

REPORT DOCUMENTATION PAGE			Form Approved OMB NO. 0704-0188		
<p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</p>					
1. REPORT DATE (DD-MM-YYYY) 17-06-2013		2. REPORT TYPE Final Report		3. DATES COVERED (From - To) 26-Nov-2012 - 25-Jun-2013	
4. TITLE AND SUBTITLE 2012 MRS Fall Meeting - Final Report for Symposia E, M, Z, GG and Acta Materialia			5a. CONTRACT NUMBER W911NF-13-1-0021		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHORS Dr. Melik C. Demirel, Dr. Steven Durbin, Dr. Zizhen Li, Dr. Jay Narayan, Mrs. Donna Gillespie			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAMES AND ADDRESSES Materials Research Society 506 Keystone Dr. Warrendale, PA 15086 -7573			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES) U.S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211			10. SPONSOR/MONITOR'S ACRONYM(S) ARO		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S) 63051-MS-CF.44		
12. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited					
13. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.					
14. ABSTRACT MRS has grown to nearly 16,000 members from the United States and over 80 other countries. The Society sponsors two major international annual Meetings encompassing approximately 75 topical symposia, offering symposium tutorials and networking opportunities, and also sponsors numerous single-topic scientific meetings. The Society recognizes professional and technical excellence and encourages technical interaction among college students through University Chapters, and among materials professionals through regional Sections. MRS also promotes communication exchange through publication of symposium proceedings, the MRS Bulletin, the Journal					
15. SUBJECT TERMS photovoltaic technologies, bioinspired directional surfaces, oxide semiconductors, mechanical behavior of metallic nanostructured materials, thermoelectric carbon materials					
16. SECURITY CLASSIFICATION OF:		17. LIMITATION OF ABSTRACT		15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UU	b. ABSTRACT UU	c. THIS PAGE UU	UU		J. Ardie Dillen
					19b. TELEPHONE NUMBER 724-779-2711

Report Title

2012 MRS Fall Meeting - Final Report for Symposia E, M, Z, GG and Acta Materialia

ABSTRACT

MRS has grown to nearly 16,000 members from the United States and over 80 other countries. The Society sponsors two major international annual Meetings encompassing approximately 75 topical symposia, offering symposium tutorials and networking opportunities, and also sponsors numerous single-topic scientific meetings. The Society recognizes professional and technical excellence and encourages technical interaction among college students through University Chapters, and among materials professionals through regional Sections. MRS also promotes communication exchange through publication of symposium proceedings, the MRS Bulletin, the Journal of Materials Research, and other publications related to current research activities. The Society works closely with other materials organizations around the world.

The Materials Research Society requests ARO financial support for several symposia to be held at the 2012 MRS Fall Meeting. ARO support of this meeting helps to ensure that both the Society and its technical programs are responsive to the interests of the research communities. The funds will provide partial travel for invited speakers, early career researchers, and students who would otherwise not have the funds to attend and network with prominent speakers in their field of study.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

<u>Received</u>	<u>Paper</u>
06/11/2013	1 R.C. Picu, J.J. Gracio, G.T. Vincze, N. Mathew, T. Schubert, A.B. Lopez, C. Buchheim. Al-SiC Nanocomposites Produced by Ball Milling and Spark Plasma Sintering, MRS Proceedings, (4 2013): 0. doi: 10.1557/opl.2013.500
06/11/2013	2 Letisha A. McLaughlin, Mohammed A. Zikry. The Mechanics and Stability of Gold Nanoparticle-Oligo-Ligand-DNA Systems, MRS Proceedings, (4 2013): 0. doi: 10.1557/opl.2013.501
06/11/2013	3 S.B. Gorti, B. Radhakrishnan. Modeling the strength and ductility of magnesium alloys containing nanotwins, MRS Proceedings, (4 2013): 0. doi: 10.1557/opl.2013.499
06/11/2013	4 Norihiko L. Okamoto, Daisuke Kashioka, Haruyuki Inui. Investigation of Specimen- and Grain-Size Dependence of Yield Stress in Electrodeposited Nanocrystalline Copper through Micropillar Compression, MRS Proceedings, (4 2013): 0. doi: 10.1557/opl.2013.559
06/11/2013	5 Andrew C. Magee, Leila J. Ladani. Temperature Effects in Al 5083 with a Bimodal Grain Size, MRS Proceedings, (4 2013): 0. doi: 10.1557/opl.2013.560
06/11/2013	6 David E.J. Armstrong, Steve G. Roberts. Radiation resistance of nano-structured tungsten-rhenium sheet, MRS Proceedings, (4 2013): 0. doi: 10.1557/opl.2013.561
06/11/2013	7 Toshitaka Ishizaki, Ryota Watanabe, Kunio Akedo, Toshikazu Satoh. Development of Low-Temperature Sintering Cu Nanoparticles, MRS Proceedings, (04 2013): 0. doi: 10.1557/opl.2013.562
06/11/2013	8 Tomohiro Sato, Yoshimasa Hirai, Takehisa Fukui, Takahiro Ejima, Masanori Takuma, Ken-ichi Saitoh. Atomic-modeling and Simulation of Copper Sulfide as Micro Solid Lubricant, MRS Proceedings, (05 2013): 0. doi: 10.1557/opl.2013.563
06/11/2013	9 Yang Hu, Dave Hollingshead, Mohammad A. Hossain, Mark Schuetz, Roger French. Comparison of multi-crystalline silicon PV modules' performance under augmented solar irradiation, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.221
06/11/2013	10 S. Saha, E. U. Onyegam, D. Sarkar, M. M. Hilali, R. A. Rao, L. Mathew, D. Jawarani, D. Xu, R. S. Smith, U. K. Das, J. G. Fossum, S. K. Banerjee. Exfoliated 25µm Si Foil for Solar Cells with Improved Light-Trapping, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.222
06/11/2013	11 Daniel Lockau, Tobias Sontheimer, Veit Preidel, Christiane Becker, Florian Ruske, Frank Schmidt, Bernd Rech. Optical properties and Limits of a Large-Area Periodic Nanophotonic Light Trapping Design for Polycrystalline Silicon Thin Film Solar Cells, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2013.28
06/11/2013	12 J.M. Walls, A. Abbas, G. D. West, J.W. Bowers, P.J.M. Isherwood, P. M. Kaminski, B. Maniscalco, W.S. Sampath, K. L. Barth. The Effect of Annealing Treatments on Close Spaced Sublimated Cadmium Telluride Thin Film Solar Cells, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2012.1704

- 06/11/2013 13 C. Maragliano, M. Stefancich, S. Rampino, L. Colace. Realistic simulation of polycrystalline CIGS absorbers and experimental verification, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.401
- 06/11/2013 14 Ahmed Zayan, Matteo Chiesa, Marco Stefancich. Point Focus Solar Spectral Splitting System for CPV Applications, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.223
- 06/11/2013 15 Chris Botros, Richard Savage. Application of Quantum Dots to Solar Cells to Increase Efficiency, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2012.1725
- 06/11/2013 16 Alaeddine Mokri, Mahieddine Emziane. Photoluminescent Effects on the Temperature Coefficient of Multi-Junction Solar Cells, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.402
- 06/11/2013 17 D. Pastor, J. Olea, A. del Prado, E. García-Hemme, R. García-Hernansanz, L. González-Pariente, I. Mártil, G. González-Díaz. Study of the electrical behavior in Intermediate Band-Si junctions, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.224
- 06/11/2013 18 Yongkun Sin, Stephen LaLumondiere, Brendan Foran, William Lotshaw, Steven C. Moss, Tae Wan Kim, Steven Ruder, Luke J. Mawst, Thomas F. Kuech. Carrier Dynamics and Defects in Bulk 1eV InGaAsNSb Materials and InGaAs Layers with MBL Grown by MOVPE for Multi-junction Solar Cells, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2012.1705
- 06/11/2013 19 Poonam Rani Kharangarh, George E Georgiou, Ken K Chin. Temperature Dependence of Electrical Characterization in n+ - CdS/ p - CdTe Thin Film Solar Cells – Study of Shallow/Deep Defects, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2013.29
- 06/13/2013 20 A. R. Middy, Kartik Ghosh. Quasicrystalline Phase of Silicon on Glass, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.225
- 06/13/2013 21 Urs Aeberhard. Quantum-kinetic Theory of Defect-mediated Recombination in Nanostructure-based Photovoltaic Devices, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.226
- 06/13/2013 22 Lewis M. fraas, Kuanrong Qiu. Ceramic IR Emitter with Spectral Match to GaSb PV Cells for TPV, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2012.1706
- 06/13/2013 23 Roger E. Welsler, Adam W. Sood, Jaehee Cho, E. Fred Schubert, Jennifer L. Harvey, Nibir K. Dhar, Ashok K. Sood. Nanostructured Transparent Conductive Oxides for Photovoltaic Applications, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2013.30
- 06/13/2013 24 Adam F. Halverson, Loucas Tsakalagos. Junction Operation of GaAs Wire Array Solar Cells, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.403
- 06/13/2013 25 Anastasiia Iefanova, Mahdi Farrokh Baroughi, Daren Davoux, Umesh Gautam, Dilip Dachhepati, Jeevan Nepal. Transparent Platinum Counter Electrode for Building Integrated Dye-Sensitized Solar Cells, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.227
- 06/13/2013 26 Avi Shalav, Christian Henderson, Tom Ratcliff, Andrew Thomson. Ion Implanted Dielectric Films for an Improved Optical and Electronic Silicon Photovoltaic Response, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2012.1674
- 06/13/2013 27 Chan-yan Huang, Yan Sun, Xin Chen, Ning Dai. Multilayer Hybrid Structure of ZnO Nanorod Arrays Imbedded in TiO₂ Network as Photoanode, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.420
- 06/13/2013 28 Jifang Cheng, Catherine Jimenez, Jacob P. Bell, Ingrid E. Anderson, Chito Kendrick, Yongan Yang, Reuben T. Collins, S. Kim R. Williams. Passivation, Separation and Characterization of Plasma Synthesized Silicon Nanoparticles, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.404

- 06/13/2013 29 Matthew J. Carnie, Cecile Charbonneau, Matthew Davies, Ian Mabbett, Trystan Watson, David Worsley. TiO₂ Film Morphology, Electron Transport and Electron Lifetime in Ultra-fast Sintered Dye-sensitized Solar Cells, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2012.1707
- 06/13/2013 30 Mohammad M. Hamasha, Atif S Alkhezali, John DeFranco, Susan Lu, Bahgat Sammakia, Charles Westgate, Khalid Alzoubi, Gihoon Choi. Comparisons of the Mechanical Behaviors of Poly (3, 4-ethylenedioxythiophene) (PEDOT) and ITO on Flexible Substrates, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.228
- 06/13/2013 31 Nathanael J. Smith. The Effect of the Dielectric Constant of a Solution of CdSe Quantum Dots on Electrophoretic Deposition of the Dots, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.405
- 06/13/2013 32 Punya A. Basnayaka, Pedro Villalba, Manoj K. Ram, Lee Stefanakos, Ashok Kumar. Photovoltaic properties of multi walled carbon nanotubes - poly(3-octathiophene) conducting polymer blends structures, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.406
- 06/13/2013 35 Hojun Yoon, Sameet Nabar, Yoav Banin. Realizing the World's First Upgradeable, 40-year Lifetime High Concentration Photovoltaic (HCPV) System – An Accelerated Pathway to Grid Parity, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.231
- 06/13/2013 36 Helio R. Moutinho, Manuel J. Romero, John Moseley, Ramesh G. Dhere, Chun-Sheng Jiang, Kim M. Jones, Joel N. Duenow, Mowafak M. Al-Jassim. Structural and Electro-Optical Properties of CdTe Films Used in CdTe/CdS Solar Cells Grown with Substrate Configuration, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2013.31
- 06/13/2013 33 A. G. Melton, B. Kucukgok, B-Z. Wang, N. Dietz, N. Lu, I. T. Ferguson. Development of indium-rich InGaN epilayers for integrated tandem solar cells, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.229
- 06/13/2013 37 Kensuke Akiyama, Hiroshi Funakubo, Masaru Itakura. Epitaxial growth of (010)-oriented γ -FeSi₂ film on Si(110) substrate, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.407
- 06/13/2013 38 Minh Nguyen, Andreas Schütt, Jürgen Carstensen, Helmut Föll. Quantitative Defect Analysis on Solar Cells by Laser Beam Induced Current (LBIC) Measurements and 3D Network Simulations, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.232
- 06/13/2013 39 Rubana Bahar Priti, Venkat Bommisetty. Microstructure and Local Charge Distribution in Hydrogenated Nanocrystalline Silicon under Illumination Studied by Electrostatic Force Microscopy., MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2013.32
- 06/13/2013 34 Lirong Zeng Broderick, Tiejun Zhang, Marco Stefancich, Brian R. Albert, Evelyn Wang, Gang Chen, Peter Armstrong, Matteo Chiesa, Lionel Kimerling, Jurgen Michel. High Efficiency Solar to Electric Energy Conversion through Spectrum Splitting and Multi-channel Full Spectrum Harvesting, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.230
- 06/13/2013 40 S.F. Wang, W.K. Fong, W. Wang, K.K. Leung, C. Surya. Growth of SnS van der Waals Epitaxies on Layered Substrates, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.234
- 06/17/2013 41 Takeshi Tomizawa, Reo Usui, Takeshi Okato, Hidefumi Odaka. Development of Selenization/Sulfurization Process for High Quality Cu(In, Ga)(S, Se)₂ Solar Cells on High Strain Point Glass Substrates, MRS Proceedings, (3 2013): 0. doi: 10.1557/opl.2013.408
- 06/17/2013 42 Yihong Jiang, JiaPeng Xu, Xiaofei Guan, Uday B. Pal, Soumendra N. Basu. Production of Silicon by Solid Oxide Membrane-Based Electrolysis Process, MRS Proceedings, (1 2013): 0. doi: 10.1557/opl.2013.33

06/17/2013 43 Eric Blanton, Keliang He, Jie Shan, Kathleen Kash. Effect of Cation Sublattice Ordering on Structure and Raman Scattering of ZnGeN₂, MRS Proceedings, (2 2013): 0. doi: 10.1557/opl.2013.235

TOTAL: 43

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 690.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Prof. Mildred Dresselhaus, Acta Materialia Award
Forum on Advanced Materials

Graduate Students

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Under Graduate students supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: 0.00

Names of Personnel receiving masters degrees

<u>NAME</u>
Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME PERCENT SUPPORTED

Yanshu Li, Invited Speaker	1.00
Akhil Mekhrotra, Invited Speaker	0.50
Joseph Faucher, Invited Speaker	0.50
Paul Quayle	0.50
Sudersena Tatavarti, Invited Spea	0.50
Kimberly Sablon, Organizer	1.00
Julia Yeomans, Invited Speaker	0.50
Lei Jiang, Invited Speaker	0.50
Kahp-Yang Suh, Invited Speaker	0.50
Walter Federle, Invited Speaker	0.50
David Quere, Invited Speaker	0.50
Sami Franssila, Invited Speaker	0.50
Ryo Yoshida, Invited Speaker	0.50
Mark Cutosky, Invited Speaker	0.50
Shawn Sallis, Symposium Assista	0.50
Steve Durbin, Organizer	1.00
Martin Albrecht, Invited Speaker	0.50
Roger Reeves, Invited Speaker	0.50
Matthew McCluskey, invited Speal	0.50
Jeffrey Davis, Invited Speaker	0.50
David Scanlon, Invited Speaker	0.50
Brad Boyce, Organizer	1.00
Jay Narayan, Invited Speaker	0.50
Yunzhi Wang, Invited Speaker	0.50
Yuntian Zhu, Invited Speaker	0.50
Qizhen Li, Organizer	0.50
Ado Jorio, Invited Speaker	0.50
Laurie McNeil, Invited Speaker	0.50
Joseph Heremans, Invited Speake	0.50
Lourdes Salamanca-Riba, Invited	0.50
Mauricio Terrones, Invited Speake	0.50
Mildred Dresselhaus, Honoree	1.00
Jagdish Narayan, Invited Speaker	0.50
George Crabtree, Invited Speaker	0.50
FTE Equivalent:	19.50
Total Number:	34

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

Technology Transfer

Symposium E: Photovoltaic Technologies – Materials, Devices and Systems

Objective

Our world is at the most crucial time to address the growing issues of global warming, climate change and depletion of conventional energy sources. With the increasing public awareness and enormous investment on developing the clean and sustainable energy sources, photovoltaics (PV), is no doubt one of the leading technologies. Over the next several years, it is expected that there will be significant advances in science and technology in the PV area. To engage and discuss the most recent developments in the field, this symposium provided a forum to explore new materials, concepts and approaches to further push the efficiency of PV devices towards the fundamental limit, as well as link multidisciplinary areas of research (physics, chemistry, materials science) and engineering for advancing the state-of-the-art PV technology.

Many exciting reports on the progress of a broad range of photovoltaic materials, devices and systems were presented. The following are a few highlights of the Symposium:

Harry Atwater (Caltech) shared his vision of achieving high solar cell efficiency beyond 50%; Paul Sharps (emcore) delivered an excellent overview of the current status of the development of the world's most efficient multifunction solar cells; and Lewis Fraas (JX Crystals) introduced the high efficiency GaSb IR cell for thermophotovoltaic (TPC) applications. Another interesting paper worth mentioning was presented by Ph.D. student Adem Yildirim from UNAM National Nanotechnology Research Center, Bilkent University, Turkey. Yildirim described large-area, robust, broad-band and omnidirectional antireflective and superhydrophobic coatings based on nanostructured organically modified silica colloids that have been developed; these coatings enhance the efficiency of dye-sensitized solar cells (DSSCs) with important self-cleaning properties.

John Walls (Loughborough University, UK) and his co-workers combined TEM, EDX and XPS analysis to explain the effect of chloride treatment on CdTe solar cells. They found 11.7% efficiency on chloride treated devices compared to 0.1% on pristine thin films. However, grain size did change significantly after chloride treatment. TEM images showed surface tilting in the (101) plane, with multiple lines corresponding to stacking. Voids and stacking faults were found all over the surface, which decreased after chloride treatment. Annealing of the as-deposited films at 4000C for different times showed that increase in annealing time decreased the defect density; stacking faults were significantly reduced in chloride treated films. EDX chlorine maps indicated decoration of grain boundaries with chlorine passivation. Walls concluded that pristine CdTe had a high density of stacking faults, and that cadmium chloride removed these faults by relaxation. Stacking fault density decreased with increase in annealing time. Cadmium chloride penetrated through the grain boundaries and built up the CdS surface which, in return, dramatically increased the efficiency of the solar cells.

In his invited talk on “Towards Ultrahigh-efficiency Solar Cells Using Dielectric Light Scattering Structures”, Albert Polman (AMOLF, Netherlands) talked about how nanophotonic design can help overcome many of the fundamental limits that are encountered in solar cells. Seth Hubbard (Rochester Institute of Technology) talked about the use of epitaxial InAs/GaAs quantum dots for bandgap engineering and optimization of single and multi-junction quantum dot solar cells. Stephen Forrest (University of Michigan) demonstrated a novel damage-free epitaxial lift-off process for multiple reuse of the parent wafer of GaAs thin-film solar cells. Both Takashi Fukui (Hokkaido University) and Diana Huffaker’s (UCLA) groups demonstrated high performance III-V nanowirebased solar cells, which stimulated lots of interesting questions and discussions. In the contributed talks, many types of solar cells fabricated from nanostructures such as quantum dots and nanowires were demonstrated.

Symposium M at the 2012 MRS Fall Meeting:

ARO Grant No. W911NF-13-1-0021

Objective

The goal of this symposium was to disseminate information related to directional surfaces in nature, their experimental characterization and theoretical understanding. Additionally, engineered directional surfaces and their experimental characterization, synthesis, and theoretical design tools were the main themes of the meeting for fabricating next generation device and technologies.

Summary

60 presenters and 16 internationally recognized invited speakers delivered talks and posters on the fabrication, synthesis and design of biologically inspired asymmetric surfaces. Experimental and theoretical approaches to the design, synthesis, and characterization of both natural and engineered surfaces demonstrating unidirectional surface properties were discussed. Directional textured surfaces on gecko, spider, and lizard feet allow the animals to climb smooth vertical walls. Inspired by natural directional surfaces, engineers have developed a myriad of synthetic surfaces with precisely tuned physicochemical properties to transport water droplets and soft materials, control imbibition, provide directional adhesion, and exhibit directional friction

Talks and highlights

There has been a growing interest to create eco-friendly materials from synthetic and biological materials exhibiting multifunctional characteristics. Ideally, these materials would be engineered using renewable resources and processing strategies. Inspired by natural biological materials and methods, a myriad of biological and synthetic surfaces have been developed with precisely tuned physicochemical properties to regulate wetting, adhesion and transport. Directional surfaces not only mimic biological function of these surfaces, but also open up new avenues for us to discover surface phenomenon that goes beyond nature. (i.e. design of new devices). Such advanced devices will be of great value to the energy and biomedical fields for applications such as directional syringes, microprocessor cooling, high-efficiency hydropower turbines, and nanoscale digital fluidics.

Submitted by:

Melik Demirel
Pennsylvania State University
May 30th, 2013

Final Report to the Army Research Office

Symposium Z: Oxide Semiconductors Block Grant Funding 2012 Fall Meeting of the Materials Research Society (MRS) Boston, MA USA

Grant Number: W911NF-13-1-0021

Amount Awarded: \$2820.

Award Period: 11/25/2012 to 6/30/2013

Prepared by: Steven M. Durbin

Department of Electrical Engineering and
Department of Physics
University at Buffalo
Buffalo, NY 14260
(716) 645-1024
sdurbin@buffalo.edu

On behalf of all Symposium Z Organizers:

Timothy Veal	University of Liverpool (UK)	– Lead Organizer
Steven Durbin	University at Buffalo (USA)	– Finances Contact
Martin Allen	University of Canterbury (New Zealand)	
Andre' Schleife	Lawrence Livermore National Laboratory (USA)	

1. Background

This symposium was the fifth in a series of Fall MRS Meeting symposia, the first of which was held in 2005 with a primary focus on ZnO. This symposium is distinct in focus from other symposia which concentrated on oxide nanostructures and transparent conducting oxides for contacts.

2. Symposium Goals

The organizers proposed the symposium to bring together researchers from around the world to discuss the current understanding of fundamental optical and electronic properties of the broad class of materials known as oxide semiconductors, as well as progress in device fabrication and characterization. In looking beyond ZnO for this symposium, we seek to broaden the scope of contributed and invited papers to include emerging materials which may prove to have more immediate device applications. In addition, it is likely that a deeper understanding of experimental observations of electrical and optical phenomena, interfacial and contact behavior, and device characteristics can be more rapidly achieved by considering several of these materials in parallel.

3. Symposium Attendance

In total, 15 separate sessions were held, spanning four full days of the Fall Meeting. These included 3 evening poster sessions. Sessions were very well-attended, in particular the high quality invited talks. Even more so than last year, Q&A sessions led to many good discussions.

4. Symposium Highlights

We are happy to report that a very diverse set of talks was presented in the symposium, covering a wide range of research at the forefront of oxide semiconductors. In particular, we highlight that the excellent selection of experimentalists was complemented by a diverse group of theoreticians and we believe that this turned out to be a successful approach that was highly beneficial for the goals of Symposium Z. In particular, leading theoretical (e.g. Van de Walle, Lany, Wei, Walsh, and Scanlon) as well as experimental (such as Hosono, Bierwagen, McCluskey, Hoffmann, and Tuomisto) experts came together to discuss controversial topics in order to push the knowledge in the field.

One of the most impressive experimental results presented at the symposium was the observation of small polarons or self-trapped holes in Ga_2O_3 using aberration-corrected high resolution transmission electron microscopy (TEM). Samples with a thickness of 2.4 nm were prepared by exfoliation, removing the deleterious effects of ion milling and enabling single atomic defects to be studied. The TEM images were shown to match very well with an ab-initio contrast simulation corresponding to the structure of the most stable of three different hole polarons. Formation, recombination and transfer processes of these polarons was revealed in real time, with the polaron lifetime being several seconds.

A promising identifiable trend in this year's symposium was a significantly greater number of contributions concerned with designing, calculating or realising p-type (or bipolar) oxide semiconductors. Within this theme, two classes of materials seem to dominate: (1) copper containing materials, due to the high lying Cu d orbitals which result in a higher valence band maximum on an absolute energy scale; and (2) layered oxychalcogenides. Many papers in the symposium in fact were devoted to the issue of the dopability of oxide materials; beyond the feasibility of p-type oxide semiconductors (such as ZnO , In_2O_3 and G_2O_3), the role of hydrogen, oxygen vacancies and vacancy complexes in controlling the transport properties of oxide materials, as well as the prospects for high quality multi-cation p-type oxide materials, were actively discussed topics, with potential applications including the future fabrication of transparent CMOS electronics for interactive optical displays, smart windows, and electronic paper. A key trend established by a number of papers was the extension of material functionality available by migrating from simple binary crystalline oxides to multi-cation amorphous oxide semiconductors.

Many theorists and experimentalists challenged the now many hundreds of publications which allege successful and reliable p-type doping of ZnO . Nitrogen, for example, has been found to be a deep acceptor and from straightforward band lineup and energy level arguments, it was reported that other candidate acceptors in ZnO are also highly likely to be deep. However, reports of p-type doping of ZnO , which fail to convince many, continue to appear in the literature every week. The possibility of p-type doping and p-type conductivity of ZnO in particular

spurred vivid discussion amongst the speakers and the audience, and shows that the field of zinc oxide is still evolving and deals with important open questions that are not well enough understood.

Experimentalists and theoreticians also debated the origin of electron accumulation e.g. at indium oxide surfaces and evaluated new insight into the different acceptor dopants and their signatures in the photoluminescence spectra of ZnO. Results for oxide alloys such as MgZnO and CdZnO were presented and the impact of radiation on ZnO was discussed. During this symposium it became clear that the community seems to be moving towards a more complete description of the fundamental band gap and the optical absorption edge by taking the influence of free carriers into account, e.g. for CdO or CdZnO.

From a device perspective, key highlights were the rapid advances reported in the development of transparent device technology based on amorphous zinc oxide based semiconductors such as indium gallium zinc oxide (IGZO), zinc tin oxide, and zinc cobalt oxide. IGZO in particular was only discovered in 2004 and is already being adopted by the semiconductor industry for transparent electronic devices. A number of papers were presented on the performance optimization of transparent amorphous oxide transistors targeted at next generation optical display applications, e.g. ultra fast wide area displays and next generation 3-D displays. Important issues discussed were the low temperature fabrication of transparent devices on flexible substrates and their switching stability under gate bias and illumination stress.

5. Funding Allocation

The following invited speakers received conference fee waivers (totaling \$2,645.00):

Martin Albrecht	IKZ Berlin (Germany)
Roger Reeves	University of Canterbury (New Zealand)
Matthew McCluskey	Washington State University (USA)
Jeffrey Davis	Swinburne University (Australia)
David Scanlon	University College London (UK)

This was very helpful in ensuring these speakers attended. They were very accessible during the meeting so that conference attendees had opportunities to speak with them in detail. In addition, a poster prize was issued to doctoral student Shawn Ellis at Binghamton University for the poster

Z13.46 Correlating p-type Doping with the Charge State of Copper in BiCuOSe

Summary		
Total Budget	\$2820	
Fee waivers		\$2645
Poster award		\$ 75
Proceedings*		\$ 100
<i>Total expenses</i>		\$2820
<i>Remaining funds</i>	\$0.	

*required hard copy of MRS Proceedings Vol. 1494

6. Future Directions

Based on the success of this symposium it was decided to continue, as many open issues remain and new opportunities exist to further explore, in particular with respect to devices, but also in terms of our understanding of fundamental properties and what happens in doped materials. We have also extended the reach of this symposium for 2013 to include complex oxides, and plan a joint session with another Symposium which is concentrating on interface electronic properties of those materials. Durbin is lead organizer for the Fall 2013 symposium, with Veal remaining as a co-organizer and new co-organizer Anderson Janotti (University of California, Santa Barbara) bringing strong theory/computational expertise joining in addition to Marius Grundmann (Universität Leipzig) returning to continue the strong device focus.

Symposium GG: Mechanical Behavior of Metallic Nanostructured Materials

Effect of Second Phase Particles on Mechanical Behavior of Nanostructured Alloys—Experiments and Modeling

Objectives

This symposium primarily focused on the aspects of processing methods, microstructural features, and mechanical behaviors of metallic nanostructured materials such as nanocrystalline materials, nanotwinned materials, nanopillars, nanocomposites, nanoscale thin films and multilayers, and nanoporous materials. This symposium was a multi-day program and its aims were two-fold:

1. One was to honor Professor Julia R. Weertman at Northwestern University for her tremendous contributions to structural characterization and mechanical behavior studies of nanostructured materials. One day of this multi-day symposium will be especially dedicated to this goal.
2. The other was to provide a platform for a group of researchers working in the field from all over the world to promote idea exchanges and advance the understanding of processing, microstructures, and mechanical behavior of metallic nanostructured materials.

Highlights, activities/findings

1. The symposium received a large number of abstracts and had 11 sessions. The symposium lasted for four and a half days.
2. Three sessions were devoted to invited talks.
3. Interesting research findings were presented in the forms of oral presentations and posters, and the program may be viewed at: www.mrs.org

Contributions to discipline

1. The symposium was utilized as a good platform for the interactions and communications among researchers in metallic nanostructured materials from all over the world.
2. ARO funding provided support to cover the researchers' registration fee, travel, etc., and thus supported the dissemination of the scientific research results.
3. The communications improved the understanding of the theoretical and practical limits of these materials and would allow engineers to optimize their performance.

Highlighted Presentation:

Malgorzata Landowska, Warsaw University of Technology

Malgorzata Lewandowska and her colleagues at Warsaw University of Technology have been putting grains inside of grains, as a means of investigating the Hall-Petch relationship (as well as inverse Hall-Petch) between strength and size at nano- and microscales. Their objective was to combine grain size refinement and nanoscale second phase particles to improve material strength. By carefully designing annealing and water-quenching parameters for aluminum, the group attained both macro- and nanoscale grains with nanoscale grains embedded inside of them. Both nanostructured materials exhibited strengthening. However, the nanoscale nanostructured aluminum grains exhibited less strengthening, and showed more dislocations as well as clusters of nano-grains precipitated at grain boundaries. Lewandowska turned to finite element modeling (FEM) to better understand the influence of nanograins at grain-boundaries. The model material had similar geometry and properties to copper grains. Three types of model material were tested: one with grain boundary material of greater strength than grain interiors, another with equal strength to grain interiors, and the third with less strength than grain interiors. The distribution of embedded particles between grain interiors and grain boundaries was also varied. Only when the grain boundary strength was less than the grain interior strength did the embedded particles influence material stress. FEM computations revealed that when grain boundary sliding is the dominant deformation mechanism, the nanoparticles clustered at grain boundaries may block motion of the grain boundaries, reduce plastic deformation, and contribute to material strengthening. Lewandowska's work presents a comprehensive exploration of the Hall-Petch relationship, and a promising means of strengthening metals through nanostructuring.

Final Report

2012 Acta Materialia Materials and Society Award Symposium—Honoring Professor Mildred Dresselhaus, MIT

On November 25, 2012, 8:30 am to 5:00 pm Republic Ballroom, Sheraton Hotel at the MRS Fall Meeting, November 25-30, 2012, Boston, Mass

Theme: Advanced Materials and their Impact on Society

Sponsored by: Acta Materialia, Inc, and Army Research Office

Chair: Jagdish (Jay) Narayan, North Carolina State University

This 2012 MRS Forum addressed the pioneering contributions of Professor Millie Dresselhaus in the field of advanced materials with emphasis on thermoelectric and carbon related materials, and how these contributions have resulted in the significant improvements in the quality of life. Throughout human history materials, from Stone Age to Iron Age to Bronze Age to present Semiconductors and Advanced Materials (Nanomaterials including), have defined major progress in our civilization. Because for every technology, there is a materials science bottleneck which must be addressed and problems solved. This MRS Forum brings together scientists and engineers of international repute to address the contributions of Professor Dresselhaus in the context of 2012 Acta Materialia Award for Materials and Society.

The MRS Forum was organized into three parts: (1) Plenary Session with about 11 Invited Talks; (2) Panel Discussion on The Future of Materials Research and Education; and (3) Evening Reception with short presentations and heavy aperitif and snacks.

Invited Speakers:

- (1) Millie Dresselhaus (MIT): Acta Materialia Award Forum on Advanced Materials
- (2) Bill Brinkman (US DOE): DOE Science and Impact on Society
- (3) Dudley Herschbach (Harvard): Advanced Materials
- (4) Ian Robertson (NSF): NSF Initiatives on Advanced Materials
- (5) George Crabtree and John Sarrao (ANL): From Quanta to the Continuum: Opportunities for Mesoscale Science
- (6) Gang Chen (MIT): Nanostructuring Approach to Thermoelectrics: Materials and Transport
- (7) Joseph Heremans (Ohio State): Thermoelectric and Spin-Thermal Solid-state Energy Conversion

(8) Marcos Pimenta (Universidade Minas Gerais, Brazil): Resonance Raman scattering in carbon Nanomaterials

(9) Riichiro Saito (Tohoku University, Japan): Optical properties of carbon nanotubes and graphene

(10) Mauricio Terrones (Penn State): Adventures with Millie in Carbon Research and Beyond

(11) Ado Jorio (Universidade Minas Gerais, Brazil): Graphene based materials - Can we eat them?

Panel Discussion: The Future of Materials Research and Education; (Chair: Millie Dresselhaus and Bill Brinkman)

Invited Participants:

(1) Marcie Black (Bandgap Engineering)

(2) Bob Brodersen (UC, Berkeley)

(3) Laurie McNeil (UNC, Chapel Hill)

(4) Lourdes Salammanca-Riba (University of Maryland)

(5) Georgy Samsonidze (Bosch Research)

(6) Nai-Chang Yeh (Cal Tech)

Evening Reception: 6-9PM (November 25, 2012) Back Bay Ballroom, Sheraton

Emails: herschbach@chemistry.harvard.edu; jean-paul.issi@uclouvain.be; Crabtree@anl.gov; gchen2@mit.edu; heremans.1@mecheng.ohio-state.edu; mpimenta@fisica.ufmg.br; rsaito@flex.phys.tohoku.ac.jp; mtterrones@gmail.com; adojorio@fisica.ufmg.br; mrkarty@yahoo.com; ncyeh@caltech.edu; Georgy.Samsonidze@us.bosch.com; rb@eecs.berkeley.edu; bob1bro@yahoo.com; riba@umd.edu; mcneil@physics.unc.edu; millie@mgm.MIT.EDU; narayan@ncsu.edu

Summary

The 2012 Acta Materialia Materials and Society Award Forum—Honoring Professor Mildred Dresselhaus, MIT, went extremely well. The Symposium was well attended with insightful research discussions. The delegates addressed cutting-edge research on thermoelectric and carbon related materials, and how these contributions have resulted in the significant improvements in the quality of life. The presentations made significant contributions to in the field of advanced materials with emphasis on thermoelectric and carbon related materials. The Panel chaired by Professor Millie Dresselhaus and Dr. Bill Brinkman focused on The Future of Materials Research and Education and its Impact on Society at large. The ARO funds were used to support primarily the registration fees of the participating delegates.