforce Challenges for PV Market Expansion and Manufacturing in Argentina 2467**
Julio A Bragagnolo, Sebastian Kind, Walter Legnani
UTN, Buenos Aires, Argentina

Y2 720 **Techno-Economic Analysis for the Placement of a Si-Based Low-Cost Solar Cells Factory in West Africa and Compared to China 2471**
Ricardo Guerrero-Lemus[1], Pedro Rivero-Rodríguez[1], Bruno Díaz-Herrera[2], Benjamín González-Díaz[1], Gerardo López[3], Francisco Jarabo[1]
[1]Univ. La Laguna, La Laguna, Spain, [2]China Technology Development Group Corporation, Hong Kong, China, [3]Polígono Industrial de Granadilla, S.A., Granadilla, Spain

Y3 721 **"Teach a 1000 Teachers": A Methodology for the Rapid Ramp-up of Photovoltaics Manpower Required for India's National Solar Mission 2477**
Chetan S. Solanki[1], B. G. Fernandes[1], B. M. Arora[1], Pratibha Sharma[1], V. Agarwal[1], M. B. Patil[1], J. Vasi[1], D. B. Phatak[2], Mukta Atrey[2], Kannan Moudgalya[3], Kamal Bijlani[4]
[1]National Centre for Photovoltaic Research and Education, Indian Institute of Technology Bombay, Mumbai, India, [2]Department of Computer Science and Engineering, Indian Institute of Technology Bombay, Mumbai, India, [3]Department of Chemical Engineering, Indian Institute of Technology Bombay, Mumbai, India, [4]Amrita University, Amritapuri, Kollam, India

Y4 722 **aSUNm Solar Decathlon House N/A**
Athena A Christodoulou[1], Joshua J Williams[2]
[1]University of New Mexico, Albuquerque, NM, USA, [2]Arizona State University, Tempe, AZ, USA

Y5 723 **Known Knowns and Known Unknowns of U.S. Patent Reform (The America Invents Act) N/A**
Clara Davis
Hollingsworth & Funk, Minneapolis, MN, USA

Y6 724 **Quantifying the Impacts of Long-Timescale Spatio-Temporal Solar Resource Variability at High PV Penetrations 2481**
Marc J. Perez, Vasilis M. Fthenakis
Columbia University, New York, NY, USA

Y7 725 **Economic Value of Solar- and Wind-Generated Electricity Calculated from Locational Marginal Prices N/A**
John H. Scofield
Oberlin College, Oberlin, OH, USA

Y8 726 **Thin-Film CIGS Report Card – Progress in CIGS Achieving Scale 2487**
Graham C. Stevens
Navigant Consulting, Inc., Burlington, MA, USA

Y9 727 **Modeling of Photovotaic Power Plants N/A**
Kevin P. Meagher, Brian Radibratovic, Silviu Darie
Power Analytics, San Diego, CA, USA

Y10 728 **Equipment Safety Standards for Semiconductor Tools Applicable to the Photovoltaic Industry 2490**
Andrew C. Rudack
SEMATECH/PVMC, Albany, NY, USA

3:30 - 5:00 PM **Exhibit Hall**

PV Job Fair

4:30 - 5:30 PM **Exhibit Hall**

IEC 40th Anniversary Reception and Ceremony

Established in 1972, the Institute of Energy Conversion (IEC) is celebrating its 40th anniversary. The hallmark of IEC's success has been the establishment of multidisciplinary core competencies to address R&D issues and the integration of industrial R&D needs with academic education and training. This has fostered a long history of contributions to the science and engineering of photovoltaics and the transfer of technology to the PV industry. Many concepts conceived at IEC during its 40 year history are now providing the foundation for the expanding PV industry. This reception and brief ceremony will highlight IEC's achievements.

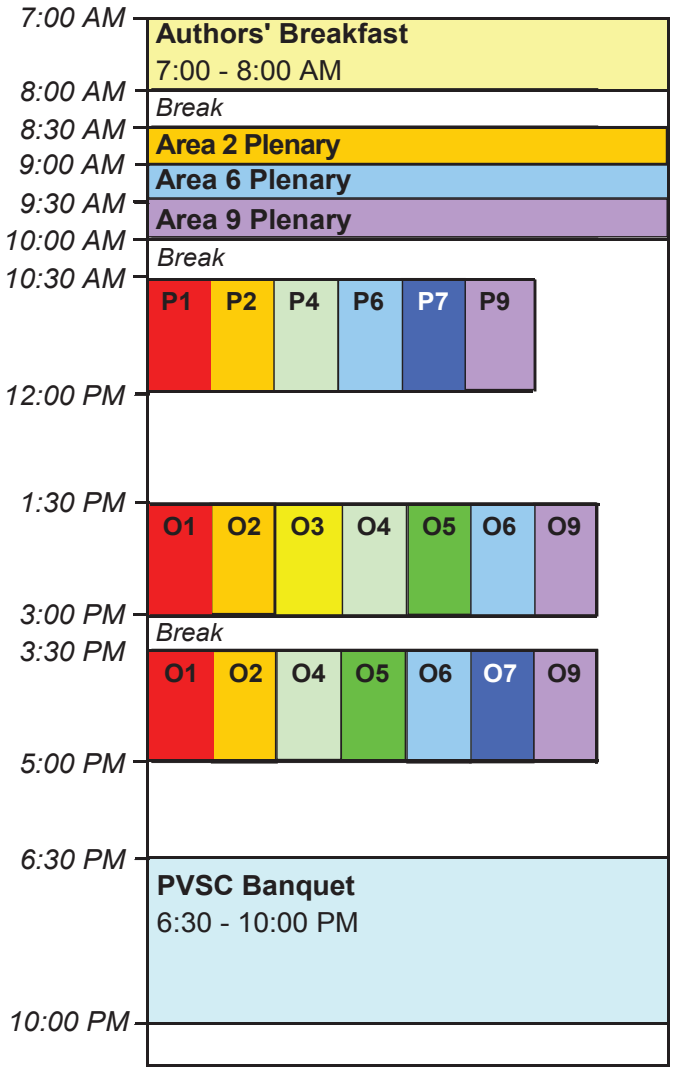
7:00 - 10:00 PM **Blrm G**

Area 1 Late Night Session

Chair(s): Ryne Raffaelle

The world premiere of "The Official Unofficial History of PV." We will debut a film of such monumental proportions that we are sure to garner serious academy consideration (disclaimer: not by any Academy of Science nor the Academy of Motion Picture Arts and Sciences). David Wilt of Albuquerque Times Daily proclaims "I have never witnessed anything quite like this in all my years in PV." Robert Walters of Northern Virginia Picayune writes "Congratulations David. Your review makes the most convincing argument for a sweeping overhaul of our public educational system I've read to date." B.J. Stanbery of the Austin Heckler writes "I must congratulate the filmmakers on their persistence! Most people would have given up and called someone competent long before finishing such a film." Don't miss this epic film which is guaranteed to change your life (no warrantees expressed or implied). Coming soon to a pirated DVD location near you.

THURSDAY PROGRAM SUMMARY



AREA LEGEND

- Area 1: Fundamentals and New Concepts for Future Technologies
- Area 2: Thin Film Polycrystalline Photovoltaics
- 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 Terrestrial Systems
- Area 10: PV Velocity Forum

O = Oral Session P = Poster Session

8:00 - 8:30 AM **4th Floor Foyer**

Coffee Break

8:30 - 9:00 AM **Blrm D**

Area 2: Polycrystalline Thin Films: Plenary

Chair(s): Markus Beck

8:30 729 **CIGS- and CdTe-Based Thin-Film PV Modules: An Industrial Revolution 2494**
Bernhard Dimmler
Manz AG, Schwaebisch Hall, Germany

9:00 - 9:30 AM **Blrm D**

Area 6: Organic Photovoltaics: Plenary

Chair(s): Dana Olson

9:00 730 **Efficient Organic Vacuum-Deposited Tandem Solar Cells and Modules on Glass and PET N/A**
Martin Pfeiffer
Heliatek GmbH, Dresden, Germany

9:30 - 10:00 AM **Blrm D**

Area 9: Modules and Systems: Plenary

Chair(s): Jennifer Granata

9:30 731 **PV System Reliability: An Operator's Perspective N/A**
Anastasios Golnas
SunEdison, Beltsville, MD, USA

10:00 - 10:30 AM **Exhibit Hall 4**

Coffee Break

10:30 - 12:00 PM **EH4-A**

Area 1: Fundamentals and New Concepts: Session 4 (Posters)

Chair(s): Annick Anctil, Chris Bailey, Seth Hubbard

A4
732 **Enhanced Photovoltaic Properties of a-C/Si Heterojunction Solar Cells 2500**
Sudip Adhikari[1], Dilip C Ghimire[1], Sunil Adhikary[2], Hideo Uchida[1], Koichi Wakita[1], Masayoshi Umeno[1]
[1]Chubu University, Kasugai, Japan, [2]Tribhuvan University, Kathmandu, Nepal

A8
733 **Performance of Luminescence Down-Shifting Layers as a Function of the Incident Solar Spectrum 2504**
Diego Alonso-Álvarez[1], David Ross[1], Keith R McIntosh[2], Bryce Richards[1]
[1]School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, United Kingdom, [2]PV Lighthouse, Coledale, Australia

A12
734 **Dye-Sensitized Solar Cell Application of Hexagonal-Shaped ZnO Nanotubes N/A**
Sadia Ameen, Minwu Song, Young Soon Kim, M. Shaheer Akhtar, Hyung-Shik Shin
Chonbuk National University, Jeonju, South Korea

A16
735 **Properties and Modeling of InGaN for High-Temperature Photovoltaics 2509**
Chris Boney[1,2], Rajeev Pillai[1,2], David Starikov[1,2], Abdelhak Bensaoula[3]
[1]Integrated Micro Sensors Inc, Houston, TX, USA, [2]Dept. of Physics, Univ. of Houston, Houston, TX, USA, [3]Depts. of Physics and Electrical and Computer Engineering, Univ. of Houston, Houston, TX, USA

A20
736 **Molecular Beam Epitaxy of n-Type ZnS: A Wide-Bandgap Emitter for Heterojunction PV Devices 2513**
Jeffrey Bosco, Faisal Tajdar, Harry Atwater
California Institute of Technology, Pasadena, CA, USA

A24
737 **Full-Spectrum Laterally-Arranged Multiple-Bandgap InGaN Solar Cells 2518**
Derek A Caselli, Cun-Zheng Ning
Arizona State University, Tempe, AZ, USA

A28
738 **Design Criteria for Nanostructured Omni-Directional Antireflection Coatings 2521**
Arvinder M Chadha[1], Weidong Zhou[1], Eric D Cline[2]
[1]University of Texas at Arlington, Arlington, TX, USA, [2]ZT Solar Inc., Dallas, TX, USA

B4
739 **Direct Liquid-Coated Cu_2SnS_3 as a New Absorber Material for Thin-Film Solar Cell N/A**
Tapas K Chaudhuri, Devendra Tiwari
Dr. K. C. Patel Research and Development Centre, Changa, India

B8 740 **$ZnSnN_2$: A New Earth-Abundant Element Semiconductor for Solar Cells 2524**

Nathaniel Feldberg[1], Benjamin Keen[1], James D. Aldous[1], David O. Scanlon[2], Patricia A. Stampe[3], Robin J. Kennedy[3], Roger J. Reeves[4], Timothy D. Veal[5], Steven M. Durbin[1,6]
[1]Dept of Physics, University at Buffalo, Buffalo, NY, USA, [2]Dept of Chemistry, University College London, London, United Kingdom, [3]Dept of Physics, Florida A&M University, Tallahassee, FL, USA, [4]Dept of Physics, University of Canterbury, Christchurch, New Zealand, [5]Stephenson Institute for Renewable Energy and Dept of Physics, University of Liverpool, Liverpool, United Kingdom, [6]Dept of Electrical Engineering, University at Buffalo, Buffalo, NY, USA

B12 741 **Si_3AlP: A New Promising Material for Solar Cell Absorber N/A**

Xingao Gong[1], Jihui Yang[1], Yingteng Zhai[1], Hengrui Liu[1], Hongjun Xiang[1], Suhuai Wei[2]
[1]MOE Laboratory for Computational Physical Sciences, Fudan University, Shanghai, China, [2]National Renewable Energy Laboratory, Colorado, CO, USA

B16 742 **Earth-Abundant Iron Oxysulfide (FeS_xO_y) for Bandgap Optimization 2528**

Xiaofei Han, Bin Zhou, Meng Tao
Arizona State University, Tempe, AZ, USA

B20 743 **The Effect of Tailoring Electron/Hole Blocking Layers on the Photovoltaic Performance of the Single-Junction Solar Cells 2533**

Ming-Han Hsieh[1], Yuh-Renn Wu[1], Jasprit Singh[2]
[1]National Taiwan University, Tapei, Taiwan, [2]University of Michigan, Ann Arbor, Ann Arbor, MI, USA

B24 744 **Dependence of Substrate Temperature of Cu_2ZnSnS_4 Thin Films Deposited by Radio-Frequency Sputtering Using Quaternary Cu_2ZnSnS_4 Target N/A**

Kuo-Min Huang[1], Meng-Chyi Wu[1,2*], I-Ping Chen[1], Yu-Ping Wang[1]
[1]Institute of Electronics Engineering, National Tsing Hua University, Hsinchu, Taiwan, [2]Institute of Photonics Technologies, National Tsing Hua University, Hsinchu, Taiwan

B28 745 **Solution-Processed Silicon Hybrid Heterojunction Photovoltaics with Silver Nanowires 2537**

Bo-Yu Huang[1], Hsiao-Wei Liu[1], Ting-Gang Chen[1], En-Chen Chen[2], Bo-han Chen[1], Ta-Yung Liu[3], Peichen Yu[1], Hsin-Fei Meng[4]
[1]Department of Photonic & Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Department of Electrical Engineering, National Tsing Hua University, Hsinchu, Taiwan, [3]Department of Materials engineering, Tatung university, Taipei, Taiwan, [4]Institute of Physics, National Chiao Tung University, Hsinchu, Taiwan

C4 746 **Fabrication of GaAsN Solar Cell by Chemical Beam Epitaxy with Improved Minority-Carrier Lifetime 2540**
Kazuma Ikeda, Makoto Inagaki, Nobuaki Kojima, Yoshio Ohshita, Masafumi Yamaguchi
Toyota Technological Institute, Nagoya, Japan

C8 747 **Bias-Dependent Admittance Measurement of GaInNAsSb-Based Solar Cell Structure 2543**
Muhammad M. Islam, Naoya Miyashita, Nazmul Ahsan, Yoshitaka Okada
Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan

C12 748 **Electrochemical Atomic Layer Deposition of a CdTe/PbTe Superlattice for the Absorber Layer of a Solar Cell 2548**
Amal Kabalan, Pritpal Singh
Villanova University, Villanova, PA, USA

C16 749 **The Plasmonics Electrodes Applied to Thin-Film Solar Cells N/A**
Andrzej Kołodziej, Witold Baranowski, Michał Kołodziej, Tomasz Kołodziej
AGH University of Science and Technology, Kraków, Poland

C20 750 **Fabrication of Hierarchical ZnO/TiO_2 Core-Shell Nanostructures for Advanced Photovoltaic Devices 2553**
Keyue Wu[1,2], Jingbiao Cui[1]
[1]University of Arkansas at Little Rock, Little Rock, AR, USA, [2]Anhui Univeristy, Hefei, China

C23 751 **Growth and *p*-Type Doping of Cuprous Oxide Thin-Fims for Photovoltaic Applications 2557**
Yun Seog Lee, Mark T. Winkler, Sin Cheng Siah, Yaron Segal, Riley Brandt, Tonio Buonassisi
Massachusetts Institute of Technology, Cambridge, MA, USA

C26 752 **Raman-Based Strategies for Improved Solar Cell Optics 2559**
Ping Lee[1], Komal Magsi[1], Som N. Dahal[2], Yeona Kang[1], C.M. Fortmann[1,2]
[1]Materials Science and Engineering Dept., Stony Brook University, Stony Brook, NY, USA, [2]Idalia Solar Technologies LLC, New York, NY, USA

D1 753 **Ag-Assisted Electrochemical Etching of Silicon for Antireflection in Large Area Crystalline Thin-Film Photovoltaics 2563**
Rui Li[1,2], Santhad Chuwongin[1], Shuling Wang[1], Weidong Zhou[1]
[1]University of Texas at Arlington, Arlington, TX, USA, [2]Dalian University of Technology, Dalian, China

D4
754 **Enhanced Graphene/Silicon Heterojunction Solar Cells with Work Function and Antireflection Optimization 2566**
Yuxuan Lin[1], Dan Xie[1], Hongwei Zhu[2,3]
[1]Tsinghua National Laboratory for Information Science and Technology (TNList), Institute of Microelectronics, Tsinghua University, Beijing, China, [2]Department of Mechanical Engineering, Tsinghua University, Beijing, China, [3]Center for Nano and Micro Mechanics, Tsinghua University, Beijing, China

D7
755 **Epitaxial Growth of (100) GaAs on CeO_x-Coated Flexible Metal Substrates 2571**
Akhil Mehrotra[1], Alex Freundlich[1], Venkat Selvamanickam[2], Renjie Wang[2], Senthil Sambandam[3]
[1]Center for Advanced Materials, University of Houston, Houston, TX, USA, [2]Department of Mechanical Engineering and Texas Center for Superconductivity, University of Houston, Houston, TX, USA, [3]SuperPower Inc., Schenectady, NY, USA

D10
756 **Equivalent Deflection Angle of Textured Surfaces 2575**
James R. Nagel, Michael A. Scarpulla
University of Utah, Salt Lake City, UT, USA

D12
757 **Exfoliated 15-micron Thin-Crystalline Germanium Heterojunction Solar Cells 2578**
Emmanuel U. Onyegam[1], Dabraj Sarkar[2], Mohamed H. Hilali[1], Sayah Saha[2], Rajesh A. Rao[2], Leo Mathew[2], Moses Ainom[2], Ricardo Garcia[1], Dharmesh Jawarani[2], Sanjay K. Banerjee[1]
[1]University of Texas-Austin, Austin, TX, USA, [2]AstroWatt Inc., Austin, TX, USA

D14
758 **Mechanism of Electrical Passivation of Si Surfaces with Quinhydrone 2583**
Robert L. Opila, Dan Yang, Nicole Kotulak, Luke Costello, Bhumika Chhabra
University of Delaware, Newark, DE, USA

D16
759 **Design Rules for Indoor Photovoltaic Cells 2588**
Karola Rühle[1,2], Stefan W. Glunz[2], Martin Kasemann[1,2]
[1]University of Freiburg, Freiburg, Germany, [2]Fraunhofer Institue for Solar Energy Systems, Freiburg, Germany

D18
760 **Single-Crystalline-Like Germanium Templates on Low-Cost, Flexible Substrates for High Efficiency Photovoltaics 2592**
Venkat Selvamanickam[1], Renjie Wang[1], Cao Jian[1], Goran Majkic[1], Eduard Galtsyan[1], Senthil Sambandam[2], Xuming Xiong[2]
[1]University of Houston, Houston, TX, USA, [2]SuperPower, Schenectady, NY, USA

D20
761 **The Effects of YAG:Ce Down-Conversion Phosphors on Solar Cells 2596**
Guojian Shao, Chaogang Lou
Southeast University, Nanjing, China

D22
762 **Growth and Characterization of Germanium-Carbide Films for Hot-Carrier Solar Cell Absorber 2601**
Santosh Shrestha, Neeti Gupta, Pasquale Aliberti, Gavin Conibeer
Photovoltaics Centre of Excellence, School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia

D24
763 **Low-Resistance Metal Contacts to Nitrogen-Doped Cuprous Oxide Thin Films 2605**
Sin Cheng Siah, Yun Seog Lee, Yaron Segal, Tonio Buonassisi
Massachusetts Institute of Technology, Cambridge, MA, USA

D26
764 **Review on Up/Down Conversion Materials for Solar Cell Application 2608**
Deepak Verma, Tor O. Sætre, Ole-Morten Midtgård
University of Agder, Grimstad, Norway

D28
765 **Application of a Graphene Buffer Layer for the Growth of High-Quality SnS Films on GaAs(100) Substrate 2614**
Wei Wang[1], Ka Kuen Leung[1], Wai Keung Fong[1], Shifeng Wang[1], Y.Y. Hui[2], Daniel Lau[2], Charles Surya[1]
[1]The Hong Kong Polytechnic University, Department of Electronic and Information Engineering, Hong Kong, China, [2]The Hong Kong Polytechnic University, Department of Applied Physics, Hong Kong, China

E2
766 **Prospects for In-Rich InGaN-Based Photovoltaics 2617**
Yuan Yao[1], James D. Aldous[2], Dongjin Won[3], Joan M. Redwing[3], Wojtek Linhart[4], Christopher F. McConville[4], Roger J. Reeves[5], Timothy D. Veal[6], Steven M. Durbin[1,2]
[1]Electrical Engineering, University at Buffalo, Buffalo, NY, USA, [2]Physics, University at Buffalo, Buffalo, NY, USA, [3]Materials Science and Engineering, The Pennsylvania State University, University Park, PA, USA, [4]Physics, University of Warwick, Coventry, United Kingdom, [5]Physics, University of Canterbury, Christchurch, New Zealand, [6]Physics, University of Liverpool, Liverpool, United Kingdom

E4
767 **Solution Processing of CdTe Nanocrystals for Thin-film Solar Cells 2621**
Woojun Yoon[1], Edward E. Foos[1], Matthew P. Lumb[1,2], Joseph G. Tischler[1]
[1]U.S. Naval Research Laboratory, Washington, DC, USA, [2]School of Engineering and Applied Science, The George Washington University, Washington, DC, USA

E5
768 **Silver Nanoparticles Incorporated in Aluminum-Doped ZnO for Heterojunction Solar Cells 2625**

Juhyung Yun[1], Eric Kozarsky[1], Joondong Kim[2], Hossein Shokri Kojori[3], Sung Jin Kim[3], Chong Tong[1], Jun Wang[1], Wayne A. Anderson[1]
[1]University at Buffalo, Buffalo, NY, USA, [2]Korea Institute of Machinery and Materials (KIMM), Daejeon, Korea, [3]University of Miami, Coral Gables, FL, USA

10:30 - 12:00 PM **EH4-B**

Area 2: Polycrystalline Thin Films: Absorber Formation and Characterization 2 (Posters)

Chair(s): Rommel Noufi, Tokio Nakada, Marcus Bär

E9
769 **Preparation of Micro-Flake Ink for Low-Cost Printing of CIS-Se absorber layers 2628**

Armin E. Zaghi[1], Guy Brammertz[2], Kim Vanmeensel[1], Marc Meuris [2], Jef Poortmans[2], Jef Vleugels[1]
[1]Department of Metallurgy and Materials Engineering, Katholieke Universiteit Leuven, Leuven, Belgium, [2]imec, Heverlee, Belgium

E13
770 **Non-Hydrazine Solution-Processed $CuIn(Se,S)_2$ Photovoltaic Device 2632**

Huanping Zhou, Chia-Jung Hsu, Wan-Ching Hsu, Yang Yang
Department of Materials Science and Engineering, University of California Los Angeles, Los Angeles, CA, USA

E17
771 **Selenization of CIS and CIGS Layers Deposited by Spray Pyrolysis N/A**

B. J. Babu[1], B. Egaas[2], S. Velumani[1], R. Asomoza[1]
[1]Department of Electrical Engineering-SEES, CINVESTAV-IPN, Zacatenco, Mexico, Mexico, [2]National Renewable Energy Laboratory, Golden, CO, USA

E21
772 **Preparation and Characterization of Electrodeposited $CuInSe_2$ Thin Films on Flexible Substrates for Solar Cell Applications 2636**

M. Estela Calixto[1], Samuel De la Luz-Merino[1], Antonio Mendez-Blas[1], Bernabe Mari-Soucase[2]
[1]Instituto de Fisica, Benemerita Universidad Autonoma de Puebla, Puebla, Mexico, [2]Departament de Fisica Aplicada-IDF, Universidad Politecnica de Valencia, Valencia, Mexico

E25
773 **Molecular Precursor Species and Their Effects on the Energy Bandgap of Hydrazine Solution Processed $CuIn(S,Se)_2$ Films 2640**

Choong-Heui Chung[1,2], Bao Lei[1,2], Brion Bob[1,2], Hsin-Sheng Duan[1,2], Sheng-Han Li[1,2], William W. Hou[1,2], Wenbing Yang[1,2], Yang Yang[1,2]
[1]Department of Materials Science and Engineering, University of California Los Angeles, Los Angeles, CA, USA, [2]California NanoSystems Institute, University of California Los Angeles, Los Angeles, CA, USA

F1
774 **Investigation of Na Out-Diffusion and Structural Properties of IGS Thin Film During Three-Stage Growth Process of CIGS Thin Film N/A**

Hamda A. Al-Thani, Falah S. Hasoon
National Energy & Water Research Center, Abu Dhabi, United Arab Emirates

F5
775 **Control of Na Diffusion from Soda-Lime Glass and NaF Film into $Cu(In,Ga)Se_2$ for Thin-Film Solar Cells N/A**

Dae-Hyung Cho[1], Yong-Duck Chung[1,2], Kyu-Seok Lee[1], Ju-Hee Kim[1,2], Soo-Jeong Park[1,2], Jeha Kim[1,2]
[1]Electronics and Telecommunications Research Institute, Daejeon, Korea, [2]University of Science and Technology, Daejeon, Korea

F9
776 **Phase Separation in $Cu(In,Ga)Se_2$ Photovoltaic Absorber Film Due to Post-Deposition Na Treatment N/A**

Chan-Wook Jeon[1], Woo-Nam Kim[1], Kyoung-Bo Kim[2], Jung-Min Cho[3], Ki-Bong Song[3], Soo-Hyun Kim[1]
[1]Yeungnam University, Gyeongsan, Korea, [2]POSCO, Incheon, Korea, [3]ETRI, Daejeon, Korea

F13
777 **Investigation of Sodium Effects on CIGS Thin Films Deposited by Sputtering from a Single Quaternary Target 2644**

Yue-Shun Su[1], Chia-Hao Hsu[1], Chia-Hsiang Chen[1], Yan-Huei Wu[1], Wen-Chieh Shih[1], Chih-Huang Lai[1,2]
[1]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan, [2]Low Carbon Energy Research Center, Tsing Hua University, Hsinchu, Taiwan

F17
778 **Quantitative Elemental Analysis of Photovoltaic $Cu(In,Ga)Se_2$ Thin Films Using MCs^+ Clusters 2647**

Kai Kaufmann, Stefanie Wahl, Sylke Meyer, Christian Hagendorf
Fraunhofer Center for Silicon Photovoltaics CSP, Halle (Saale), Germany

F21 779 **Vertically Aligned $CuInSe_2$ Nanowire Arrays on Titanium Coated Glass Substrates for Photovoltaic Applications 2650**
Bhavananda R. Nadimpally[1], Sai Guduru[1], Raghu Mangu[2], Suresh Rajaputra[1], Vijay P. Singh[1]
[1]Department of Electrical and Computer Engineering and Center for Nanoscale Science and Engineering (CeNSE), University of Kentucky, Lexington, KY, USA, [2]International Rectifier Corporation, El Segundo, CA, USA

F25 780 **Grain Growth Enhancement of Selenide CIGSe Nanoparticles to Densified CIGSe Films Using Copper Selenide Additives 2654**
Bryce C. Walker, Steven M. McLeod, Rakesh Agrawal
Purdue University, West Lafayette, IN, USA

G1 781 **Band Alignment Limitations and Light-Soaking Effects in CZTSSe and CZTGeSSe 2658**
Charles J. Hages[1], James Moore[2], Sourabh Dongaonkar [2], Muhammad A. Alam[2], Mark S. Lundstrom[2], Rakesh Agrawal[1]
[1]Dept. of Chemical Engineering, Purdue University, West Lafayette, IN, USA, [2]Dept. of Electrical and Computer Engineering, West Lafayette, IN, USA

G5 782 **Novel Solution Processing of High-Efficiency Earth-Abundant CZTSSe Solar Cells 2664**
Wenbing Yang[1,2], Hsin-Sheng Duan[1,2], Brion Bob[1,2], Sheng-Han Li[1,2], Yang Yang[1,2]
[1]Department of Materials Science and Engineering,University of California Los Angeles, Los Angeles, CA, USA, [2]California NanoSystems Institute, Los Angeles, CA, USA

G9 783 **Low-Cost Cu_2ZnSnS_4 Thin Films for Large-Area High-Efficiency Heterojunction Solar Cells 2668**
Sandip Das, Krishna C. Mandal
University of South Carolina, Columbia, SC, USA

G13 784 **Comparison of Cu_2ZnSnS_4 Thin-Film Properties Prepared by Thermal Evaporation of Elemental Metals and Binary Sulfide Sources 2674**
Sandip Das, Krishna C. Mandal
University of South Carolina, Columbia, SC, USA

G17 785 **Preparation of 4.8%-Efficiency $Cu_2ZnSnSe_4$-Based Solar Cell by a Two-Step Process 2679**
Andrew Fairbrother[1], Edgardo Saucedo[1], Xavier Fontané[1], Victor Izquierdo-Roca[1], Diouldé Sylla[1], Moisés Espindola-Rodriguez[1,2], Fabián A. Pulgarín[3], Osvaldo Vigil-Galán[2], Alejandro Pérez-Rodríguez[1,4]
[1]Catalonia Institute for Energy Research (IREC), Barcelona, Spain, [2]Escuela Superior de Física y Matemáticas (ESFM), IPN, México DF, Mexico, [3]Centro de Investigación en Energía-UNAM, Temixco, Morelos, Mexico, [4]IN2UB, Departament d'Electrònica, Universitat de Barcelona, Barcelona, Spain

G21 786 **Carrier Transport and Low-Temperature Device Properties of $Cu_2ZnSnSe_4$ Thin Films with Different Cu and Zn/Sn Ratio 2685**
Ah Reum Jeong[1], William Jo[1], Jin Woo Lee[2], Jin Young Kim[3]
[1]Department of Physics, Seoul, Korea, [2]Solar Cell Business Dept./Product Development Gr., LG Innotek, Osan-City, Korea, [3]Solar Cell Center, Energy Division, Korea Institute of Science and Technology (KIST), Seoul, Korea

G25 787 **Growth of $Cu_2ZnSnSe_4$ Thin Films by Selenization of Magnetron-Sputtered Precursors for Solar Cells 2688**
Shou-Yi Kuo[1], Jui-Fu Yang[1,2], Fang-I Lai[2], Chun-Jung Lin[3]
[1]Department of Electronic Engineering, Chang Gung University, Tao-Yuan, Taiwan, [2]Department of Photonics Engineering, Yuan-Ze University, Chung-Li, Taiwan, [3]Solar Applied Materials Technology Corp., Tainan, Taiwan

H1 788 **The Nanocomposite Synthesis and Characterization of Kesterite Cu_2ZnSnS_4 (CZTS) for Photovoltaic Applications N/A**
Elizabeth K. Michael, Danielle Norcini, Jeffrey R.S. Brownson
The Pennsylvania State University, University Park, PA, USA

H4 789 **Optical Determination of Phase Composition and Processing Effects on $Cu_2ZnSnSe_4$ Film Quality and Device Performance 2692**
D. L. Morel, C. S. Ferekides, S. Bendapudi, Y. Wang
University of Sout Florida, Tampa, FL, USA

H6 790 **CdS Nanowire Layers of Enhanced Transmittance for Window Layer Applications in Thin-Film Solar Cells 2697**
Hongmei Dang, Vijay Singh, Suresh Rajaputra, Jianhao Chen, Sai Guduru, Nandu Reddy
Department of Electrical and Computer Engineering, University of Kentucky, Lexington, KY, USA

H7 791 **$Cu_2ZnSn(S,Se)_4$ Thin Film Prepared from a Single-Step Electrodeposited Cu-Zn-Sn-Se Precursor 2702**
Wilman Septina, Shigeru Ikeda, Akio Kyoraiseki, Takashi Harada, Michio Matsumura
Research Center for Solar Energy Chemistry, Osaka University, Osaka, Japan

H8 792 **Properties of $CuInSe_2$ Thin Films Using Multi-Stage Process by Metalorganic Chemical Vapor Deposition N/A**
Seong Man Yu[1], Gwang Soo Lim[1], Arun Khalkar[1], Ji-Beom Yoo[1,2]
[1]Sungkyunkwan Advanced Institute of Nanotechnology(SAINT), Sungkyunkwan University, Suwon, South Korea, [2]Department of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon, South Korea

10:30 - 12:00 PM **EH4-C**

Area 4: Crystalline Silicon: Feedstock, Crystallization, and Wafering (Posters)

Chair(s): Jim Rand

I27 793 **An Effective Doping Model to Prevent Earlier Breakdown of Upgraded Metallurgical-Grade Silicon Solar Cell N/A**
Ya-Wen Chang, Jui-Chen Pu, Liang Wenglin, Yu-Chung Chen, Chih-Hsyong Wu
Motech Industries, Inc., Tainan, Taiwan

J3 794 **Quality Investigation of B-Doped CZ-Silicon Using Multiple Recharges Process N/A**
Wen-Pin Chen, Yu-Hou Wu, Hung-Pang Chou, Yu-Chung Chen, Chih-Hsyong Wu, Wen-Tai Chung
Motech Industries, Inc, Tainan, Taiwan

J7 795 **A Bilayer Passivation Structure with Good Reflectance for Silicon Solar Cell N/A**
Yi-Fan Chen[1], Chia-Ling Yang[1,2], Tai-Jui Wang [1], Chia-Liang Sun[1], Sheng-Min Yu[1], Wen-Ching Sun[1], Tzer-Shen Lin[1], Fu-Ron Chen [2]
[1]Material & Chemical Research Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan, [2]Department of Engineering and System Science Center for Transmission Electron Microcopy, National Tsing Hua University, Hsinchu, Taiwan

J11 796 **Enhancement of Crystal Growth Rate by a 22-Inch Hot-Zone Modification and CZ Recipe Adjustment N/A**
Wen-Tai Chung, Yu-Hou Wu, Hung-Pang Chou, Chih Hsyong Chen, Wen-Pin Chen
Motech Industries, Inc., Tainan, Taiwan

J15 797 **Fracture Strength Analysis of Slurry Cut mc-Si Wafers 2707**
Chris Yang[1], Shreyes Melkote[1,2], Steven Danyluk[2], Mike Seacrist[3]
[1]Manufacturing Research Center, Georgia Institute of Technology, Atlanta, GA, USA, [2]G.W.W School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA, [3]MEMC Electronic Materials, St. Peters, MO, USA

J19 798 **The Study of Metallurgical Refining Silicon by Using Directional Solidification for Photovoltaic System 2712**
Eun-Su Jang[1], Dongho Park[1], Tae U Yu[1], Byung Moon Moon[2]
[1]Energy System R&D Group, Korea Institute of Industrial Technology, Hongcheon-Ri, Ipjang-Myeon, Seobuk-Gu, Cheonan-Si, Chungcheongnam-Do, Korea, [2]Production Technology R&D Division, Liquid Processing & Casting Technology R&D Department, Korea Institute of Industrial Technology, Songdo-Dong, Yeonsu-Gu, Incheon, Korea

J23 799 **Filtration of Waste Coolants from Fixed-Abrasive Wire Sawing and Recycle of Retrieved Silicon Powders for Feedstock 2716**
Shohei Miki, Norihisa Iio, Sho-ichi Taniguchi, Hiroshi Satone, Koji Arafune
University of Hyogo, Himeji, Japan

J27 800 **Modeling and Laboratory-Scale Proof of Concept of the Horizontal Ribbon Growth Process: Application to Silicon Wafer Manufacturing 2720**
German A. Oliveros, Ray Wang, Sridhar Seetharaman, B. Erik Ydstie
Carnegie Mellon University, Pittsburgh, PA, USA

K3 801 **Analysis of Saw Damages of Monocrystalline Slurry-Sawn Si Wafers by Raman Spectroscopy 2723**
Marion Radet, Perine Jaffrennou, Nada Habka, Julien Penaud, Benoît Lombardet
Total Gas & Power - R&D Division, Paris, France

K7 802 **Growth of Multicrystalline Silicon Ingot from the Top of the Melt: Control of Microstructures and Reduction of Stress 2728**
Noritaka Usami[1], Wugen Pan[1], Satoru Matsushima[1], Kazuo Nakajima[2], Haruna Watanabe[1]
[1]Tohoku University, Sendai, Japan, [2]Kyoto University, Kyoto, Japan

K11 803 **Fabrication of an Ultrathin Silicon Wafer with Honeycomb Structure by Thermal-Stress Induced Pattern Transfer (TIPT) Method 2731**
Teng-Yu Wang[1], Chien-Hsun Chen[1], Chen-Hsun Du[1,2], Chung-Yuan Kung[3]
[1]Green Energy and Environment Research Labs, Industrial Technology Research Institute, Hsinchu, Taiwan, [2]Institute of NanoEngineering and MicroSystems, National Tsing Hua University, Hsinchu, Taiwan, [3]Department of Electrical Engineering, National Chung-Hsing University, Taichung, Taiwan

K15 804 **Dependence of Si-Faceted Dendrite Growth Orientation on Twin Spacing and Undercooling N/A**
Xinbo Yang[1,2], Kozo Fujiwara[1], Satoshi Uda[1]
[1]Institute for Materials Research (IMR), Tohoku University, Sendai, Japan, [2]Research School of Engineering, College of Engineering and Computer Science, The Australian National University, Canberra, Australia

K19 805 **The Characteristics of Sub-Grains in the Mono-Like Silicon Crystals Grown with Directional Solidification Method 2735**
Tao Zhang, Dongli Hu, Liang He, Dejing Zhong, Xuewen Huang, Yuepeng Wan
LDK Solar Co. Ltd., Xinyu, Jiangxi, China

K23 806 **Light-Induced Degradation in Upgraded Metallurgical-Grade Silicon Solar Cells 2739**
Kamel Ounadjela[1], Omar Sidelkheir[1], Chun-sheng Jiang[2], Mowafak Al-Jassim[2]
[1]Calisolar Inc., Sunnyvale, CA, USA, [2]NREL, Golden, CO, USA

10:30 - 12:00 PM **EH4-D**

Area 6: Organic Photovoltaics: OPV Materials and Devices (Posters)

Chair(s): Erin Ratcliff, Barry Rand

P7
807 **A Mathematical Model for the Fabrication of Thin-Film Photovoltaic Solar Cells 2744**
Morteza Eslamian
Texas A&M University-Corpus Christi, Corpus Christi, TX, USA

P9
808 **Analysis of Light Intensity Dependence of Organic Photovoltaics: Towards Efficient Large-Area Solar Cells 2750**
Yulia Galagan[1], Assaf Manor[2], Ronn Andriessen[1], Eugene A. Katz[2]
[1]Holst Centre, Eindhoven, Netherlands, [2]Ben-Gurion University of the Negev, Sede Boker Campus, Israel

P11
809 **The Novel Organic Photovoltaic Cell Using Interlayer for Hole-Electron Separation 2753**
You Hyun Kim[1], Sang Youn Lee[2], Nam Ho Kim[1], C.-B. Moon[1], Chul Gyu Jhun[1], Woo Young Kim[1,3]
[1]Department of Green Energy & Semiconductors, Hoseo University, Asan, Korea, [2]Semiconductor Display Engineering, Hoseo University, Asan, Korea, [3]Department of Engineering Physics, McMaster University, Hamilton, ON, Canada

P13
810 **Photocurrent Transients in Polymer-Fullerene Bulk Heterojunction Organic Solar Cells 2756**
Lijun Li[1,3], Kejia Li[1,3], Petr Khlyabich[2,3], Beate Burkhart[2,3], Barry Thompson[2,3], Joe Campbell[1,3]
[1]University of Virginia, Charlottesville, VA, USA, [2]University of Southern California, Los Angeles, CA, USA, [3]Center for Energy Nanoscience, Los Angeles, CA, USA

P15
811 **Morphologic Improvement of the P3HT:Indene-C60 Bis-Adduct (ICBA) Blend Film with Mixed Solvent in Inverted Polymer Solar Cells 2761**
Shang-Hong Lin[1], Ching-Fuh Lin[1,2], Shiang Lang[1], Jen-Yu Sun[1]
[1]Graduate Institute of Photonics and Optoelectronics,National Taiwan University, Taipei, Taiwan, [2]Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan

P17 812 **Fabrication and Characterization of MEH-PPV-Based Bulk-Heterojunc tion Solar Cell Using Spray-Deposited Indium Sulfide Electron Selective Layer 2764**

M. R. Rajesh Menon [1], M. V. Maheshkumar[2], K. Sreekumar[2], C. Sudha Kartha[1], K. P. Vijayakumar[1]
[1]Department of Physics, Cochin University of Science and Technology, Cochin, India, [2]Department of Applied Chemistry, Cochin University of Science and Technology, Cochin, India

P19 813 **Study the S-Shape Behavior of Illuminated IV in Bilayer Organic Solar Cells N/A**

Seyyed Sadegh Mottaghian, Mahdi Farrokh Baroughi
South Dakota State University EECS department, Brookings, SD, USA

P21 814 **Investigation of Electrical Characteristics of P3HT:PCBM Organic Solar Cells 2770**

Yang Shen, Mool C. Gupta
University of Virginia, Department of Electrical and Computer Engineering, Charlottesville, VA, USA

P23 815 **Influence of Squaraine Aggregation on Short-Circuit Current and Device Efficiency 2775**

Susan D. Spencer[1], Victor Murcia[1], Obadiah Reid[2], Garry Rumbles[2], Kevin Belfield[3], Christopher Collison[1]
[1]Rochester Institute of Technology, Rochester, NY, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]University of Central Florida, Orlando, FL, USA

P25 816 **Effect of Post-Annealing Treatment on the Contact Resistance of Small Molecule Solar Cells 2780**

Jiaqi Wu[1,2], Wenjuan Wu[1,2], Xi Xi[2,3], Zhenjiao Wang[1,2], Hongqiang Qian[1,2], Guangyao Jin[1,2], Haidong Zhu[1,2], Hongyan Lu[1,2], Jian Yang[1,2], Jingjia Ji[1,2], Guangchun Zhang[1,2], Zhengrong Shi[1,2], Guohua Li[2,4]
[1]Suntech Power Corp., Ltd, Wuxi, China, [2]Jiangsu (Suntech) Institute for Photovoltaic Technology, Wuxi, China, [3]School of Internet of Things, Jiangnan University, Wuxi, China, [4]School of Science, Jiangnan University, Wuxi, China

P26 817 **Gold Nanoclusters Decorated Multilayer Graphene as Transparent Electrodes for Polymer Solar Cells N/A**

Di Zhang[1], Wallace C.H. Choy[1], Hongwei Zhu[2,3]
[1]Department of Electrical and Electronic Engineering, the University of Hong Kong, Hong Kong, Hong Kong, [2]Key Laboratory for Advanced Manufacturing by Materials Processing Technology, Department of Mechanical Engineering, Tsinghua University, Beijing, China, [3]Center for Nano and Micro Mechanics, Tsinghua University, Beijing, China

P27 818 **11.3%-Efficient Planar Si-PEDOT:PSS Hybrid Solar Cell with a Thin Interfacial Oxide 2785**
Lining He[1,2,3], Changyun Jiang[2], Hao Wang[1,3], Lei Hong[1], Donny Lai[1,3], N.A. Rusli[1,3]
*[1]School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, Singapore, [2]Institute of Materials Research and Engineering, A*STAR, Singapore, Singapore, [3]CINTRA CNRS/NTU/THALES, Singapore, Singapore*

10:30 - 12:00 PM **EH4-E**

Area 7: Space Technologies: Space PV Technologies (Posters)

Chair(s): Bao Hoang, David Wilt

P28 819 **Evolution of a 2.05 eV AlGaInP Top Subcell for 5J-IMM and 6J-IMM Applications 2788**
Arthur B. Cornfeld, Pravin Patel, John Spann, Daniel Aiken, James McCarty
Emcore Photovoltaics, Alburquerque, NM, USA

Q1 820 **Strain Effects on Radiation Tolerance of Quantum Dot Solar Cells 2792**
Christopher Kerestes[1], David V. Forbes[1], Zac Bittner[1], Stephen Polly[1], Yong Lin[2], Benjamin Richards[2], Paul Sharps[2], Seth M. Hubbard[1]
[1]NanoPower Research Labs, RIT, Rochester, NY, USA, [2]Emcore Photovoltaics, Albuquerque, NM, USA

Q2 821 **Bandgap Optimization of Lattice-Matched Triple-Junction Solar Cells by Incorporation of InAs Quantum Dots 2797**
Benjamin C. Richards[1], Yong Lin[1], Pravin Patel[1], Daniel Chumney[1], Paul R. Sharps[1], Chris Kerestes[2], David Forbes[2], Kristina Driscoll[2], Seth Hubbard[2]
[1]Emcore Corporation, Albuquerque, NM, USA, [2]Nanopower Research Labs, Rochester Institute of Technology, Rochester, NY, USA

Q3 822 **Improved Electrical Properties of Direct Wafer-Bonded GaAs/InP Interfaces for III-V Multijunction Solar Cells N/A**
Lijie Sun, Mengyan Zhang, Wei Zhang, Kaijian Chen, Xin Fang, Chuanming Xu, Yang Yang, Wencan Zhou
Center for Photovoltaic Engineering, Shanghai Institute of Space Power Sources, Shanghai, China

Q4 823 **Radiation Effect Models in Solar Cells – Comparison of Simulations with Experimental Data 2801**
Alexander Fedoseyev[1], Timothy Bald[1], Marek Turowski[1], Ashok Raman[1], Cory Cress[2], Robert Walters[2], Seth M. Hubbard[3]
[1]CFDRC, Huntsville, AL, USA, [2]NRL, Washington, DC, USA, [3]RIT, Rochester, NY, USA

Q5 824 **Semi-Transparent Photovoltaic Devices for Smart Window Applications 2807**
Soo Kim[1], Yu Nung Huang[1], F. Ameena[1], David Hoffman[2], Michael H.-C. Jin[1], Kulbinder K. Banger[3], David A. Scheiman[4], Lyndsey B. McMillon[5], Jeremiah S. McNatt[5]
[1]Department of Materials Science and Engineering, University of Texas, Arlington, TX, USA, [2]Department of Mechanical and Aerospace Engineering, University of Texas, Arlington, TX, USA, [3]University of Cambridge, Cambridge, United Kingdom, [4]Ohio Aerospace Institute, Cleveland, OH, USA, [5]NASA Glenn Research Center, Cleveland, OH, USA

Q6 825 **The 8-Year Effort to Address Systems-Level Space Solar Power Issues for U.S. Government Satellite Programs 2811**
Brad Reed
Industrial Base and Critical Technologies Manager, Space and Missile Systems Center, Los Angeles Air Force Base, Los Angeles, CA, USA

Q7 826 **Optimization of the Photovoltaic-Powered Systems with Dust-Mitigation Technology for Future Lunar and Martian Missions 2815**
Nicoleta Sorloaica-Hickman[1], Judith McFall [2], Steven Nason [1], Kris Davis[1], Ellen Arens[3]
[1]Florida Solar Energy Center, Cocoa, FL, USA, [2]ASRC Aerospace Corporation, Titusville, FL, USA, [3]Kennedy Space Center, Cape Canaveral, FL, USA

Q8 827 **Non-Solar Photovoltaics for Small Space Missions 2819**
Geoffrey A. Landis[1], Sheila G. Bailey[1], Eric B. Clark[1], Matthew G. Myers[1], Michael F. Piszczor[1], Marcus S. Murbach[2]
[1]NASA Glenn Research Center, Cleveland, OH, USA, [2]NASA Ames Research Center, Moffett Field, CA, USA

Q9 828 **Development of a Laser Power Beaming Experiment 2825**
Henry W. Brandhorst[1], Marcus D. Smith[2], Brian Tillotson[3], Jeffrey Oliver[4], Nicholas Tarasenko[5], Thomas Schoelzel[6]
[1]Carbon-Free Energy, LLC, Auburn, AL, USA, [2]AFRL Tyndall Air Force Base, Panama City, FL, USA, [3]Boeing Co., Seattle, WA, USA, [4]AFRL/RHDO, Brooks City Base, TX, USA, [5]AFRL/RDTA, Albuquerque, NM, USA, [6]s Diode Laser, Inc, Tucson, AZ, USA

Q10 829 **Innovative Technologies on Proton Irradiation Tests for Space Solar Cells 2831**
Mitsuru Imaizumi[1], Yosuke Yuri[2], Shin-ichiro Sato[2], Takeshi Ohshima[2], Paul Bolton[3]
[1]JAXA, Tsukuba, Japan, [2]JAEA, Takasaki, Japan, [3]JAEA, Kizugawa, Japan

Q11 830 **Increasing the TRL Level of New PV Technologies Using Modular Solar Panels 2835**
Theodore G. Stern[1], Nicholas Walmsley[1], David M. Wilt[2]
[1]Vanguard Space Technologies, San Diego, CA, USA, [2]Air Force Research Laboratories, Kirtland AFB, NM, USA

Q12 831 **Solar Cell Short Circuit Current Errors and Uncertainties During High Altitude Calibrations 2840**
David B. Snyder
NASA Glenn Research Center, Cleveland, OH, USA

Q13 832 **Change in I-V Characteristics of Subcells in a Multijunction Solar Cell Due to Radiation Irradiation 2846**
Tetsuya Nakamura[1], Mitsuru Imaizumi[1], Takeshi Ohshima[2]
[1]Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan, [2]Japan Atomic Energy Agency (JAEA), Takasaki, Japan

Q14 833 **Aquarius/SAC-D Mission: Telemetry Data Analysis for the First Year 2851**
Elena M. Godfrin, Igor Prario, Julio C. Duran
Comision Nacional de Energia Atomica, San Martin, Argentina

Q15 834 **Degradation Behavior of Flexible a-Si/a-SiGe/ a-SiGe Triple-Junction Solar Cells Irradiated with 20-350keV Protons 2856**
Shin-ichiro Sato[1], Kevin Beernink[2], Takeshi Ohshima[1]
[1]Japan Atomic Energy Agency, Gunma, Japan, [2]United Solar Ovonic LLC, Troy, MI, USA

Q16 835 **In Situ Control Over Ge(100):As Dimer Orientation in Vapor Phase Epitaxy Ambient N/A**
Sebastian Brueckner[1,2], Enrique Barrigón[3], Oliver Supplie[1], Peter Kleinschmidt[1,4], Johannes Luczak[1], Ignacio Rey-Stolle[3], Henning Doescher[1,2], Thomas Hannappel[1,2,4]
[1]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, [2]Ilmenau University of Technology, Ilmenau, Germany, [3]Instituto de Energía Solar, Madrid, Spain, [4]CiS Research Institute, Erfurt, Germany

Q17 836 **Experimental Research of GaAs Photovoltaic Converter to Transform Infrared Laser Radiation for Wireless Electric Power Transmission N/A**
Olga Zayats[1], Vjacheslav Tugaenko[1], Marlen Kagan[2], Boris Zhalnin[2]
[1]S.P. Korolev RSC «Energia», Korolev, Russia, [2]OJSC RPE «KVANT», Moscow, Russia

Q18 837 **Mirrors in Space for Low-Cost Terrestrial Solar Electric Power at Night 2862**
Lewis M. Fraas
JX Crystals Inc., Issaquah, WA, USA

Q19 838 **Dry-Epitaxial Lift-off, Integration, Interconnect and Encapsulation of Foldable/Rollable High Efficiency Solar Cell Modules 2868**
John Farah
OptiCOMP Networks, Attleboro, MA, USA

10:30 - 12:00 PM **EH4-F**

Area 9: Modules and Systems: Irradiance Resources, PV Modeling, and Off-Grid Applications (Posters)

Chair(s): Dan Riley, Cliff Hansen, Alma Cota

T11 839 **Experiences with Back-up PV System for Remote Rescue Application 2874**
Kun-Lung Yen[1], Mao-Ting Huang[1], Chiou-Jye Huang[1], Ming-Sian R. Bai[2]
[1]Industrial Technology Research Institute, Hsinchu County, Taiwan, [2]National Tsing Hua University, Hsinchu City, Taiwan

T15 840 **New Jersey International & Network Distribution Center (NJNDC) Field Testing Solar Powered Location Sensors for the Yard Management System 2880**
Dilip. A. Pandya[1], John C. Yochum[1], Ronald R. Regan[2], Robert C. Corson[2]
[1]US Postal Service-NJINDC, Jersey City, NJ, USA, [2]Triad Consulting Engineers, Inc., Morris Plains, NJ, USA

T19 841 **Water Densalination System Powered by Solar Energy N/A**
Gayane Minasyan[2], Karen Ayvazyan[1], Artak Barseghyan[2]
[1]Engineering Academy, Yerevan, Armenia, [2]EcoAtom Co., Yerevan, Armenia

T23 842 **Intelicell, Hybrid Photovoltaic System for Energy Support 2883**
Johann A. Hernández[1,4], Johan S. Patiño[1,2,4], Miguel A. Moreno[3]
[1]Facultad de Ingeniería, Universidad Distrital Francisco José de Caldas, Bogota, Columbia, [2]Especialización en Planeamiento Energético, Universidad Autónoma de Colombia, Bogota, Columbia, [3]ASSYCE Group, Granada, Spain, [4]Smart green Colombia, Bogota, Columbia

U3 843 **Selection of Photovoltaic Modules for Off-Grid Rural Application Based on Analytical Hierarchy Process (AHP) 2888**
Vivek Kuthanazhi, Anand B. Rao
Centre for Technology Alternatives for Rural Areas, Indian Institute of Technology Bombay, Mumbai, India

U7 844 **Assessment of Photovoltaic Systems for Schools in Kuwait N/A**
Ahmad H. Alotaibi, Ahmad Almulla
Kuwait Institute for Scientific Research, Shuwaikh, Kuwait

U11 845 **Optimization of Commercial Rooftop PV Systems in the Continental United States Using Angle-and-Wavelength-Resolved Solar Irradiance Data 2894**
Bowen Zhou[1], Cheng Zheng[2], Costas P. Grigoropoulos[2]
[1]Department of Civil and Environmental Engineering, University of California, Berkeley, CA, USA, [2]Department of Mechanical Engineering, University of California, Berkeley, CA, USA

U15 846 **Comparison of Pyranometers vs. PV Reference Cells for Evaluation of PV Array Performance 2899**
Lawrence Dunn, Michael Gostein
Atonometrics, Inc., Austin, TX, USA

U19 847 **Design and Implementation of Sun Tracker Prototype for Solar Module Positioning 2905**
Carlos A. Arredondo, Fabian Pineda
Universidad Antonio Nariño, Facultad de Ing. Electrónica, Grupor REM, Bogotá D.C., Columbia

U23 848 **Design of a Low-Cost Irradiance Meter Using a Photovoltaic Panel 2911**
Eduardo I. Ortiz-Rivera, Joel Cruz-Colon, Luis R. Martinez-Mitjans
University of Puerto Rico-Mayaguez, Mayaguez, PR, USA

V3 849 **Biharmonic Spline Interpolation for Solar Radiation Mapping Using Puerto Rico as a Case of Study N/A**
Eduardo I. Ortiz-Rivera, Luisa I. Feliciano
University of Puerto Rico-Mayaguez, Mayaguez, PR, USA

V7 850 **Online Tuned Neural Networks for PV Plant Production Forecasting 2916**
Lucio Ciabattoni[1], Gianluca Ippoliti[1], Massimo Grisostomi[1], Sauro Longhi[1], Emanuele Mainardi[2]
[1]Università Politecnica delle Marche, Ancona, Italy, [2]Energy Resources Spa, Jesi, Italy

V11 851 **Extending Performance and Evaluating Risks of PV Systems Failure Using a Fault Tree and Event Tree Approach: Analysis of the Possible Application 2922**
Alessandra Colli
Brookhaven National Laboratory, Upton, NY, USA

V15 852 **Approximation of a Photovoltaic Module Model Using Fractional and Integral Polynomials 2927**
Eduardo I. Ortiz-Rivera
University of Puerto Rico-Mayaguez, Mayaguez, PR, USA

V19 853 **Development and Use of a Simple Numerical Model to Quantify the Impact of Key Photovoltaics System Parameters on the Levelized Cost of Electricity 2932**
Moon Hee Kang[1], Ajeet Rohatgi[1,2]
[1]University Center of Excellence for Photovoltaics Research and Education, School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA, [2]Suniva Inc., Norcross, GA, USA

V23 854 **Advanced PV Module Performance Characterization and Validation Using the Novel Loss Factors Model 2938**
Stefan Sellner[1], Juergen Sutterlueti[1], Ludwig Schreier[1], Steve Ransome[2]
[1]Oerlikon Solar Ltd., Truebbach, Switzerland, [2]SRCL Steve Ransome Consulting Ltd., Kingston upon Thames, United Kingdom

W3 855 **Thermal Effects Due to Environmental Variables in Photovoltaic Cells 2944**
Buvaneshwari Muthirayan[1,2], Reinhart Appels[1], Herman Oprins[2], Urmimala Chatterjee[1], Francky Catthoor[2], Johan Driesen[1], Kris Baert[2]
[1]ESAT/ELECTA, KU Leuven, Heverlee, Belgium, [2]IMEC vzw, Heverlee, Belgium

W7 856 **Multilayer Thermal Models of PV Modules for Monitoring Applications 2947**
Giuseppe M. Tina, Giuseppe Marletta, Salvatore Sardella
University of Catania - DIEEI, Catania, Italy

W11 857 **Statistical Analysis of Back Surface vs. Cell Temperatures of c-Si Modules Using Measurement Error Models 2953**
Joseph M. Kuitche[1], Rong Pan[1], Govindasamy Tamizhmani[1,2]
[1]Arizona State University, Tempe, AZ, USA, [2]TUV Rheinland PTL, Tempe, AZ, USA

W15 858 **Crystalline-Silicon-Based Photovoltaic (PV) Module: Analytical Thermal Stress Modeling at the Design Stage N/A**
Ephraim Suhir
University of California, Santa Cruz, CA, USA

W19 859 **Analysing Partial Shading of PV Modules by Circuit Modeling 2957**
Siyu Guo, Timothy M. Walsh, Armin G. Aberle, Marius Peters
Solar Energy Research Institute of Singapore, Singapore, Singapore

W23 860 **LabVIEW-Based Emulation of Photovoltaic Array to Study Maximum Power Point Tracking Algorithms 2961**
Kapil S. Bhise, Nataraj Pragallapati, Sushil S. Thale, Vivek Agarwal
Dept of Elec Engg, IIT-Bombay, Mumbai, India

X2 861 **Modeling of Annual DC Energy Losses Due to Off Maximum Power Point Operation in PV Arrays 2967**
Aron P. Dobos
National Renewable Energy Laboratory, Golden, CO, USA

X5 862 **VLS-PV Intermittence and Stationary Storage N/A**
Aurélien BERTIN[1,2]
[1]Hélios Energie, Paris, France, [2]Institut de Physique du Globe de Paris, Paris, France

X8 863 **Changes in Cadmium Telluride Photovoltaic System Performance Due to Spectrum N/A**
Lauren Nelson, Mark Frichtl
First Solar, San Francisco, CA, USA

X11 864 **A New Approach in Numerical Simulation of PV Systems for PV-Powered Boats N/A**
Tim Gorter[1], Ernst-Jan Voerman[2], Peter Joore[2,3], Angèle Reinders[1,3], Fred Van Houten[1]
[1] University of Twente, Faculty of CTW, Department of Design, Production and Management, Enschede, Netherlands, [2]University of Applied Sciences, NHL hogeschool, Leeuwarden, Netherlands, [3]Delft University of Technology, Faculty of Industrial Design Engineering, Delft, Netherlands

1:30 - 3:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Advanced Approaches for Photoconversion (Orals)

Chair(s): Ryne P. Raffaelle, Martha Symko-Davies, Loucas Tsakalakas

1:30 865 **Best Student Presentation Award Finalist**
Characterization of a Quantum Dot *nipi* Photovoltaic Device 2970
Michael A. Slocum, David V. Forbes, Seth M. Hubbard
Rochester Institute of Technology, Rochester, NY, USA

2:00 866 **Infrared Optical Response of Geometric Diode Rectenna Solar Cells 2976**
Saumil Joshi[1], Zixu Zhu[1], Sachit Grover[2], Garret Moddel[1]
[1]Department of Electrical, Computer, and Energy Engineering, University of Colorado, Boulder, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

2:15 867 **Bandgap Engineering Achieved with Doping Superlattices 2979**
Michael K. Yakes[1], Cory D. Cress[1], Matthew P. Lumb[1,2], Jeffrey H. Warner[1], Christopher G. Bailey[1], Raymond Hoheisel[1,2], Robert J. Walters[1]
[1]Naval Research Laboratory, Washington, DC, USA, [2]The George Washington University, Washington, DC, USA

2:30 868 **Modeling the Optical and Electrical Response of Nanostructured III-V Solar Cells 2985**
Kristina Driscoll, Seth M. Hubbard
Rochester Institute of Technology, Rochester, NY, USA

2:45 869 **GaAs/ PBnDT-FTAZ Nanopillar Hybrid Solar Cells: Study of Effect of Passivation Agent on the Morphology and Performance N/A**
Ramesh babu Laghumavarapu[1], Michael Anthony Haddad[1], Liang Yan[2], Wei You[2], Diana L. Huffaker[1]
[1]University of California, Los Angeles, CA, USA, [2]University of North Carolina, Chapel Hill, CA, USA

1:30 - 3:00 PM **18CD**

Area 2: Polycrystalline Thin Films: Kesterites (Orals)

Chair(s): Katsumi Kushiya, Greg Hanket

1:30 870 **Kesterite Successes, Ongoing Work, and Challenges: A Perspective from Vacuum Deposition N/A**
Ingrid L. Repins[1], Manuel J. Romero[1], Glenn Teeter[1], Jian V. Li[1], Su-Huai Wei[1], Darius Kuciauskas[1], Carolyn L. Beall[1], Clay M. DeHart[1], Jonathan R. Mann[1], Wan-Ching Hsu[2], Alan C. Goodrich[1], Rommel Noufi[1]
[1]National Renewable Energy Lab, Golden, CO, USA, [2]Department of Materials Science and Engineering, University of California, Los Angeles, CA, USA

2:00 871 **Effect of Composition on High-Efficiency CZTSSe Devices Fabricated by Co-Sputtering of Compound Targets 2990**
Vardaan Chawla[1], Bruce Clemens[2]
[1]AQT Solar, Sunnyvale, CA, USA, [2]Stanford University, Stanford, CA, USA

2:15 872 **A Simple Solution-Based Route to High-Efficiency CZTSSe Thin-Fim Solar Cells 2993**
Qijie Guo, Yanyan Cao, Jonathan V. Caspar, William E. Farneth, Alex S. Ionkin, Lynda K. Johnson, Meijun Lu, Irina Malajovich, Daniela Radu, Kaushik Roy Choudhury, H David Rosenfeld, Wei Wu
The DuPont Company, Central Research and Development, Experimental Station, Wilmington, DE, USA

2:30 873 **Over 8% Efficiency Cu_2ZnSnS_4 Submodules with Ultrathin Absorber 2997**
Hiroki Sugimoto, Homare Hiroi, Noriyuki Sakai, Satoshi Muraoka, Takuya Katou
Solar Frontier K.K., Atsugi, Japan

2:45 874 **Device Characteristics of High-Performance Cu_2ZnSnS_4 Solar Cell 3001**
Oki Gunawan, Tayfun Gokmen, Byungha Shin, Supratik Guha
IBM T J Watson Research Center, Yorktown Heights, NY, USA

1:30 - 3:00 PM **17B**

Area 3: III-V's and Concentrators: High-Efficiency Cells (Orals)

Chair(s): Dan Aiken, Damien Buie

1:30 875 **Measuring IV Curves and Subcell Photocurrents in the Presence of Luminescent Coupling** **N/A**
Myles A. Steiner, John F. Geisz, Tom E. Moriarty, Ryan M. France, William E. McMahon, Jerry M. Olson, Sarah R. Kurtz, Daniel J. Friedman
National Renewable Energy Laboratory, Golden, CO, USA

1:48 876 **Best Student Presentation Award Finalist**
Temperature Accelerated Life Test (ALT) on III-V Concentrator Triple-Junction Solar Cells **N/A**
Pilar Espinet-González[1], Carlos Algora[1], Jesús Bautista[1], Neftalí Núñez[1,2], Manuel Vázquez[1,2], Kenji Araki[3]
[1]Institute of Solar Energy (IES), Technical University of Madrid (UPM), Madrid, Spain, [2]EUIT de Telecomunicación, Universidad Politécnica de Madrid, Madrid, Spain, [3]Daido Steel Co., Nagoya, Japan

2:06 877 **Lattice-Matched Solar Cells with 40% Average Efficiency in Pilot Production and a Roadmap to 45%** **N/A**
Daniel J. Aiken, Pravin Patel, Fred Newman, Edwin Dons
Emcore Corporation, Albuquerque, NM, USA

2:24 878 **Pushing Inverted Metamorphic Multijunction Solar Cells Towards Higher Efficiency at Realistic Operating Conditions** **N/A**
Ryan M. France, John F. Geisz, Myles A. Steiner, Daniel J. Friedman, J. Scott Ward, Jerry M. Olson, Waldo Olavarria, Michelle Young, Anna Duda
National Renewable Energy Laboratory, Golden, CO, USA

2:42 879 **Comparison of III-V Concentrator Multijunction Solar Cells** **N/A**
Mingguo Liu, Geoffrey S. Kinsey, Aditya Nayak, William Bagienski, Vahan Garboushian
Amonix Inc., Seal Beach, CA, USA

1:30 - 3:00 PM **Blrm G**

Area 4: Crystalline Silicon: Texture, Emitter, and ARC (Orals)

Chair(s): Joachim John

1:30 880 **Progress in N-type Si Solar Cell and Module Technology for High Efficiency and Low Cost 3004**
L.J. Geerligs[1], I.G. Romijn[1], A.R. Burgers[1], A.W. Weeber[1], J.H. Bultman[1], Hongfang Wang[2], Fang Lang[2], Wenchao Zhao[2], Gaofei Li[2], Zhiyan Hu[2], Jingfeng Xiong[2], Ard Vlooswijk[3]
[1]ECN Solar Energy, Petten, Netherlands, [2]Yingli Solar, Baoding, China, [3]Tempress Systems BV, Vaassen, Netherlands

2:00 881 **Crystalline Silicon Photovoltaic Solar Power : Accelerating to Global Grid Parity N/A**
Charlie Gay
President, Applied Solar

2:15 882 **Etching Paste for Innovative Solar Cell Applications N/A**
Mohamamdreza Nejati[1], Wen Zhang[2], Lun Huang[2]
[1]GP Solar GmbH, Konstanz, Germany, [2]Dongfang Electric (YiXing) MAGI Solar Power Technology Co., Ltd., Yixing Jiangsu, China

2:30 883 **Analysis of Cast Monocrystalline Ingot Characteristics with Applications to Solar Cells 3009**
Brian C. Rounsaville, Ian Cooper, John K. Tate, Malka Kadish, Arnab Das, Ajeet Rohatgi
UCEP, Georgia Tech, Atlanta, GA, USA

2:45 884 **Immeasurably Low Surface Recombination Velocity Passivated by Low Absorption Silicon Nitride on c-Si N/A**
Yimao Wan[1], Keith R. McIntosh[2], Andrew F. Thomson[1], Andres Cuevas[1]
[1]Research school of Engineering, Australian National University (ANU), Canberra ACT, Australia, [2]PV Lighthouse, Coledale NSW, Australia

1:30 - 3:00 PM **19A**

Area 5: Thin-Film Silicon: Light Trapping in Solar Cells 2 (Orals)

Chair(s): Laura Sivec, AJM van Erven

1:30 885 **Light Harvesting Schemes for High-Efficiency Thin-Film Solar Cells 3015**
Matthieu Despeisse, Mathieu Boccard, Corsin Battaglia, Jordi Escarré, Karin Söderström, Laura Ding, Sylvain Nicolay, Jan-Willem Schüttauf, Simon Hänni, Gregory Bugnon, Michael Stuckelberger, Maximilien Bonnet-Eymard, Gaetano Parascandolo, Fanny Meillaud, Christophe Ballif
Institute of Microengineering (IMT), Ecole Polytechnique Fédérale de Lausanne (EPFL), Laboratory of Photovoltaics and Thin Film Electronics, Neuchatel, Switzerland

2:00 886 **Development of High-Efficiency Tandem Silicon Solar Cells on W-Textured Zinc Oxide-Coated Soda-Lime Glass Substrates 3020**
Yuki Moriya[1], Taweewat Krajangsang[3], Porponth Sichanugrist[1], Makoto Konagai[1,2]
[1]Department of Physical Electronics, Tokyo Institute of Technology, Tokyo, Japan, [2]Photovoltaic Research Center (PVREC), Tokyo Institute of Technology, Tokyo, Japan, [3]Solar Energy Technology Laboratory, National Electronics and Computer Technology Center, Pathumthani, Thailand

2:15 887 **Quantification of Optical Deflection by Laser-Structured ZnO:Al N/A**
Marcel Berner, Marc Sämann, Ahmed Garamoun, Markus B. Schubert
Universität Stuttgart, Institut für Photovoltaik, Stuttgart, Germany

2:30 888 **Optical Modeling and Optimization of Flattened Light-Scattering Substrate for Thin-Film Silicon Solar Cells 3024**
Olindo Isabella[1], Hitoshi Sai[2], Michio Kondo[2], Miro Zeman[1]
[1]Photovoltaic Materials and Devices Laboratory, Delft University of Technology, Delft, Netherlands, [2]Research Center for Photovoltaic Technologies, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

2:45 889 **Lithographically-Definable Solar Cell Random Reflector Using Genetic Algorithm Optimization 3030**
Albert S. Lin[1], Sze-Ming Fu[1], Yan-Kai Chung[2]
[1]Institute of Electronic Engineering, National Chiao-Tung University, Hsinchu, Taiwan, [2]Department of Electro-Physics, National Chiao-Tung University, Hsinchu, Taiwan

1:30 - 3:00 PM **17A**

Area 6: Organic Photovoltaics: New Organic and Interface Materials (Orals)

Chair(s): Erin Ratcliff, Ivgenny Katz

1:30 890 **Wrinkles and Folds as Photonic Structures in Polymer Photovoltaics N/A**
Y.-L. Loo
Princeton University, Princeton, NJ, USA

2:00 891 **Best Student Presentation Award Finalist**
Efficiency Limitations in Organic Bulk Heterojunction Solar Cells 3035
Kejia Li[1,3], Lijun Li[1,3], Petr P. Khlyabich[2,3], Beate Burkhart[2,3], Barry C. Thompson[2,3], Joe C. Campbell[1,3]
[1]University of Virginia, Charlottesville, VA, USA, [2]University of Southern California, Los Angeles, CA, USA, [3]Center for Energy Nanoscience at University of Southern California, Los Angeles, CA, USA

2:15 892 **Recombination Barrier Layers in Solid-State Quantum Dot-Sensitized Solar Cells 3040**
Katherine E. Roelofs[1], Thomas P. Brennan[2], Juan C. Dominguez[2], Stacey F. Bent[2]
[1]Department of Materials Science and Engineering, Stanford University, Stanford, CA, USA, [2]Department of Chemical Engineering, Stanford University, Stanford, CA, USA

2:30 893 **Electrical Study on Effects of 2-D Plasmonic Grating on Organic Solar Cells N/A**
Wei E.I. Sha[1], Wallace C.H. Choy[1], Weng Cho Chew[1,2]
[1]Department of Electrical and Electronic Engineering, the University of Hong Kong, Hong Kong, Hong Kong, [2]Department of Electrical and Computer Engineering, University of Illinois, Urbana-Champaign, Champaign, IL, USA

2:45 894 **Thermally-Induced Morphological Changes in PAT/PCBM Bulk Heterojunctions Studied by Time-Resolved Small- and Wide-Angle X-ray Scattering 3044**
Soo Kim[1], Eun Ji Lee[2], Jong Kwan Lee[1], Kwang Hee Lee[2], Michael H.-C. Jin[1]
[1]Department of Materials Science and Engineering, University of Texas, Arlington, TX, USA, [2]Department of Polymer Science and Engineering, Inha University, Incheon, South Korea

1:30 - 3:00 PM **16AB**

Area 9: Modules and Systems: PV Performance Modeling Collaborative (Orals)

Chair(s): Dan Riley, Ben Bourne

1:30 895 **The Photovoltaic Performance Modeling Collaborative 3048**
Joshua S. Stein
Sandia National Laboratories, Albuquerque, NM, USA

1:45 896 **What Must Project Developers and Technology Providers Do to Support Performance Estimates During Project Development? 3053**
Evan Riley
Black & Veatch, San Francisco, CA, USA

2:00 897 **Solar Input Data for PV Performance Modeling 3056**
Marie A. Schnitzer, Christopher C. Thuman, Peter N. Johnson, Janine M. Freeman
AWS Truepower, LLC, Albany, NY, USA

2:15 898 **PV Technology Differences and Discrepancies in Modeling Between Simulation Programs and Measurements 3061**
Steve J. Ransome
srcl, London, United Kingdom

2:30 899 **Calibration of the Sandia Array Performance Model Using Indoor Measurements 3067**
Clifford W. Hansen[1], Daniel M. Riley[1], Manuel Jaramillo[2]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]CFV Solar Test Laboratory, Inc., Albuquerque, NM, USA

2:45 900 **Thermal Modeling Accuracy of Hourly Averaged Data for Large Free-Field Cadmium Telluride PV Arrays N/A**
William J. Hayes, Alex F. Panchula
First Solar, Inc., San Francisco, CA, USA

3:00 - 3:30 PM **4th Floor Foyer**

Coffee Break

3:30 - 5:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Novel Materials 1 (Orals)

Chair(s): Ryne P. Raffaelle, Alex Freudnlich

3:30 901 **Intermediate-Band to Conduction-Band Optical Absorption in ZnTeO** **N/A**
Elisa Antolin[1,2], Iñigo Ramiro[1], Esther Lopez[1], Estela Hernandez[1], Irene Artacho[1], Cesar Tablero[1], Antonio Marti[1], Antonio Luque[1], Chihyu Chen[3], Justin Foley[3], Jamie D. Phillips[3]
[1]Instituto de Energia Solar, Universidad Politecnica de Madrid, Madrid, Spain, [2]Instituto de Microelectronica de Madrid, Consejo Superior de Investigaciones Cientificas, Tres Cantos, Madrid, Spain, [3]Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA

4:00 902 **A Highly Efficient Hybrid CdS-GaAs Solar Cell** **3073**
Hsin Chu Chen[1], Chien Chung Lin[2], Yu Lin Tsai[1], Hau Vei Han[1], PeiChen Yu[1], Hao Chung Kuo[1]
[1]Department of Photonic & Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Institute of Photonic System, National Chiao Tung University, Tainan, Taiwan

4:15 903 **Heterogeneous Integration of InGaN and Silicon Solar Cells for Enhanced Energy Harvesting** **3076**
Naresh C Das[1], Meredith Reed[1], Mike Wraback[1], Anand Sampath[1], Paul Shen[1], Robert Farrell[2], M. Iza[2], S.C. Cruz[2], J.R. Lang[2], N.G. Young[2], Y. Terao[2], C.J. Neufeld[3], S. Keller[3], S Nakamura[2,3], U.K. Mishra[3], James Speck[2]
[1]Army Researcch Laboratory, Adelphi, MD, USA, [2]Material Science Department, Santa Barbara, CA, USA, [3]Electrical Engineering Department, Santa Barbara, CA, USA

4:30 904 **High-Perfomance Patterned Arrays of Core-Shell GaAs Nanopillar Solar Cells with** ***In Situ*** **InGaP Passivation Layer** **3080**
Giacomo Mariani[1], Adam Scofield[1], Diana Huffaker[1,2]
[1]University of California, Los Angeles, Los Angeles, CA, USA, [2]California Nanosystem Institute, Los Angeles, CA, USA

4:45 905 **Fabrication and Modeling of Large-Scale Silicon Nanowire Solar Cells for Thin-Film Photovoltaics** **3083**
Yu-Chih Cheng[1], Ting-Gang Chen[1], Feng-Yu Chang[1], Bo-Yu Huang[1], Huai-Te Pan[1], Peichen Yu[1], Chi-Kang Li[2], Yuh-Renn Wu[2]
[1]Department of Photonic & Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan

3:30 - 5:00 PM **18CD**

Area 2: Polycrystalline Thin Films: CIGS Absorber Processing (Orals)

Chair(s): Gregory Wilson, Shogo Ishizuka

3:30
906 **Hybrid Sputtering/Evaporation Deposition of $Cu(In,Ga)Se_2$ Thin-Film Solar Cells 3087**
Maurizio Acciarri[1], Simona Binetti[1], Alessia Le Donne[1], Bruno Vodopivec[1], Leo Miglio[1], Stefano Marchionna[2], Maurilio Meschia[2], Raffaele Moneta[2]
[1]Dip. of Material Science and Solar Energy Research Center, University of Milan-Bicocca, Milan, Italy, [2]Voltasolar s.r.l, Turate (Co), Italy

3:45
907 **Three-Step $H_2Se/Ar/H_2S$ Reaction of Metal Precursors for Large-Area $Cu(In,Ga)(Se,S)_2$ with Uniform Ga Distribution N/A**
Kihwan Kim, Evan L. Kimberly, Andrew Damiani, Gregory M. Hanket, William N. Shafarman
University of Delaware, Newark, DE, USA

4:00
908 **Advances in Electroplating-Based CIGS Solar Cell Fabrication 3092**
Serdar Aksu, Sarah Lastella, Shirish Pethe, Alan Kleiman-Shwarsctein, Sambhu Kundu, Mustafa Pinarbasi
SoloPower, Inc., San Jose, CA, USA

4:15
909 **Structural and Electronic Characteristics of $Cu(In,Ga)Se_2$ Thin Films Sputtered from Quaternary Targets 3098**
Jesse A. Frantz[1], Robel Y. Bekele[2], Jason D. Myers[1], Vinh Q. Nguyen[1], Jasbinder S. Sanghera[1], Sergey I. Maximenko[1], Maria Gonzalez[3], Joseph G. Tischler[1], Robert J. Walters[1], Marina S. Leite[4,5], Allan Bruce[6], Sergey V. Frolov[6], Michael Cyrus[6]
[1]U.S. Naval Research Laboratory, Washington, DC, USA, [2]University Research Foundation, Greenbelt, MD, USA, [3]Sotera Defense Solutions, Crofton, MD, USA, [4]CNST, National Institute for Standards and Technology, Gaithersburg, MD, USA, [5]Maryland Nanocenter, University of Maryland, College Park, MD, USA, [6]Sunlight Photonics Inc., South Plainfield, NJ, USA

4:30
910 **High-Efficiency CIGSe Solar Cells by Sputtered Cu(In,Ga) Followed by Selenization 3102**
Haifan Liang, Wei Liu, Sang Lee, Jeroen van Duren, Tim Franklin, Michael Patten, Sandeep Nijhawan
Intermolecular Inc., San Jose, CA, USA

4:45
911 **Fabrication of Selenized/Sulfurized $Cu(in,Ga)(Se,S)_2$ Solar Cells Based on High-Temperature Process Using High-Strain-Point Glass Substrate 3108**
Reo Usui, Takeshi Tomizawa, Takeshi Okato, Hidehumi Odaka
Asahi Glass Co, Ltd., Yokohama, Kanagawa, Japan

3:30 - 5:00 PM **Blrm G**

Area 4: Crystalline Silicon: Discussion and Harumph (Workshop)

Chair(s): Nathan Stoddard, Zhigang Rick Li

3:30 - 5:00 PM **19A**

Area 5: Thin-Film Silicon: Fundamentals and Defects in Solar Cells (Orals)

Chair(s): David Young, Nicolas Podraza

3:30
912

Best Student Presentation Award Finalist

The Relation Between Vacancies and the Dominant Defects in Hydrogenated Amorphous Silicon N/A

Jimmy Melskens[1], Arno H.M. Smets[1], Stephan W.H. Eijt[2], Henk Schut[3], Miro Zeman[1]
[1]Photovoltaic Materials and Devices, Faculty of Electrical Engineering, Mathematics and Computer Science, Delft University of Technology, Delft, Netherlands, [2]Fundamental Aspects of Materials and Energy, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands, [3]Neutron and Positron Methods in Materials, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands

4:00
913

Best Student Presentation Award Finalist

Valence Band Alignment of the ZnO:Al/a-Si:B Interface: Unraveling the Electronic Structure of a Poorly Performing Contact N/A

D. Gerlach[1], D. Wippler[2], R.G. Wilks[1], M. Wimmer[1], M. Lozach[3], S. Ueda[3], H. Yoshikawa[4], M. Sumiya[3], K. Kobayashi[3], J. Hüpkes[2], M. Bär[1]
[1]Helmholtz-Zentrum Berlin, Berlin, Germany, [2]Forschungszentrum Jülich, Jülich, Germany, [3]National Institute for Materials Science, Hyogo, Japan, [4]NIMS Beamline Station, SPring-8, Tsukuba, Japan

4:15
914

Infrared Dielectric Functions of Hydrogenated Amorphous Silicon Thin Films Determined by Spectroscopic Ellipsometry 3112

David B. Saint John[1], Haoting Shen[1], Hang-Beum Shin[2], Thomas N. Jackson[2], Nikolas J. Podraza[3]
[1]Department of Materials Science and Engineering, University Park, PA, USA, [2]Department of Electrical Engineering, University Park, PA, USA, [3]Department of Physics and Astronomy, Toledo, OH, USA

4:30
915

Identification of Defects in Thin-Film Solar Cells for New-Generation Energy Devices 3118

Yohko Naruse, Mitsuhiro Matsumoto, Takeyuki Sekimoto, Mitsuoki Hishida, Youichirou Aya, Wataru Shinohara, Atsushi Fukushima, Shigeo Yata, Akira Terakawa, Masahiro Iseki, Makoto Tanaka
Panasonic Corporation, Gifu, Japan

4:45
916

Hydrogenation of Dislocation-Limited Heteroepitaxial Silicon Solar Cells 3124

Michael L. Bolen[1], Sachit Grover[1], Charles W. Teplin[1], David Bobela[2], Howard M. Branz[1], Paul Stradins[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Ampulse Corporation, Golden, CO, USA

3:30 - 5:00 PM **17A**

Area 6: Organic Photovoltaics: Device Concepts (Orals)

Chair(s): Dana Olson, Barry Rand

3:30
917 **Modeling Low-Cost Hybrid Tandem Photovoltaics with Power Conversion Efficiencies Exceeding 20% 3129**
Michael D. McGehee, Zach M. Beiley
Stanford University, Department of Materials Science and Engineering, Stanford, CA, USA

4:00
918 **OPV Technology Flow Accelerates from the Laboratory to the Customer N/A**
James Buntaine
Konarka Technologies, Inc., Lowell, MA, USA

4:15
919 **Guided-Mode Absorption in Ultrathin Organic Photovoltaics 3131**
Yutong Pang[1,2], Nanditha Dissanayake[2], Matthew D. Eisaman[1,2]
[1]Stony Brook University, Stony Brook, NY, USA, [2]Brookhaven National Laboratory, Upton, NY, USA

4:30
920 **Large-Area CVD Graphene as Transparent Electrode for Efficient Organic Solar Cells 3137**
Golap Kalita[1], Masaki Tanemura[2], Koichi Wakita[1], Masayoshi Umeno[1]
[1]Department of Electronics and Information Engineering, Chubu University, Kasugai, Japan, [2]Department of Frontier Materials, Nagoya Institute of Technology, Nagoya, Japan

4:45
921 **Best Student Presentation Award Finalist**
Fabrication and Device Modeling of Micro-Textured Conductive Polymer/Silicon Heterojunction Solar Cells 3142
Ting-Gang Chen[1], Bo-Yu Huang[1], Yang-Yue Huang[1], En-Chen Chen[2], Peichen Yu[1], Hsin-Fei Meng[2]
[1]Department of Photonics and Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Institute of Physics, National Chiao Tung University, Hsinchu, Taiwan

3:30 - 5:00 PM **17B**

Area 7: Space Technologies: High Performance PV for Space Applications (Orals)

Chair(s): Steve Taylor, Mitsuru Imazumi

3:30
922 **Initial Results of the Monolithically-Grown Six-Junction Inverted Metamorphic Multijunction Solar Cell N/A**
Pravin M. Patel, Daniel Aiken, Daniel Chumney, Arthur Cornfeld, Yong Lin, Chelsea Mackos, Jim McCarty, Nathaniel Miller, Paul Sharps, Mark Stan
EMCORE Corporation, Albuquerque, NM, USA

4:00
923 **Recent Progress of Spectrolab High-Efficiency Space Solar Cells 3146**
Daniel C. Law, X.Q. Liu, J.C. Boisvert, E.M. Rehder, C.M. Fetzer, S. Mesropian, R.R King, K.E Edmondson, B. Jun, R.L. Woo, D.D. Krut, P.T. Chiu, D.M. Bhusari, S.K. Sharma, N.H. Karam
Spectrolab Inc, a wholly owned subsidary of Boeing, Sylmar, CA, USA

4:15
924 **Best Student Presentation Award Finalist**
Superior Radiation and Dislocation Tolerance of IMM Space Solar Cells 3150
Akhil Mehrotra, Alex Freundlich
Center for Advanced Materials, University of Houston, Houston, TX, USA

4:30
925 **The One-per-Wafer ZTJ Solar Cell from Emcore- Confidence Testing and Volume Manufacturing Performance 3155**
Benjamin Cho, MIchael Winter, Ian Aeby, Pravin Patel, Navid Fatemi, Paul Sharps
Emcore Photovoltaics, Albuquerque, NM, USA

4:45
926 **Best Student Presentation Award Finalist**
Characterization of InGaP Heterojunction Emitter Quantum Dot Solar Cells 3158
Zachary S. Bittner[1], Christopher G. Bailey[2], Stephen J. Polly[1], David V. Forbes[1], Seth M. Hubbard[1]
[1]Rochester Institute of Technology, Rochester, NY, USA, [2]U.S. Naval Research Laboratory, Washington, DC, USA

3:30 - 5:00 PM **16AB**

Area 9: Modules and Systems: Module Materials, Durability, and Performance 2 (Orals)

Chair(s): Wilfried van Sark, Howard O Barikmo

3:30 927 **How Can We Make PV Modules Safer? 3162**
John H. Wohlgemuth, Sarah Kurtz
NREL, Golden, CO, USA

3:45 928 **I-V Curves from 300 Modules Deployed over 2-Years in Tucson 3166**
Emily S. Kopp[1], Patricia L. Hidalgo-Gonzalez [2], Adria E. Brooks[3,4], Vincent P. Lonij[3], Alexander D. Cronin[1,3]
[1]University of Arizona, College of Optical Sciences, Tucson, AZ, USA, [2]Pontificia Universidad Católica de Chile, Santiago, Chile, [3]University of Arizona, Department of Physics, Tucson, AZ, USA, [4]Arizona Research Institute for Solar Energy, Tucson, AZ, USA

4:00 929 **Stress Analysis of Silicon-Wafer-Based Photovoltaic Modules in Operation 3172**
Yixian Lee[1,2], Andrew A.O. Tay[1,2]
[1]Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore, [2]Department of Mechanical Engineering, National University of Singapore, Singapore, Singapore

4:15 930 **Optimized Module Design: A Study of Encapsulation Losses and the Influence of Design Parameters on Module Performance 3178**
Max B. Koentopp, Robert Seguin
Q-Cells SE, Bitterfeld-Wolfen, Germany

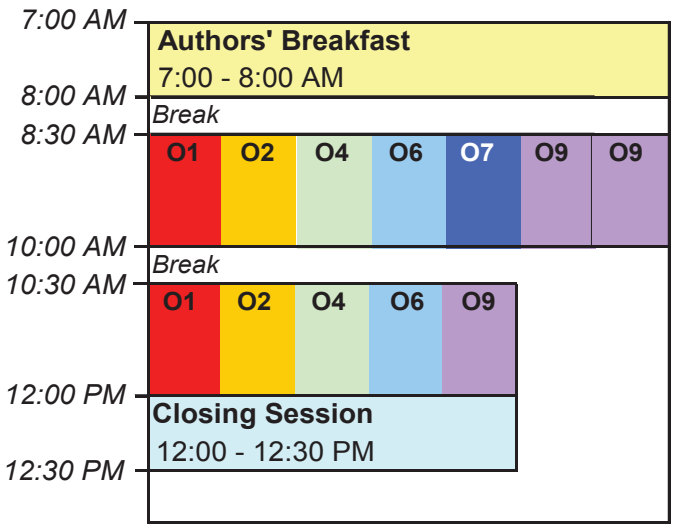
4:30 931 **NICE Modules Technology from Concept to Mass Production: A 10-Year Review 3183**
Julien Dupuis[1], Etienne Saint-Sernin[1], Oleksiy Nichiporuk[1], Paul Lefillastre[2], Denis Bussery[3], Roland Einhaus[1]
[1]Apollon Solar, Lyon, France, [2]CEA INES, LMPV Modules, Le Bourget du Lac, France, [3]Vincent Industrie, Brignais, France

4:45 932 **New Module Efficiency Record: 23.5% Under 1-Sun Illumination Using Thin-Film Single-Junction GaAs Solar Cells 3187**
Laila S. Mattos, Shawn R. Scully, Maria Syfu, Eric Olson, Linlin Yang, Gang He
Alta Devices, Inc., Santa Clara, CA, USA

6:30 - 10:00 PM

PVSC Banquet
Austin City Limits at Moody Theater

FRIDAY PROGRAM SUMMARY



AREA LEGEND

- Area 1: Fundamentals and New Concepts for Future Technologies
- Area 2: Thin Film Polycrystalline Photovoltaics
- 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 Terrestrial Systems
- Area 10: PV Velocity Forum

O = Oral Session P = Poster Session

8:00 - 8:30 AM **4th Floor Foyer**

Coffee Break

8:30 - 10:00 AM **18AB**

Area 1: Fundamentals and New Concepts: Novel Materials 2 (Orals)

Chair(s): Ryne P. Raffaelle

8:30 933 **Analysis of Current Transport Mechanisms in GaAsN Homojunction Solar Cell Grown by Chemical Beam Epitaxy N/A**
Boussairi Bouzazi, Nobuaki Kojima, Yoshio Ohshita, Masafumi Yamaguchi
Toyota Technological Institute, Nagoyta, Japan

9:00 934 **Thin, Free-Standing Cu_2O Substrates via Thermal Oxidation for Photovoltaic Devices 3191**
Samantha S. Wilson, Chengxiang Xiang, Yulia Tolstova, Harry A. Atwater
California Institute of Technology, Pasadena, CA, USA

9:15 935 **High-Efficiency Quantum Dot Solar Cells Using 2-Dimensional 6.4-nm-Diameter Si Nanodisk with SiC Interlayer 3195**
Makoto Igarashi[1,4], Mohd Fairuz Budiman[1,4], Wugen Pan[2], Yusuke Hoshi[2], Weiguo Hu[1,4], Mohd Erman Syazwan[1,4], Kentarou Sawano[3], Noritaka Usami[2], Seiji Samukawa[1,4]
[1]Institute of Fluid Science, Tohoku University, Sendai, Japan, [2]Institute for Materials Research Crystal Physics, Tohoku University, Sendai, Japan, [3]Research Center for Silicon Nano-Science, Advanced Research Laboratories, Tokyo City University, Tokyo, Japan, [4]Japan Science and Technology Agency, CREST, Tokyo, Japan

9:30 936 **Enhanced Carrier Extraction Under Strong Light Irradiation in Ge/Si Type-II Quantum Dot Solar Cells 3200**
Takeshi Tayagaki[1,2], Noritaka Usami[3], Wugen Pan[3], Yusuke Hoshi[3], Yoshihiko Kanemitsu[1]
[1]Kyoto University, Uji, Japan, [2]PRESTO-JST, Kawaguchi, Japan, [3]Tohoku University, Sendai, Japan

9:45 937 **Bandgap Engineering of ZnSnxGe1-xN2 Alloys as Earth-Abundant Photovoltaic Absorber Materials 3204**
Naomi C. Coronel[1], Lise Lahourcade[1], Kris T. Delaney[2], Amanda M. Shing[1], Harry A. Atwater[1,3]
[1]Thomas J Watson Laboratories of Applied Physics, Caltech, Pasadena, CA, USA, [2]Materials Research Laboratory, UCSB, Santa Barbara, CA, USA, [3]Kavli Nanoscience Institute, Caltech, Pasadena, CA, USA

8:30 - 10:00 AM **18CD**

Area 2: Polycrystalline Thin Films: CdTe Processing & Devices (Orals)

Chair(s): Markus Gloeckler, Ayodhya Tiwari

8:30
938 **Development of Substrate Structure CdTe Photovoltaic Devices with Performance Exceeding 10% 3208**
Ramesh G. Dhere, Joel N. Duenow, Clay M. DeHart, Jian V. Li, Darius Kuciauskas, Timothy A. Gessert
National Renewable Energy Laboratory, Golden, CO, USA

8:45
939 **Response of CdS/CdTe Devices to Te Additions at Back Contact 3212**
Timothy A. Gessert, James Burst, Jie Ma, Darius Kuciauskas, Teresa Barnes, William Rance
National Renewable Energy Laboratory, Golden, CO, USA

9:00
940 **High-Resolution Local-Current Measurement of CdTe Solar Cells 3217**
Heayoung P. Yoon[1,3], Dmitry Ruzmetov[1,3], Paul M. Haney[1], Marina S. Leite[1,3], Behrang H. Hamadani[1], A. Alec Talin[1], Nikolai B. Zhitenev[1]
[1]Center for Nanoscale Science and Technology, National Institute of Standards and Technology, Giathersburg, MD, USA, [2]Energy and Environment Division, Engineering Laboratory, National Institute of Science and Technology, Gaithersburg, MD, USA, [3]Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD, USA

9:15
941 **Improved Performance of CdTe Solar Cells Grown at High Temperatures on Specialty Glass 3220**
Teresa M. Barnes[1], James Burst[1], Matthew O. Reese[1], Will Rance[1], Timothy A. Gessert[1], Kan Zhang[2], Kim M. Fuller[2], Charles T. Hamilton[2], Bruce Aitken[2], Carlo A. Kosik-Williams[2]
[1]National Renewable Energy Lab, Golden, CO, USA, [2]Corning, Inc, Corning, NY, USA

9:30
942 **Oxygen Incorporation During Fabrication of Substrate CdTe Photovoltaic Devices 3225**
Joel N. Duenow, Ramesh G. Dhere, Darius Kuciauskas, Jian V. Li, Joel W. Pankow, Patricia C. Dippo, Clay M. DeHart, Timothy A. Gessert
National Renewable Energy Laboratory, Golden, CO, USA

9:45
943 **Device Characteristics of a 17.1%-Efficient Solar Cell Deposited by Non-Vacuum Printing Method on Flexible Foil 3230**
Gregory Brown, Peter Stone, Jacob Woodruff, Ben Cardozo, David Jackrel
Nanosolar, San Jose, CA, USA

8:30 - 10:00 AM **Blrm G**

Area 4: Crystalline Silicon: Feedstock (Orals)

Chair(s): Roland Einhaus

8:30
944 **19% Efficiency Heterojunction Solar Cells on Cz Wafers from Non-Blended Upgraded Metallurgical Silicon 3234**
J. Kraiem[1], P. Papet[2], J. Degoulange[1], O. Nichiporuk[1], Y. Andrault[2], D. Grosset-Bourbange[3], F. Cocco[3], R. Einhaus[1]
[1]Apollon Solar, Lyon, France, [2]Roth & Rau, Neuchatel, Switzerland, [3]FerroPem, Chambéry, France

9:00
945 **Fluidized Bed Silicon for Solar Cells N/A**
Paul Ege, Alireza Abbasi
Reactech, Markham, ON, Canada

9:15
946 **The Value Proposition for High Lifetime Silicon in Solar PV Applications 3238**
Alan C. Goodrich, Michael Woodhouse, Peter Hacke
NREL, Golden, CO, USA

9:30
947 **Best Student Presentation Award Finalist**
Incomplete Ionization and Carrier Mobility in Compensated Silicon N/A
Maxime Forster[1, 2, 3], Andres Cuevas[2], Fiacre Emile Rougieux[2], Erwann Fourmond[3], Mustapha Lemiti[3]
[1]APOLLON SOLAR, Lyon, France, [2]The Australian National University, Canberra, Australia, [3]INSA de Lyon, Lyon, France

9:45
948 **Light-Induced Degradation in Compensated mc-Si p-Type Solar Cells 3242**
Simone Bernardini[1], Desislava Saynova[1], Simona Binetti[2], Gianluca Coletti[1]
[1]ECN Solar Energy, Petten, Netherlands, [2]Materials Science Departement, University of Milano-Bicocca, Milano, Italy

8:30 - 10:00 AM **17A**

Area 6: Organic Photovoltaics: Lifetime Processing and Reliability (Orals)

Chair(s): Yang Yang, Neal Armstrong

8:30
949 **Advanced Design and Up-Scaling of ITO-Free Solar Cells via All-Solution Roll-to-Roll Processing 3248**
Yulia Galagan
Holst Centre, Eindhoven, Netherlands

9:00
950 **Low-Bandgap Organic Solar Cells with Enhanced Optical Properties by Embedded PEDOT:PSS Gratings N/A**
Xiaolong Zhu[1], Chuihui Duan[2], Wallace C.H. Choy[1], Fengxian Xie[1], Chuandao Wang[1], Fei Huang[2], Yong Cao[2]
[1]Department of Electrical and Electronic Engineering, the University of Hong Kong, Hong Kong, Hong Kong, [2]Institute of Polymer Optoelectronic Materials and Devices, State Key Laboratory of Luminescent Materials and Devices, South China University of Technology, Guangzhou, China

9:15
951 **Accelerated Stability Testing of Organic Photovoltaics Using Concentrated Sunlight 3249**
Eugene A. Katz[1], Assaf Manor[1], Asaf Mescheloff[1], Thomas Tromholt[2], Frederik C. Kreebs[2]
[1]Dept. of Solar Energy and Environmental Physics, J. Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Sede Boker, Israel, [2]Risø National Lab., Technical University of Denmark, Roskilde, Denmark

9:30
952 **A Methodology to Characterize OPV Temperature, Humidity and Irradiation Degradation: Preliminary Results 3253**
Elsa Kam-Lum
Total New Energies USA, Lowell, MA, USA

9:45
953 **The Effect of Anneal, Solar Irradiation and Humidity on the Adhesion/Cohesion Properties of P3HT:PCBM-Based Inverted Polymer Solar Cells 3259**
Stephanie R. Dupont[1], Eszter Voroshazi[2,3], Paul Heremans[2,3], Reinhold H. Dauskardt[1]
[1]Stanford University, Stanford, CA, USA, [2]Imec, Leuven, Belgium, [3]Katholieke Universiteit Leuven, ESAT, Leuven, Belgium

8:30 - 10:00 AM **17B**

Area 7: Space Technologies: Testing and Design of Space PV Technologies (Orals)

Chair(s): Scott Billets, Claus Zimmerman

8:30
954 **Test Program of Multijunction GaAs/Ge Solar Array Coupons with Combined Space Environmental Exposures 3263**
Bao Hoang[1], Frankie Wong[1], Ron Corey[1], George Gardiner[1], Victor Funderburk[1], Richard Gahart[1], Todd Schneider[2], Jason Vaungh[2], Kenneth Wright[3]
[1]Space Systems Loral, Palo Alto, CA, USA, [2]NASA Marshall Space Flight Center, Huntsville, AL, USA, [3]University of Alabama, Huntsville, Huntsville, AL, USA

8:45
955 **High-Irradiance High-Temperature Vacuum Testing of the Solar Probe Plus Array Design 3269**
Andreea Boca, Philip Blumenfeld, Kevin Crist, Karen De Zetter, Richard Mitchell, Benjamin Richards, Charles Sarver, Paul Sharps, Mark Stan, Cory Tourino
Emcore Photovoltaics, Albuquerque, NM, USA

9:00
956 **The Influence of High Temperatures on the Radiation Behaviour of $GaInP_2$/GaInAs/Ge Triple-Junction Cells N/A**
Christan Brandt[1], Carsten Baur[2], Antonio Caon[2], Peter Müller-Buschbaum[3], Claus Zimmermann[1], Thomas Andreev[1]
[1]EADS Astrium GmbH Satellites, Munich, Germany, [2]European Space Agency (ESA/ESTEC), Noordwijk, Netherlands, [3]TU-München, Physik-Department, Lehrstuhl für Funktionelle Materialien, Garching, Germany

9:15
957 **Selected On-Orbit Data from the FTSCE II Aboard the MISSE 7 Testbed 3275**
Alexander D. Howard[1], David M. Wilt[1], Phillip P. Jenkins[2], Kelly M. Trautz[2], John M. Merrill[1]
[1]Air Force Research Laboratory Space Vehicles Directorate, Kirtland AFB, NM, USA, [2]US Naval Research Laboratory, Washington, DC, USA

9:30
958 **Advancements to SCREAM: Multiple Spectrum Input and ShielDDDose Options 3281**
Scott R. Messenger, Eric A. Jackson, Jeffrey H. Warner, Phillip P. Jenkins, Robert J. Walters
US Naval Research Laboratory, Washington, DC, USA

9:45
959 **Solar Cell and Array Technology Development for NASA Solar Electric Propulsion Missions 3287**
Michael F. Piszczor[1], Jeremiah S. McNatt[1], Carolyn R. Mercer[1], Thomas W. Kerslake[1], Richard S. Pappa[2]
[1]NASA Glenn Research Center, Cleveland, OH, USA, [2]NASA Langley Research Center, Hampton, VA, USA

8:30 - 10:00 AM **16AB**

Area 9: Modules and Systems: Irradiance Resources (Orals)

Chair(s): Steve Ransome, Joshua Stein

8:30
960
Performance Testing Using Silicon Devices: Analysis of Accuracy 3290
Manajit Sengupta, Peter Gotseff, Daryl Myers, Thomas Stoffel
National Renewable Energy Laboratory, Golden, CO, USA

8:45
961
Spectrally Selective Sensors for PV System Performance Monitoring 3294
Anton Driesse, Daniela Dirnberger, Nils Reich, Christian Reise
Fraunhofer ISE, Freiburg, Germany

9:00
962
Over-Irradiance (Cloud Enhancement) Events at High Latitudes N/A
Georgi Hristov Yordanov[1,2], Ole-Morten Midtgård[1,2], Tor Oskar Saetre[1], Henrik Kofoed Nielsen[1], Lars Einar Norum[2]
[1]University of Agder (UiA), Grimstad, Norway, [2]Norwegian University of Science and Technology (NTNU), Trondheim, Norway

9:15
963
Best Student Presentation Award Finalist
PV Output Variability Modeling Using Satellite Imagery and Neural Networks N/A
Matthew J. Reno[1,2], Joshua S. Stein[1]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Georgia Institute of Technology, Atlanta, GA, USA

9:30
964
Best Student Presentation Award Finalist
Analyzing and Simulating the Reduction in PV Powerplant Output Variability Due to Geographic Smoothing in Ota City, Japan and Alamosa, Colorado N/A
Matthew Lave, Joshua S. Stein, Abraham Ellis
Sandia Nantional Laboratories, Albuquerque, NM, USA

9:45
965
Improving Forecasts of PV Power Output Using Real-Time Measurements of PV Output of 100 Residential PV Systems 3300
Vincent P. Lonij[1], Vijai T. Jayadevan[1], Adria E. Brooks[1], Kevin Koch[2], Mike Leuthold[1], Alexander D. Cronin[1]
[1]University of Arizona, Tucson, AZ, USA, [2]Technicians for Sustainability, Tucsin, AZ, USA

8:30 - 10:00 AM **19A**

Area 9: Modules and Systems: Off-Grid Applications (Orals)

Chair(s): Robert Foster, Vaughn Nelson

8:30 966 **Afghanistan Photovoltaic Power Applications for Rural Development N/A**
Robert Foster[1,2], Alma D. Cota[1]
[1]Winrock International, Arlington, VA, USA, [2]New Mexico State University, Las Cruces, NM, USA

9:00 967 **New Growth Markets for PV: Mini-Grids in Developing Countries – Implications for PV Technology 3306**
Andy Skumanich, Shannon Fulton
SolarVision Co, Los Gatos, CA, USA

9:15 968 **Remote Markets for Photovoltaic Technologies, 1974 to Present and Ten-Year Forecast 3310**
Paula J. Mints
Navigant, Palo Alto, CA, USA

9:30 969 **Mobile Solar Power N/A**
Kelly M. Trautz[1], Phillip P. Jenkins[1], Robert J. Walters[1], David A. Scheiman[1], Raymond Hoheisel[1,2], Rao Tatavarti[3], Ray Chan[3], Haruki Miyamoto[3], Jessica Adams[3], Victor Elarde[3], James L. Grimsley[4]
[1]US Naval Research Laboratory, Washington, DC, USA, [2]George Washington University, Washington, DC, USA, [3]MicroLink Devices, Inc., Niles, IL, USA, [4]Design Intelligence Incorporated, LLC, Norman, OK, USA

9:45 970 **PV System Data Analysis of a PV-Powered Racing Boat During the Frisian Solar Challenge 2010 3316**
Tim Gorter[1], Ernst-Jan Voerman[2], Peter Joore[2,3], Angèle Reinders[1,3], Fred Van Houten[1]
[1]University of Twente, Faculty of CTW, Department of Design, Production and Management, Enschede, Netherlands, [2]University of Applied Sciences, NHL hogeschool, Leeuwarden, Netherlands, [3]Delft University of Technology, Faculty of Industrial Design Engineering, Delft, Netherlands

10:00 - 10:30 AM **4th Floor Foyer**

Coffee Break

10:30 - 12:00 PM **18AB**

Area 1: Fundamentals and New Concepts: Light Concentration and Light Trapping 2 (Orals)

Chair(s): Ryne P. Raffaelle, Peichen Yu

10:30
971 **Antireflective Scheme for InGaP/InGaAs/Ge Triple-Junction Solar Cells based on TiO_2 Biomimetic Structures** **3322**
Kuo-Hsuan Hung[1], Ting-Gang Chen[1], Tung-Ting Yang[1], Peichen Yu[1], Chung-Yu Hong[2], Yu-Rue Wu[2], Guo-Chung Chi[1]
[1]Department of Photonics and Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan, [2]Arima Photovoltaic & Optical Corp, Taoyuan, Taiwan

11:00
972 **Configuration Optimization of a Nanosphere Array on Top of a Thin-Film Solar Cell** **3325**
Jonathan Grandidier, Dennis M. Callahan, Harry A. Atwater
Caltech, Pasadena, CA, USA

11:15
973 **Design and Demonstration of Light Trapping for Ge:Si Solar Cell Below Si Solar Cell in a Multijunction Solar Cell System** **3328**
Yi Wang[1], Andrew Gerger[2], Anthony Lochtefeld[2], Robert Opila[1,3], Allen Barnett[1,4]
[1]Department of Electrical Engineering, University of Delaware, Newark, DE, USA, [2]AmberWave, Inc., Salem, NH, USA, [3]Department of Materials Science, University of Delaware, Newark, DE, USA, [4]School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia

11:30
974 **Flexible Luminescent Solar Concentrators Utilizing Bio-Derived Tandem Fluorophores** **3333**
Martyn Fisher[1], Daniel Farrell[1], Kelly Trautz[2], Maria González[2], Robert Walters[2], Christian Ippen[3], Andreas Büchtemann[3], John Morseman[4], Amanda Chatten[1]
[1]Imperial College London, London, United Kingdom, [2]Naval Research Laboratory, Washington, DC, USA, [3]Fraunhofer Institute for Applied Polymer Research, Potsdam, Germany, [4]Columbia Biosciences, Washington, DC, USA

11:45
975 **Broadband Nanostructured Antireflection Coating on Glass for Photovoltaic Applications** **3339**
Roger Welser[1], Xing Yan[2], David Poxson[2], Adam Sood[1], Jaehee Cho[2], Ashok Sood[1], Jennifer Harvey[3], E. Fred Schubert[2]
[1]Magnolia Solar, Albany, NY, USA, [2]Rensselaer Polytechnic Institute, Troy, NY, USA, [3]NYSERDA, Albany, NY, USA

10:30 - 12:00 PM **18CD**

Area 2: Polycrystalline Thin Films: CIGS Processing & Devices (Orals)

Chair(s): Ingrid Repins, Chris Ferekides

10:30 976 **Roadmap for Manufacturing Cost-Competitive CIGS Modules 3343**
Vijay Kapur, vincent Kapur, Ashish Bansal, Steve Roth
International Solar Electric Technology Inc. (ISET), Chatsworth, CA, USA

10:45 977 **Why Are Cu-Rich CIS Solar Cells Not Living Up to Their Promises? N/A**
Valérie Depredurand[1], Daisuke Tanaka[1,2], Yasuhiro Aida[2], Nicole Fevre[1], Susanne Siebentritt[1]
[1]University of Luxembourg - LPV, Belval, Luxembourg, [2]TDK Corporation, Ichikawa, Japan

11:00 978 **Rapid Two-Step Selenization Growth of Cu(In,Ga)Se_2 Thin Films N/A**
Shogo Ishizuka[1,2], Lorelle M. Mansfield[1], Clay DeHart[1], Marty Scott[1], Bobby To[1], Matthew R. Young[1], Rommel Noufi[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan

11:15 979 **Best Student Presentation Award Finalist**
High-Efficiency Ultrathin Cu(In,Ga)$(Se,S)_2$ Solar Cells by Three-Step $H_2Se/Ar/H_2S$ Reaction of Cu-In-Ga Metal Precursor N/A
Kihwan Kim[1], Hyeonwook Park[2], Woo Kyoung Kim[2], Gregory M. Hanket[1], William N. Shafarman[1]
[1]University of Delaware, Newark, DE, USA, [2]Yeungnam University, Gyeongsan, South Korea

11:30 980 **A Comparative Study of the Defect Point Physics and Luminescence of the Kesterites Cu_2ZnSnS_4 and $Cu_2ZnSnSe_4$ and Their Related Chalcopyrites Cu(In,Ga)S_2 and Cu(In,Ga)Se_2 3349**
Manuel Romero[1], Ingrid Repins[1], Glenn Teeter[1], Miguel Contreras[1], Thomas Unold[2], Jo Klaer[2], Mowafak Al-Jassim[1], Rommel Noufi[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Helmontz Zentrum Berlin fur Materialien und Energie, Berlin, Germany

11:45 981 **Influence of the Ga Content on the Optical and electrical Properties of $CuIn_{1-x}Ga_xSe_2$ Thin-Film Solar Cells N/A**
Zhenhao Zhang[1,2], Wolfram Witte[3], Oliver Kiowski[3], Uli Lemmer[1], Michael Powalla[1,3], Hendrik Hölscher[2]
[1]Light Technology Institute, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, [2]Institute of Microstructure Technology, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, [3]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Stuttgart, Germany

10:30 - 12:00 PM **Blrm G**

Area 4: Crystalline Silicon: Metallization (Orals)

Chair(s): Zhigang Rick Li

10:30 982 **Silver Metallization for Crystalline Silicon Cells N/A**
Weiming Zhang
Heraeus Precious Metals North America Conshohocken LLC, Conshohocken, PA, USA

10:45 983 **Formation of Very Low Resistance Contact for Silicon Photovoltaic Cells 3354**
Baomin Xu, Scott Limb, Alexandra Rodkin, Eric Shrader, Sean Garner
Palo Alto Research Center, Palo Alto, CA, USA

11:00 984 **Low Resistance Screen-Printed Ag Contacts to $POCl_3$ Emitters with Low Saturation Current Density for High-Efficiency Si Solar Cells 3359**
Ian B. Cooper[1], Keith Tate[1], Alan F. Carroll[2], Kurt R. Mikeska[3], Ajeet Rohatgi[1]
[1]Georgia Institute of Technology, Atlanta, GA, USA, [2]DuPont Microcircuit Materials, Research Triangle Park, NC, USA, [3]Dupont Central Research & Development, Wilmington, DE, USA

11:15 985 **The Effect of Front-Side Ag Metallization on Underlying n^+-p Junction in Multicrystalline Si Solar Cells 3365**
Chun-Sheng Jiang, Helio R. Moutinho, Mowafak M. Al-Jassim
National Renewable Energy Laboratory, Golden, CO, USA

11:30 986 **19.6% Cast Mono MWT Solar Cells and 268W Modules N/A**
Weiwei Yin, Feng Zhang, Xusheng Wang, Lingjun Zhang
Canadian Solar Inc., Suzhou, China

11:45 987 **Integration of High Sheet Resistance Front Homogeneous Emitter in a Process Flow for PERI-Type Solar Cells with Cu Contacts 3371**
Michel Ngamo[1], Loic Tous[2], Emanuele Cornagliotti[2], Jorg Horzel[2], Tom Janssens[2], Richard Russell[2], Jeff Poortmans[2], Benoit Lombardet[1]
[1]TOTAL Gas & Power, Paris la défense, France, [2]imec vzw, Leuven, Belgium

10:30 - 12:00 PM **17A**

Area 6: Organic Photovoltaics: OPV Modeling and Inorganic Hybrids (Orals)

Chair(s): Darin Laird, Barry Rand

10:30
988 **Understanding Energy Level Alignment in PCDTBT:$PC_{70}BM$ Solar Cells** **3377**
Erin L. Ratcliff[1], Andres Garcia[2], Sarah R. Cowan[2], Jens Meyer[3], K. Xerxes Steirer[1], Sergio A. Paniagua[4], Anthony Giorando[4], Seth Marder[4], Neal R. Armstrong[1], Antoine Kahn[3], David Ginley[2], Dana C. Olson[2]
[1]University of Arizona, Tucson, AZ, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Princeton University, Princeton, NJ, USA, [4]Georgia Institute of Technology, Atlanta, GA, USA

11:00
989 **Understanding the Origin of Free-Carrier Generation in Organic Photovoltaic Devices** **N/A**
Garry Rumbles[1,2], Obadiah Reid[1], David Coffey[2], Nikos Kopidakis[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University of Colorado, Boulder, CO, USA

11:30
990 **Plasmonic Au Nanoparticles Integration into All Polymer Layers for Improving the Efficiency of Organic Solar Cells** **N/A**
Wallace C.H. Choy, Charlie C.D. Wang, Dixon D.S. Fung, Wei E.I. Sha, Feng-Xian Xie
Department of Electrical and Electronic Engineering, the University of Hong Kong, Hong Kong, Hong Kong

11:45
991 **Optimizing Bulk Heterojunctions of Organic Solar Cells via Multi-Scale Simulation** **N/A**
Fanan Wei[1], Lianqing Liu[2], Zaili Dong[2], Guangyong Li[1]
[1]University of Pittsburgh, Pittsburgh, PA, USA, [2]Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang, China

10:30 - 12:00 PM **16AB**

Area 9: Modules and Systems: Performance Modeling (Orals)

Chair(s): Bruce King, Rhonda Bailey

10:30 992 **Best Student Presentation Award Finalist**
Experimental Characterization of a Thermoelectrical Model of Photovoltaic Modules 3380
Sharif Z. Aljoaba, Aaron M. Cramer, Bruce L. Walcott
Department of Electrical and Computer Engineering, University of Kentucky, Lexington, KY, USA

10:45 993 **Prediction of Energy Effects on Photovoltaic Systems Due to Snowfall Events 3386**
Rob Andrews[1], Joshua M. Pearce[2]
[1]Department of Mechanical and Materials Engineering Queen's University, Kingston, ON, Canada, [2]Department of Materials Science & Engineering and Department of Electrical & Computer Engineering, Michigan Technological University, Houghton, MI, USA

11:00 994 **Beyond the Module Model and into the Array: Mismatch in Series Strings 3392**
Sara MacAlpine, Michael Brandemuehl, Robert Erickson
University of Colorado, Boulder, CO, USA

11:15 995 **Direct Monitoring of Energy Lost Due to Soiling on First Solar Modules in California N/A**
Riley Caron, Bodo Littmann
First Solar, San Francisco, CA, USA

11:30 996 **Soiling Correction Model for Long-Term Energy Prediction in Photovoltaic Modules 3397**
Hassan Qasem, Tom Betts, Ralph Gottschalg
Centre for Renewable Energy Systems Technology (CREST), School of Electronic, Electrical and System Engineering, Loughborough University, Loughborough, United Kingdom

11:45 997 **Influence of Atmospheric Variations on Photovoltaic Performance and Modeling Their Effects for Days with Clear Skies 3402**
Bill Marion
National Renewable Energy Laboratory, Golden, CO, USA

12:00 - 12:30 PM **Blrm D**

Closing Session