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C.-Y. Chen, Y. Li, Y.-Y. Chen, H.-T. Chang, S.-C. Hsu, W.-T. Huang, C.-M. Yang, and L.-W. Chen, Parallel and Scientific Computing Laboratory, Department of Electrical and Computer Engineering, National Chiao Tung University, Hsinchu, TAIWAN
- III-45 **Toward Single Molecule Detection in Physiological Buffer Using Planar FET Biosensors**  
Y. Wang<sup>1</sup>, P. Casal<sup>2</sup>, S. C. Lee<sup>2</sup>, and W. Lu<sup>1,3</sup>, <sup>1</sup>Department of Electrical and Computer Engineering, <sup>2</sup>Department of Biomedical Engineering, The Ohio State University, Columbus, Ohio, USA and <sup>3</sup>Department of Nanobio Materials and Electronics, Gwangju Institute of Science and Technology, KOREA
- III-46 **High Threshold Voltage in GaN MOS-HEMTs Modulated by Fluorine Plasma and Gate Oxide**  
Y. Zhang, M. Sun, S. J. Joglekar, and T. Palacios, Microsystems Technology Laboratories, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
- III-47 **Small Signal Characteristics of Ionic Liquid Gated Mott Transistors**  
Y. Zhou and S. Ramanathan, Harvard University, School of Engineering and Applied Sciences, Cambridge, Massachusetts, USA
- III-48 **Atomistic Simulation on Gate-recessed InAs/GaSb TFETs and Performance Benchmark**  
Z. Jiang<sup>1</sup>, Y. He<sup>1</sup>, G. Zhou<sup>2</sup>, T. Kubis<sup>1</sup>, H. G. Xing<sup>2</sup>, and G. Klimeck<sup>1</sup>, <sup>1</sup>Network for Computational Nanotechnology, Purdue University, West Lafayette, Indiana, USA and <sup>2</sup>University of Notre Dame, Notre Dame, Indiana, USA

## Session IV.A. GRAPHENE II

147-154

- IV.A-1 **Graphene p-n Junctions for Electron-Optics Devices**  
8:50 S. Sutar, E. Comfort, and J. U. Lee, College of Nanoscale Science and Engineering, UAlbany-SUNY, Albany, New York, USA
- IV.A-2 **Reduction of Charge Transfer Region Using Graphene Nano-ribbon Geometry for Improved Complementary FET Performance at Sub-Micron Channel Length**  
9:30 M. J. Hollander<sup>1</sup>, N. Shukla<sup>1</sup>, N. Agrawal<sup>1</sup>, H. Madan<sup>1</sup>, J. A. Robinson<sup>2</sup> and S. Datta<sup>1</sup>, <sup>1</sup>Department of Electrical Engineering and <sup>2</sup>Department of Materials Science and Engineering, The Pennsylvania State University, University Park, Pennsylvania, USA

IV.A-3  
9:50 AM

**Evaluating the Scalability of Multilayer MoS<sub>2</sub> Transistors**

S. Das & J. Appenzeller, Birck Nanotechnology Center & Department of ECE, Purdue University, West Lafayette, Indiana, USA

**Session IV.B. THIN FILM AND SENSORS**

**155-172**

IV.B-1  
8:50 AM

**Increasing the Speed of Flexible Electronics**

J.-H. Seo<sup>1</sup>, W. Zhou<sup>2</sup>, and Z. Ma<sup>1</sup>, <sup>1</sup>Department of Electrical and Computer Engineering, University of Wisconsin-Madison, Madison, Wisconsin, USA and <sup>2</sup>Department of Electrical Engineering, NanoFAB Center, University of Texas at Arlington, Arlington, Texas, USA

IV.B-2  
9:30 AM

**Evaporation-Enhanced Impedance Sensing for Highly-Sensitive Differentiation of dsDNA from ssDNA**

A. Ebrahimi and M. A. Alam, School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana, USA

IV.B-3  
9:50 AM

**High Performance Bi<sub>2</sub>Se<sub>3</sub> Nanowire Field-Effect Transistors**

H. Zhu<sup>1,2</sup>, C. A. Richter<sup>1</sup>, E. Zhao<sup>3</sup>, J. E. Bonevich<sup>4</sup>, H.-J. Jang<sup>1</sup>, H. Yuan<sup>1,2</sup>, H. Li<sup>1,2</sup>, A. Arab<sup>2</sup>, O. Kirillov<sup>1</sup>, W. A. Kimes<sup>5</sup>, J. E. Maslar<sup>5</sup>, and Q. Li<sup>1,2</sup>, <sup>1</sup>Semiconductor and Dimensional Metrology Division, National Institute of Standards and Technology, Gaithersburg, Maryland, USA, <sup>2</sup>Department of Electrical and Computer Engineering, <sup>3</sup>School of Physics, Astronomy, and Computational Sciences, George Mason University, Fairfax, Virginia, USA, <sup>4</sup>Materials Science and Engineering Division, National Institute of Standards and Technology, Gaithersburg, Maryland, USA, and <sup>5</sup>Chemical and Biochemical Reference Data Division, National Institute of Standards and Technology, Gaithersburg, Maryland, USA

IV.B-4  
10:30 AM

**Dual-Gate MOSFETs on Monolayer CVD MoS<sub>2</sub> Films**

H. Liu<sup>1</sup>, M. Si<sup>1</sup>, S. Najmaei<sup>2</sup>, A. T. Neal<sup>1</sup>, Y. Du<sup>1</sup>, P. M. Ajayan<sup>2</sup>, J. Lou<sup>2</sup> and P. D. Ye<sup>1</sup>, <sup>1</sup>School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana, USA and <sup>2</sup>Dept. of Mechanical Engineering and Materials Science, Rice University, Houston, Texas, USA

IV.B-5  
10:50 AM

**InGaZnO TFTs on a Flexible Membrane Transferred to a Curved Surface with a Radius of 2 mm**

N. Münzenrieder, G. A. Salvatore, T. Kinkeldei, L. Petti, C. Zysset, L. Büthe, and G. Tröster, Electronics Laboratory, Swiss Federal Institute of Technology, Zurich, SWITZERLAND

IV.B-6  
11:10 AM

**Tri-layer PEALD ZnO Thin Film Transistors and Circuits**

Y. V. Li<sup>1,2</sup>, K. G. Sun<sup>1,2</sup>, J. I. Ramirez<sup>1,2</sup> and T. N. Jackson<sup>1,2</sup>, <sup>1</sup>Center for Thin Film Devices and Materials Research Institute and <sup>2</sup>Department of Electrical Engineering, Penn State University, University Park, PA 16802 USA

IV.B-7  
11:30 AM

**Zinc Oxide Ring Oscillators with Vertical Thin Film Transistors**

S. F. Nelson and L. W. Tutt, Kodak Technology Center, Eastman Kodak Company, Rochester New York, USA

IV.B-8  
11:50 AM

**Effects of Gamma-Ray Irradiation and Electrical Stress on ZnO Thin Film Transistors**

J. I. Ramirez<sup>1,2</sup>, Y. V. Li<sup>1,2</sup>, H. Basantani<sup>1,3</sup>, and T. N. Jackson<sup>1,2</sup>, <sup>1</sup>Center for Thin Film Devices and Materials Research Institute, <sup>2</sup>Department of Electrical Engineering, Penn State University, University Park, Pennsylvania, USA, and <sup>3</sup>Department of Engineering Science and Mechanics, Penn State University, University Park, Pennsylvania, USA

**Session IV.C SPIN/MEMORY**

**173-182**

IV.C-1  
10:30 PM

**Magnetic Logic and Computation using Magnetic Tunnel Junctions**

J.-P. Wang, Electrical and Computer Engineering Department, University of Minnesota, Minneapolis, Minnesota, USA

IV.C-2  
11:10 PM

**Design Considerations for FE-Charge DRAM-Flash Hybrid Memory**

K. Auluck, S. R. Rajwade and E. C. Kan, School of Electrical and Computer Engineering, Cornell University, Ithaca, New York, USA



IV.C-3  
11:30 PM **Validation and Extension of the Temperature Extraction Method of Conductive Filaments in Resistive Switching Materials**  
E. Yalon, A. Gavrilov, S. Cohen, and D. Ritter, Department of Electrical Engineering, Technion, Israel Institute of Technology, Haifa, ISRAEL

IV.C-4  
11:50 PM **Forming Voltage Scaling of Resistive Switching Memories**  
A. Chen, TD Research, GLOBALFOUNDRIES, Sunnyvale, California, USA

## Session V.A OPTOELECTRONIC DEVICES

183-190

V.B-1  
1:30 PM **Single Photon Avalanche Diodes**  
J. C. Campbell, University of Virginia, Charlottesville, Virginia, USA

V.B-2  
2:10 PM **3.4  $\mu\text{m}$  Diode Lasers Employing Al-Free GaInAsSb/GaSb MQW Active Regions at 20  $^{\circ}\text{C}$**   
H. P. Nair, R. Salas, N. T. Sheehan, S. J. Maddox and S. R. Bank, Microelectronics Research Center, Electrical and Computer Engineering, The University of Texas at Austin, Austin, Texas, USA

V.B-3  
2:30 PM **Cavity optomechanics and cavity optoelectromechanics**  
H. Tang, School of Engineering and Applied Science, Yale University, New Haven, Connecticut, USA

## Session V.B TRANSISTORS

191-210

V.B-1  
1:30 PM **Si based Tunneling Field Effect Transistors and Inverters**  
S. Mantl<sup>1</sup>, L. Knoll<sup>1</sup>, S. Richter<sup>1</sup>, M. Schmidt<sup>1</sup>, S. Wirths<sup>1</sup>, A. Nichau<sup>1</sup>, A. Schäfer<sup>1</sup>, S. Blaeser<sup>1</sup>, S. Trellenkamp<sup>1</sup>, J.-M. Hartmann<sup>2</sup>, K. K. Bourdelle<sup>3</sup>, D. Buca<sup>1</sup> and Q.-T. Zhao<sup>1</sup>, <sup>1</sup>PGI-9(IT), JARA-FIT, Forschungszentrum Jülich, Jülich, GERMANY, <sup>2</sup>CEA, LETI, MINATEC Campus, Grenoble, FRANCE, and <sup>3</sup>SOITEC, Bernin, FRANCE

V.B-2  
2:10 PM **High Linearity Nanowire Channel GaN HEMTg**  
D. S. Lee<sup>1</sup>, H. Wang<sup>1</sup>, A. Hsu<sup>1</sup>, M. Azize<sup>1</sup>, O. Laboutin<sup>2</sup>, Y. Cao<sup>2</sup>, W. Johnson<sup>2</sup>, E. Beam<sup>3</sup>, A. Ketterson<sup>3</sup>, M. Schuette<sup>3</sup>, P. Saunier<sup>3</sup>, and T. Palacios<sup>1</sup>, <sup>1</sup>MIT Microsystems Technology Laboratory, Cambridge, Massachusetts, USA, <sup>2</sup>IQE KC LLC, Taunton, Massachusetts, USA, and <sup>3</sup>Triquint Semiconductor Inc., Richardson, Texas, USA

V.B-3  
2:30 PM **N-polar GaN/InAlN/AlGaIn MIS-HEMTs with 1.89 S/mm extrinsic transconductance, 4 A/mm drain current, 204 GHz  $f_T$  and 405 GHz  $f_{max}$**   
D. Denninghoff\*, J. Lu, E. Ahmadi, S. Keller and U. K. Mishra, Department of Electrical and Computer Engineering, University of California, Santa Barbara, California, USA \*Now with Teledyne Scientific & Imaging LLC, Thousand Oaks, California, USA

V.B-4  
2:50 PM **Normally-Off GaN-on-Si Transistors Enabling Nanosecond Power Switching at One Kilowatt**  
R. Chu, B. Hughes, M. Chen, D. Brown, R. Li, S. Khalil, D. Zehnder, S. Chen, A. Williams, A. Garrido, M. Musni, and K. Boutros, HRL Laboratories LLC, Malibu, California, USA

V.B-5  
3:30 **CMOS scaling in the single digit nodes**  
M. A. Guillorn, Thomas J. Watson Research Center, Yorktown Heights, New York, USA

V.B-6  
4:10 **GaN Heterostructure Barrier Diodes (HBD) with Polarization-Induced Delta-Doping**  
P. Zhao, A. Verma, J. Verma, H. Xing, P. Fay and D. Jena, Department of Electrical Engineering, University of Notre Dame, Notre Dame, Indiana, USA

V.B-7  
4:30 **SrTiO<sub>3</sub>/GdTiO<sub>3</sub> Heterostructure Field Effect Transistors**  
O. F. Shoron<sup>1</sup>, M. Boucherit<sup>1</sup>, C. A. Jackson<sup>2</sup>, P. Moetakef<sup>2</sup>, S. Stemmer<sup>2</sup> and S. Rajan<sup>1</sup>, <sup>1</sup>Electrical and Computer Engineering Department, The Ohio State University, Columbus, Ohio, USA and <sup>2</sup>Materials Department, University of California, Santa Barbara, California, USA

V.B-8  
4:50 **Nanomembrane  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> High-Voltage Field Effect Transistors**  
W. S. Hwang<sup>1,2</sup>, A. Verma<sup>1</sup>, V. Protasenko<sup>1</sup>, Sergei Rouvimov<sup>1</sup>, H. Xing<sup>1</sup>, A. Seabaugh<sup>1</sup>,  
W. Haensch<sup>2</sup>, C. Van de Walle<sup>3</sup>, Z. Galazka<sup>4</sup>, M. Albrecht<sup>4</sup>, R. Fornari<sup>4</sup>, and D. Jena<sup>1</sup>  
<sup>1</sup>Department of Electrical Engineering, University of Notre Dame, Notre Dame, Indiana, USA, <sup>2</sup>IBM T. J. Watson Research Center, Yorktown Heights, New York, USA, <sup>3</sup>Materials Department, University of California Santa Barbara, California, USA, and <sup>4</sup>Leibniz Institute for Crystal Growth, Berlin, GERMANY

V.B-9  
5:10 **Steep Subthreshold Slope Nanoelectromechanical Field-Effect Transistors with Nanowire Channel and Back Gate Geometry**  
J.-H. Kim, Z. C. Y. Chen, S. Kwon and J. Xiang, Department of Electrical and Computer Engineering, University of California San Diego, La Jolla, California, USA

## Session V.C GaN

211-216

V.C-1  
1:30 PM **GaN Devices for Sub-Millimeter-Wave MMIC and High-Speed Low-Loss Power Switch Applications**  
K. Shinohara, HRL Laboratories, Malibu, California, USA

V.C-2  
1:50 PM **Red-emitting InGaN/GaN Quantum Dot Laser**  
T. Frost, A. Banerjee, and P. Bhattacharya, Center for Photonics and Multiscale Nanomaterials, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, Michigan, USA

V.C -3  
2:10 PM **Late News**

V.C -4  
2:30 PM **Late News**

## Rump Sessions

217-218

R.1  
8:30 PM **Thin film transistors: Graphene, TMDs, ZnO, or something else?**  
Session Organizers: Eric Pop, University of Illinois and Ioannis Kyriakidis, Columbia University

R.2  
8:30 PM **The transistor has changed the world. What's next?**  
Session Organizers: Seth Bank, University of Texas and Debdeep Jena, Notre Dame University

## Joint DRC/EMC Plenary Session

219-220

8:30 AM **Mott Memristors, Spiking Neuristors and Electronic Action Potentials**  
R. Stanley Williams, Hewlett-Packard Laboratories

## Session VI.A PROCESS AND TESTING INNOVATIONS

221-232

VI.A-1  
10:00 AM **Tuning the Fermi level position at metal/high-k interfaces**  
M. Eizenberg and L. Kornblum, Department of Materials Science and Engineering, Technion – Israel Institute of Technology, Haifa, ISRAEL

VI.A-2  
10:40 AM **Extraction of Series Resistance on Junctionless and Inversion-mode nanowire FET through the Method based on Y-function**  
C.-H. Park<sup>1</sup>, M.-D. Ko<sup>1</sup>, K.-H. Kim<sup>1</sup>, J.-H. Hong<sup>1</sup>, R.-H. Baek<sup>2</sup>, J.-S. Yoon<sup>3</sup>, J.-S. Lee<sup>1,4</sup>, and Y.-H. Jeong<sup>1,3,4</sup>, <sup>1</sup>Dept. of Electrical Engineering, POSTECH, <sup>2</sup>SEMATECH, Albany, New York, USA, <sup>3</sup>Dept. of Creative IT Excellence Engineering, and <sup>4</sup>Division of IT-Convergence Engineering, POSTECH, Pohang, Gyeongbuk, KOREA

VI.A-3  
11:00 AM

**Miniaturized On-Chip Passive Devices based on Self-Rolled-Up SiNx Nanomembrane Inductive Tube**

W. Huang<sup>1</sup>, X. Yu<sup>1</sup>, T. Comberiate<sup>1</sup>, C.-W. Qiu<sup>2</sup>, J. E. Schutt-Ainé<sup>1</sup>, and X. Li<sup>1</sup>, <sup>1</sup>Department of Electrical and Computer Engineering, University of Illinois, Urbana, Illinois, USA and <sup>2</sup>Department of Electrical and Computer Engineering, National University of Singapore, SINGAPORE

VI.A-4  
11:20 AM

**Solution-processed High-k Dielectrics for Low-Voltage IGZO TFTs**

S.-B. Ji, H. Im, N. Seong, and Y. Hong, Department of Electrical Engineering and Computer Science and Inter-University Semiconductor Research Center (ISRC), Seoul National University, Seoul, KOREA

VI.A-5  
11:40 AM

**Heat dissipation and thermometry in nanosystems: when interfaces dominate**

B. Gotsmann, F. Menges, S. Karg, V. Troncale, M. Lantz, P. Mensch, H. Schmid, P. Das Kanungo, U. Drechsler, V. Schmidt, M. Tschudy, A. Stemmer, and H. Riel, IBM Research - Zurich, Nanotechnology Group, ETH-Zurich, SWITZERLAND

# 71<sup>st</sup> Device Research Conference

## Technical Program

### Late News

**Monday, June 24, 2013**

**4:50 PM – II.A-9**

**Controlling Electronic Properties of Wafer-Bonded Interfaces among Dissimilar Materials: a Path to Developing Novel Wafer-Bonded Devices**

S. Lal<sup>1</sup>, J. Lu<sup>1</sup>, M. Guidry<sup>1</sup>, B. Thibeault<sup>1</sup>, S. P. Denbaars<sup>2</sup>, and U. K. Mishra<sup>1</sup>, <sup>1</sup>Department of Electrical and Computer Engineering and <sup>2</sup>Materials Department, University of California, Santa Barbara, California, USA

**Monday, June 24, 2013**

**5:10 PM – II.A-10**

**Complete Band Alignment Determination of InAs-GaSb Broken-Gap Tunneling Field-effect Transistor Hetero-Junction**

W. Li<sup>1,2</sup>, Q. Zhang<sup>1</sup>, O. A. Kirillov<sup>1</sup>, R. Bijesh<sup>3</sup>, Y. Liang<sup>2</sup>, D. Mohata<sup>3</sup>, B. Tian<sup>2</sup>, X. Liang<sup>2</sup>, S. Datta<sup>3</sup>, C. A. Richter<sup>1</sup>, D. J. Gundlach<sup>1</sup>, and N. V. Nguyen<sup>1</sup>, <sup>1</sup>National Institute of Standards and Technology, Gaithersburg, Maryland, USA, <sup>2</sup>Key Laboratory for the Physics and Chemistry of Nanodevices and Department of Electronics, Peking University, Beijing, CHINA, and <sup>3</sup>Department of Electrical Engineering, The Pennsylvania State University, University Park, Pennsylvania, USA

**Monday, June 24, 2013**

**4:50 PM – II.B-9**

**Can we engineer current saturation in narrow gap graphitic FETs without hurting mobility?**

F. Tseng<sup>1</sup>, G. Fiori<sup>2</sup>, and A.W. Ghosh<sup>1</sup>, <sup>1</sup>ECE, University of Virginia, Charlottesville, Virginia, USA and <sup>2</sup>Universita di Pisa, Pisa, ITALY

**Monday, June 24, 2013**

**5:10 PM – II.B-10**

**Functionalized 3D 7x20-array of Vertically Stacked SiNW FET for Streptavidin Sensing**

E. Buitrago<sup>1</sup>, M. Fernández-Bolaños Badia<sup>1</sup>, Y. M. Georgiev<sup>2</sup>, R. Yu<sup>2</sup>, O. Lotty<sup>2</sup>, Justin D. Holmes<sup>2</sup>, A. M. Nightingale<sup>3</sup> and A. M. Ionescu<sup>1</sup>, <sup>1</sup>Nanolab, EPFL, Lausanne, SWITZERLAND, <sup>2</sup>Materials Chemistry and Analysis Group, Department of Chemistry and Tyndall National Institute, University College Cork, Cork, IRELAND, and <sup>3</sup>Imperial College London, South Kensington, London, UK

**Tuesday, June 25, 2013**

**8:30 AM – IV.A**

**A High Response MoS<sub>2</sub>-Graphene Hetero-Junction Photodetector with Broad Spectral Range**

J. Y. Kwak<sup>1</sup>, J. Hwang<sup>1</sup>, M. Graham<sup>2</sup>, H. Alsalman<sup>1</sup>, N. Munoz<sup>1</sup>, B. Calderon<sup>1</sup>, D. Campbell<sup>1</sup>, and M. G. Spencer<sup>1</sup>, <sup>1</sup>School of Electrical and Computer Engineering, Cornell University, Ithaca, New York, USA and <sup>2</sup>Kavli Institute at Cornell for Nanoscale Science, Cornell University, Ithaca, New York, USA

**Tuesday, June 25, 2013**

**8:30 AM – IV.B**

**Is A Heterojunction Essential for High-Efficiency Organic Solar Cells?**

B. Ray and M. A. Alam, School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana, USA

**Tuesday, June 25, 2013**

**4:30 PM – V.C-3**

**Depletion-mode Ga<sub>2</sub>O<sub>3</sub> MOSFETs**

M. Higashiwaki<sup>1</sup>, K. Sasaki<sup>2,1</sup>, T. Kamimura<sup>1</sup>, M. H. Wong<sup>1</sup>, D. Krishnamurthy<sup>1</sup>, A. Kuramata<sup>2</sup>, T. Masui<sup>3</sup>, and S. Yamakoshi<sup>2</sup>, <sup>1</sup>National Institute of Information and Communications Technology (NICT), Tokyo, JAPAN, <sup>2</sup>Tamura Corporation, Saitama, JAPAN, and <sup>3</sup>Koha Co., Ltd, Tokyo, JAPAN

**Tuesday, June 25, 2013**

**4:50 PM – V.C-4**

**Dynamic Response of Amorphous In-Ga-Zn-O Thin-Film Transistors for 8Kx4K Flat-Panel Display**

R. Zhang, L. Bie, E. Yu and J. Kanicki, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, Michigan, USA

**Tuesday, June 25, 2013**

**5:10 PM – V.C-5**

**Room-Temperature Quantum Oscillations in Ge Junctionless MOSFETs at the Scaling Limit**

H. Wu, J. Y. Zhang, J. J. Gu, L. Dong, N. J. Conrad, and P. D. Ye, School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana, USA

**Tuesday, June 25, 2013**

**5:30 PM – V.C-6**

**Narrow-Channel Accumulated-Body Bulk Si MOSFETs with Wide-Range Dynamic Threshold Voltage Tuning**

M. B. Akbulut<sup>1</sup>, F. Dirisaglik<sup>1</sup>, A. Cywar<sup>1</sup>, A. Faraclas<sup>1</sup>, D. Pence<sup>1</sup>, J. Patel<sup>2</sup>, S. Steen<sup>2</sup>, R. Nunes<sup>2</sup>, H. Silva<sup>1</sup>, and A. Gokirmak<sup>1</sup>, <sup>1</sup>Electrical & Computer Engineering, University of Connecticut, Storrs, Connecticut, USA and <sup>2</sup>IBM Thomas J. Watson Research Center, Yorktown Heights, New York, USA

**Tuesday, June 25, 2013**

**5:30 PM – V.B-10**

**Formation of Sub-10 nm width InGaAs finFETs of 200 nm Height by Atomic Layer Epitaxy**

D. Cohen-Elias<sup>1</sup>, J. J. M. Law<sup>1</sup>, H. W. Chiang<sup>1</sup>, A. Sivanathan<sup>1</sup>, C. Zhang<sup>1</sup>, B. J. Thibeault<sup>1</sup>, W. J. Mitchell<sup>1</sup>, S. Lee<sup>1</sup>, A. D. Carter<sup>1</sup>, C.-Y. Huang<sup>1</sup>, V. Chobpattana<sup>2</sup>, S. Stemmer<sup>2</sup>, S. Keller<sup>1</sup>, and M. J. W. Rodwell<sup>1</sup>, <sup>1</sup>ECE Department and <sup>2</sup>Materials Department, University of California, Santa Barbara, California, USA