Solar Energy: New Materials and Nanostructured Devices for High Efficiency

June 24–25, 2008

Stanford University
Stanford, California, USA

Postdeadline Submission Deadline: June 16, 2008, 12:00 p.m. EDT (16.00 GMT)
Register for Solar
Agenda Information

General Chair:
Peter Peumans, Stanford Univ., USA

Program Chair:
Shanhui Fan, Stanford Univ., USA
Ali Shakouri, Univ. of California at Santa Cruz, USA

Global energy consumption is inexorably increasing, driven by population growth and the wave of industrialization in developing countries. Plentiful, renewable, and non-polluting sources of energy are needed. One such energy source is based on the efficient conversion of solar radiation into useful energy forms; directly to electrical power as in photovoltaic solar cells, and indirectly by concentration of solar radiation to create high temperatures to drive thermal engines.

This topical meeting, “Solar Energy: New Materials and Nanostructured Devices for High Efficiency”, **will bring together researchers active in solar energy conversion with scientists from the materials research and nanotechnology communities**. Presentations at the meeting will address leading edge scientific and technical challenges involved in the development of advanced devices for third generation (and beyond) solar cells and for other high-efficient energy conversion devices.

For more information, please go to the **SPRC Website**.

Topics to be considered include:

New high-efficiency organic and inorganic photovoltaic materials engineered to match the solar emission spectrum

Improved efficiency photovoltaics using metamaterials such as photonic bandgap crystals and metal nanostructures exhibiting plasmon resonances

Flexible, low-cost, active materials and transparent electrodes for low cost roll-to-roll manufacturing of solar cells

Enhancing the efficiency of solar cells by nanostructuring the active interfaces to reduce the distance that the photo-produced charge carriers or energy need to travel before being harvested

Materials and nanophotonic structures such as photonic band gap crystals and metamaterials for thermophotovoltaics and concentrated solar power

MEMS-based mechanical devices for solar energy conversion into mechanical energy

Metamaterials for thermoelectric energy conversion

Current Invited Speakers

Harry A. Atwater, Jr.
Howard Hughes Professor of Applied Physics and Materials Science, Cal Tech
Plasmonic Solar Cells

Mark Brongersma
Assistant Professor of Materials Science and Engineering, Stanford University
Nanoscale Photonic Materials

Gang Chen
Warren and Towneley Rohsenow Professor of Mechanical Engineering, MIT
Solar Thermoelectrics and Thermophotovoltaics

Shanhui Fan
Associate Professor of Electrical Engineering, Stanford University
Conference Co-Chair

Martin Green
Executive Research Director, ARC Photovoltaics Centre of Excellence, University of New South Wales
High Efficiency Silicon Solar Cells

Jean-Jacques Greffet
Professor, École Centrale Paris
Optical Antennas for Enhanced Efficiency

James R. Heath
Elizabeth W. Gilloon Professor of Chemistry, Cal Tech
Silicon Nanowire Thermoelectrics

Joseph Heremans
Professor of Mechanical Engineering, Ohio State University
Nanostructured Thermoelectric Materials

Michael McGehee
Assistant Professor of Materials Science and Engineering, Stanford University
Nanostructured Solar Cells

Peter Peumans
Assistant Professor of Electrical Engineering, Stanford University
Conference Co-Chair

Ali Shakouri
Associate Professor of Electrical Engineering, UC Santa Cruz
Conference Co-Chair

Peter Würfel
Professor, Institut fuer angewandte Physik, Universitaet Karlsruhe
Thermodynamic Limits of Solar Cell Efficiency

Solar Energy: New Materials and Nanostructured Devices for High Efficiency

Tuesday, June 24

8:00 – 8:30 Check-in / On-site Registration / Continental Breakfast
8:30 – 8:45 Introduction

Plenary Session

8:45 – 9:30 **Thermodynamic Limits of Solar Cell Efficiency**
Peter Würfel, Universität Karlsruhe

9:30 – 10:15 **Photovoltaic Plasmonics**
Martin Green, University of New South Wales

10:15 – 10:45 **COFFEE BREAK** *sponsored by Corning*

Thermal Photovoltaics

10:45 – 11:15 **Optical Antennas for Enhanced Efficiency**
Jean-Jacques Greffet, École Centrale Paris

11:15 – 11:30 **Nanostructured Tungsten Absorber and Emitter for Solar Thermal Photovoltaics**
Eden Rephaeli, Stanford University

11:30 – 12:00 **Solar Thermoelectrics and Thermophotovoltaics**
Gang Chen, MIT

12:00 – 2:00 **LUNCH AND POSTER SESSION**

Plasmonic Solar Cells

2:00 – 2:30 **Nanoscale Photonic Materials**
Mark Brongersma, Stanford University

2:30 – 2:45 **Reduced Graphene Oxide Transparent Electrodes for Photovoltaic Applications**
Junbo Wu, Stanford University

2:45 – 3:15 **Plasmonic Photovoltaics**
Harry Atwater, Cal Tech

3:15 – 3:45 **COFFEE BREAK** *sponsored by Coherent*

Advances in Solar Energy

3:45 – 4:00 **Quantum Dot Materials for Solar Cell Applications: Effects of Strain-Reducing and Strain-Compensated Barriers on Dot Structural and Optical Properties**
Anup Pancholi, University of Delaware

4:00 – 4:30 **Transparent Electrodes, Alternatives to ITO**
George Gruner, University of California, Los Angeles

4:30 – 4:45 **Light Trapping in the Wave Regime in Thin-film Solar Cells**
Mukul Agrawal, Stanford University

4:45 – 5:00 **Molecular Organic Thin-Film Solar Cells Deposited on Fibers**
Brendan O'Connor, University of Michigan

5:30 – 9:00 **Reception and Banquet** at Stanford Faculty Club, *sponsored by GCEP*
After-Dinner Speaker: Martin Roscheisen, Nanosolar

Solar Energy: New Materials and Nanostructured Devices for High Efficiency
Wednesday, June 25, 2008

8:00 – 8:30 Breakfast

Nanostructured Solar Cells

8:30 – 9:00 **Nanostructured Solar Cells**
Mike McGehee, Stanford University

9:00 – 9:15 **Optimizing Hybrid Nanocrystal/Polymer Photovoltaics through Ligand Choice**
Jeremy Olson, University of California at Santa Cruz

9:15 – 9:30 **InAs/GaAs Quantum-Dot Intermediate-Band Solar Cells**
Alysha Grenko, Carnegie Mellon University

9:30 – 10:00 **High Performance Polymer Opto-Electronic Devices Based on Nano-Scale Engineering**
Yang Yang, University of California, Los Angeles

10:00 – 10:30 **COFFEE BREAK** *sponsored by Newport/Spectra-Physics*

Thermoelectrics

10:30 – 11:00 **Silicon Nanowire Thermoelectrics**
Jim Heath, Cal Tech

11:00 – 11:15 **In-plane Thermoelectric Properties of Epitaxial InGaAlAs Films embedded with ErAs Nanoparticles**
Anastassios Mavrokefalos, University of Texas

11:15 – 11:45 **Nanostructured Thermoelectric Materials**
Joseph Heremans, Ohio State University

11:45 – 12:00 **Nanoparticle Scattering in Thermoelectric Transport**
Mona Zebarjadi, University of California at Santa Cruz

12:00 – 2:00 **LUNCH AND POSTDEADLINE POSTER SESSION**

Commercial Realities and Economics of Photovoltaics

2:00 – 2:15 Lucas Tsakalakos, GE Global Research

2:15 – 2:30 Joseph Stagner, Stanford University

2:30 – 2:45 Anthony E. Siegman, Stanford University

2:45 – 3:00 Doug Rose, SunPower

3:00 – 3:15 TBA

3:15 – 3:45 **COFFEE BREAK**

3:45 – 4:50 Panel Discussion

4:50 – 5:00 Closing Remarks

Agenda of Sessions

Tuesday, June 24, 2008		
8:00 a.m.–8:30 a.m.	**Check-In/On-Site Registration/Continental Breakfast**	*Skilling Auditorium Tents*
8:30 a.m.–8:45 a.m.	**Introduction**	*Skilling Auditorium*
8:45 a.m.–10:15 a.m.	**STuA • Plenary Session**	*Skilling Auditorium*
10:15 a.m.–10:45 a.m.	**Coffee Break**	*Skilling Auditorium Tents*
10:45 a.m.–12:00 p.m.	**STuB • Thermal Photovoltaics**	*Skilling Auditorium*
12:00 p.m.–2:00 p.m.	**STuC • Poster Session/Lunch**	*Skilling Auditorium Tents and Upstairs Patio*
2:00 p.m.–3:15 p.m.	**STuD • Plasmonic Solar Cells**	*Skilling Auditorium*
3:15 p.m.–3:45 p.m.	**Coffee Break**	*Skilling Auditorium Tents*
3:45 p.m.–5:00 p.m.	**STuE • Advances in Solar Energy**	*Skilling Auditorium*
5:30 p.m.–9:00 p.m.	**Reception and Banquet**	*Stanford Faculty Club*
Wednesday, June 25, 2008		
8:00 a.m.–8:30 a.m.	**Breakfast**	*Skilling Auditorium Tents*
8:30 a.m.–10:00 a.m.	**SWA • Nanostructured Solar Cells**	*Skilling Auditorium*
10:00 a.m.–10:30 a.m.	**Coffee Break**	*Skilling Auditorium Tents*
10:30 a.m.–12:00 p.m.	**SWB • Thermoelectrics**	*Skilling Auditorium*
12:00 p.m.–2:00 p.m.	**SWC • Postdeadline Poster Session/Lunch**	*Skilling Auditorium Tents and Upstairs Patio*
2:00 p.m.–3:20 p.m.	**SWD • Commercial Realities and Economics of Photovoltaics**	*Skilling Auditorium*
3:20 p.m.–3:50 p.m.	**Coffee Break**	*Skilling Auditorium Tents*
3:50 p.m.–4:50 p.m.	**SWE • Industrial Panel**	*Skilling Auditorium*
4:50 p.m.–5:00 p.m.	**Closing Remarks**	*Skilling Auditorium*

General Chair:

Peter Peumans, *Stanford Univ., USA*

Program Chairs:

Shanhui Fan, *Stanford Univ., USA*

Ali Shakouri, *Univ. of California at Santa Cruz, USA*

•Tuesday, June 24, 2008•

Skilling Auditorium Tents
8:00 a.m.–8:30 a.m.
Check-In/On-Site Registration/Continental Breakfast

Skilling Auditorium
8:30 a.m.–8:45 a.m.
Introduction

STuA • Plenary Session

Skilling Auditorium
8:45 a.m.–10:15 a.m.
STuA • Plenary Session

STuA1 • 8:45 a.m. Invited
Thermodynamic Limits of Solar Cell Efficiency, *Peter Würfel; Univ. Karlsruhe, Germany.* A general analysis of the coversion of solar heat to electrical energy in solar cells is presented. Some solar cell structures and processes are described which, in principle, avoid thermalization losses and allow efficiencies as high as 86%.

STuA2 • 9:30 a.m. Invited
Photovoltaic Plasmonics, *Martin Green[1], Supriya Pillai[1], Kylie Catchpole[1,2]; [1]Univ. of New South Wales, Australia, [2]Ctr. for Nanophotonics, FOM Inst. for Atomic and Molecular Physics (AMOLF), Netherlands.* Metal nanoparticles enhance response 16 times at 1050 nm in thin silicon solar cells. Schemes using propagating surface plasmons have potential in our group's "third generation" silicon quantum dot and hot carrier devices.

Skilling Auditorium Tents
10:15 a.m.–10:45 a.m.
Coffee Break

STuB • Thermal Photovoltaics

Skilling Auditorium
10:45 a.m.–12:00 p.m.
STuB • Thermal Photovoltaics

STuB1 • 10:45 a.m. Invited
Optical Antennas for Enhanced Efficiency, *Ruben Esteban, Marine Laroche, Jean Jacques Greffet; Ecole Centrale Paris, France.* High efficiency solutions for photovoltaics requires taking advantage of IR photons energy. Possible solutions are based on up-conversion processes which have a low cross section. We will discuss different solutions to enhance the absorption.

STuB2 • 11:15 a.m.
Nanostructured Tungsten Absorber and Emitter for Solar Thermal Photovoltaics, *Eden Rephaeli, Shanhui Fan; Stanford Univ., USA.* Using 3-D finite-difference time-domain simulations, we designed nanostructured Tungsten absorber and emitter for solar thermophotovoltaics applications. The absorber exhibits unity absorptivity over the solar bandwidth, emitter has unity emissivity at 1.1eV, corresponding to Si bandgap.

STuB3 • 11:30 a.m. Invited
Solar Thermoelectric and Thermophotovoltaic Converters, *Gang Chen; MIT, USA.* This paper discusses potentials of converting solar energy first into a terrestrial heat source and then into electricity via solid-state thermoelectric and thermophotovoltaic devices. Theoretical efficiency as well as recent materials advances will be presented.

Skilling Auditorium Tents
12:00 p.m.–2:00 p.m.
Lunch

STuC • Poster Session

Skilling Auditorium Upstairs Patio
12:00 p.m.–2:00 p.m.
STuC • Poster Session

STuC1
All-Inorganic Spin-Cast Nanoparticle Solar Cell with Non-Selective Electrodes, *Ingrid E. Anderson, Y. W. Chavez, L. Yang, J. D. Olson, S. A. Carter; Univ. of California at Santa Cruz, USA.* Spin-cast all-inorganic nanoparticle solutions have been used to make a CdTe/CdSe solar cell with an efficiency of up to 1.9%. The non-selective nature of the contacts made to these devices is explored.

STuC2
Reduced Graphene Oxide Transparent Electrodes for Photovoltaic Applications, *J. Wu, Hector Alejandro Becerril-Garcia, Z. Liu, Y. Chen, Z. Bao, P. Peumans; Stanford Univ., USA.* We demonstrate reduced graphene oxide (RGO) thin films can be used as transparent electrodes for organic solar cells and organic light emitting diodes. Graphene oxide was deposited by solution processing and reduced to enhance conductivity.

STuC3
Fiber Lasers in Solar Applications, *Tony Hoult, Jack Gabzdyl, Ken Dzurko; SPI Lasers, USA.* Fiber Laser MOPAs, with operational flexibility, high peak energies and high repetition rates, are rapidly emerging as a versatile and economic tool for photovoltaic processing over a wide range of material systems and process requirements.

STuC4
Synthesis and Design of Acene-Containing Polymers for Organic Photovoltaics, *Toshihiro Okamoto[1], Ying Jiang[2], Fei Qu[2], Alex C. Mayer[2], Jack Parmer[2], Michael D. McGehee[2], Zhenan Bao[2]; [1]Inst. of Physical and Chemical Res. (RIKEN), Japan, [2]Stanford Univ., USA.* Triisopropylethynyl derivatives of pentacene (TIPSEP) and anthradithiophene (TIPSEAdT) copolymerized with diethynylbenzene and fluorene via Sonogashira and Suzuki coupling show optical bandgaps between 1.6 and 2.0 eV. TIPSEAdT-9,9-dioctylfluorene yielded preliminary photovoltaic power conversion efficiency of 0.69%.

STuC5
Improvement of Light Transmission Using Photonic Lattices for Solar Cells, *Xiaomin Jin, Simeon Trieu; California Polytechnic State Univ., USA.* We study solar-cell interface designs using photonic lattices. We simulate rectangular and triangular micro-profiles as the solar cell surface. Compared to the conventional flat surface, the photonic lattice interface can increase light transmission to 98%.

STuC6
Semiconductor Alloy Nanowires with Spatially Graded Compositions for Full-Spectrum Solar Cell Applications, *A. L. Pan[1], E. S. P. Leong[1], M. Sun[1,2], C. Z. Ning[1], W. C. Zhou[2], B. S. Zou[2]; [1]Arizona State Univ., USA, [2]Hunan Univ., China.* We demonstrate CdS_xSe_{1-x} nanowire growth with x changing from 0 to 1 continuously within 1-cm substrate corresponding to 200-nm wavelength variation on a *single substrate*, providing novel full-spectrum materials for high-efficiency solar cell applications.

STuC7
Temperature Dependent Characteristics of Thin Film Nanocrystal Solar Cells, *Yvonne W. Rodriguez, Jeremy D. Olson, Ingrid E. Anderson, Glenn P. Gray, Sue A. Carter; Univ. of California at Santa Cruz, USA.* Photovoltaic devices made from thin films cadmium selenide (CdSe) and cadmium telluride (CdTe) nanocrystals and poly(3-hexylthiophene) (P3HT) are studied. The temperature dependence of photovoltaic characteristics suggest hopping dominated transport in sintered nanoparticle films.

STuC8
The Basic Economics of Photovoltaics, *Greg P. Smestad; Solar Energy Materials and Solar Cells, USA.*
With widespread deployment of PV power imminent, it is useful for researchers to have a basic knowledge of the economic principles that govern PV modules and systems. Several simplified and illustrative equations are presented.

STuC9
Enhanced Efficiency of Polymer Photovoltaic Devices by Using Silicon Nanowires, *Wei-Hsiang Su, Ching-Fuh Lin; Graduate Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan.* Wet-etching silicon nanowires were integrated into poly(3-hexylthiophene) (P3HT)/[6,6]phenyl-C61-butyric acid methyl ester) (PCBM) bi-layer solar cells by using a transferring method, resulting in an enhancement of the power conversion efficiency from 0.47% to 0.7%.

STuD • Plasmonic Solar Cells

Skilling Auditorium
2:00 p.m.–3:15 p.m.
STuD • Plasmonic Solar Cells

STuD1 • 2:00 p.m. **Invited**
Nanoscale Photonic Materials, *Mark Brongersma; Stanford Univ., USA.* In this presentation I will discuss the unique optical properties of metallic (i.e. plasmonic) nanostructures and how they can be employed to enhance the efficiency of photovoltaic devices.

STuD2 • 2:30 p.m.
Enhanced Absorption of an InGaN/GaN Quantum Well through Surface Plasmon Coupling, *Yen-Cheng Lu, Wen-Hung Chuang, Cheng-Yen Chen, Kun-Ching Shen, Dong-Ming Yeh, Jyh-Yang Wang, Yean-Woei Kiang, C. C. Yang; Natl. Taiwan Univ., Taiwan.* The observation of the enhanced absorption of an InGaN/GaN quantum well through the coupling with localized surface plasmons (LSPs) and the dependence of LSP resonance energy on the geometry of a metal layer are reported.

STuD3 • 2:45 p.m. **Invited**
Plasmonic Photovoltaics, *Harry Atwater, Katsuaki Tanabe, Keisuke Nakayama, Vivian Ferry, Luke Sweatlock, Dominico Pacifici; Caltech, USA.* We outline approaches to dramatically modify the light absorption and carrier collection characteristics of photovoltaic materials and devices using plasmonic structures to localize light at subwavelength dimensions.

Skilling Auditorium Tents
3:15 p.m.–3:45 p.m.
Coffee Break

STuE • Advances in Solar Energy

Skilling Auditorium
3:45 p.m.–5:00 p.m.
STuE • Advances in Solar Energy

STuE1 • 3:45 p.m.
Quantum Dot Materials for Solar Cell Applications: Effects of Strain-Reducing and Strain-Compensated Barriers on Dot Structural and Optical Properties, *Anup Pancholi[1], Yuanchang Zhang[1], Jonathan Boyle[1], Valeria Gabriela Stoleru[1], Mark C. Hanna[2], Andrew G. Norman[2], Stephen Bremner[1], Christiana Honsberg[1]; [1]Univ. of Delaware, USA, [2]Natl. Renewable Energy Lab, USA.* We present structural and optical analysis of (In,Ga)As quantum dot structures with strain-compensated and strain-reduced barriers for intermediate band solar cell applications.

STuE2 • 4:00 p.m. Invited
Transparent Electrodes, Alternatives to ITO, *George Gruner; Univ. of California at Los Angeles, USA.*
This talk will discuss alternatives to conventional metal oxide transparent electrodes with a reduced cost and higher performance.

STuE3 • 4:30 p.m.
Light Trapping in the Wave Regime in Thin-Film Solar Cells, *Mukul Agrawal, Peter Peumans; Stanford Univ., USA.* It is shown that nanoscale structuring of the active medium of a thin-film solar cell in three dimensions is an effective approach to light trapping that approaches the theoretical limits.

STuE4 • 4:45 p.m.
Molecular Organic Thin-Film Solar Cells Deposited on Fibers, *Brendan O'Connor, Kevin P. Pipe, Max Shtein; Univ. of Michigan, USA.* We demonstrate and analyze in detail a fiber-shaped organic photovoltaic cell that utilizes concentric thin films of small molecular weight compounds and metals, permitting illumination normal to the fiber axis.

Stanford Faculty Club
5:30 p.m.–9:00 p.m.
Reception and Banquet

NOTES

•Wednesday, June 25, 2008•

Skilling Auditorium Tents
8:00 a.m–8:30 a.m.
Breakfast

SWA • Nanostructured Solar Cells

Skilling Auditorium
8:30 a.m.–10:00 a.m.
SWA • Nanostructured Solar Cells

SWA1 • 8:30 a.m. Invited
Nanostructured Solar Cells, *Michael McGehee; Stanford Univ., USA.* Abstract not available.

SWA2 • 9:00 a.m.
Optimizing Hybrid Nanocrystal/Polymer Photovoltaics through Ligand Choice, *Jeremy D. Olson, Glenn P. Gray, Sue A. Carter; Univ. of California at Santa Cruz, USA.* Photovoltaic devices made from blended cadmium selenide (CdSe) nanocrystals with various capping ligands and poly-3-hexylthiophene (P3HT) were prepared. The effects of capping ligands were investigated. We find that capping ligands dominate morphology/phase separation.

SWA3 • 9:15 a.m. Invited
To Be Announced

SWA4 • 9:45 a.m.
InAs/GaAs Quantum-Dot Intermediate-Band Solar Cells, *Alysha Grenko, Ibrahim Kimukin, John Walker, Elias Towe; Carnegie Mellon Univ., USA.* Results for quantum-dot intermediate-band solar cells are presented. It is shown that quantum dots in conventional *p-i-n* structures can extend the photoresponse to 1300 nm, well beyond what is possible with the base GaAs material.

Skilling Auditorium Tents
10:00 a.m.–10:30 a.m.
Coffee Break

SWB • Thermoelectrics

Skilling Auditorium
10:30 a.m.–12:00 p.m.
SWB • Thermoelectrics

SWB1 • 10:30 a.m. Invited
Silicon Nanowire Thermoelectrics, *Jim Heath; Caltech, USA.* Heat dissipation in fundamentally modified in nanoscale materials, leading to new opportunities for high efficiency thermoelectric materials designed for energy conversion. I will review recent work in 3 classes of materials, including Si nanowire thermoelectrics.

SWB2 • 11:00 a.m.
In-Plane Thermoelectric Properties of Epitaxial InGaAlAs Films Embedded with ErAs Nanoparticles, *Anastassios Mavrokefalos[1], Li Shi[1], Joshua M. Zide[2], Hong Lu[3], Arthur Gossard[3], Ali Shakouri[4]; [1]Univ. of Texas at Austin, USA, [2]Univ. of Delaware, USA, [3]Univ. of California at Santa Barbara, USA, [4]Univ. of California at Santa Cruz, USA.* The in-plane thermoelectric properties of InGaAlAs films with embedded ErAs nanoparticles are measured using a suspended device. The measurement results are compared with cross-plane and in-plane properties measured using other methods.

SWB3 • 11:15 a.m. Invited
Nanostructured Thermoelectric Materials, *Joseph Heremans; Ohio State Univ., USA.* Thermal solar energy conversion utilizes the sun's entire spectrum and can work in conjunction with photovoltaic conversion and use waste heat. Recent progress in materials requirements of thermoelectric conversion in this application will be reviewed.

SWB4 • 11:45 a.m.
Nanoparticle Scattering in Thermoelectric Transport *Mona Zebarjadi, Keivan Esfarjani, Ali Shakouri; Univ. of California, Santa Cruz, USA.* We calculate the scattering cross section of the electron-nanoparticle collision using the Born approximation and partial-waves technique. The Born approximation leads to incorrect transport properties for electron energies comparable to the nanoparticle barrier height.

Skilling Auditorium Tents
12:00 p.m.–2:00 p.m.
Lunch

SWC • Postdeadline Poster Session

Skilling Auditorium Upstairs Patio
12:00 p.m.–2:00 p.m.
SWC • Postdeadline Poster Session

More information about the presentations during the Postdeadline Poster Session may be found in your Postdeadline Paper booklet.

SWD• Commercial Realities and Economics of Photovoltaics

Skilling Auditorium
2:00 p.m.–3:20 p.m.
SWD• Commercial Realities and Economics of Photovoltaics

SWD1 • 2:00 p.m.
Loucas Tsakalakos, GE Global Research, USA.

SWD2 • 2:20 p.m.
Joseph Stagner, Stanford Univ., USA.

SWD3 • 2:40 p.m.
Anthony E. Siegman, Stanford Univ., USA.

SWD4 • 3:00 p.m.
To Be Announced

3:20 p.m.–3:50 p.m.
Coffee Break

SWE • Industrial Panel

Skilling Auditorium
3:50 p.m.–4:50 p.m.
SWE • Industrial Panel

Skilling Auditorium
4:50 p.m.–5:00 p.m.
Closing Remarks

NOTES

Key to Authors and Presiders

(**Bold** denotes Presenting Author)