

**Thursday, May 14**

**8:30 a.m. CT-16 An Update on the Center for Advanced Molecular Photovoltaics**

M. McGehee, Department of Materials Science and Engineering, Stanford University, Stanford, CA

*Invited 40 min. Talk*

Molecular photovoltaic cells can be fabricated at low-cost using roll-to-roll coating processes similar to those used to make newspapers. They can be much cheaper than conventional cells because, in addition to having low materials costs, the cells can be printed and connected to each other in a high-throughput, integrated architecture. Today's best organic solar cells have an efficiency of 6.5 % and last approximately 1 year under sunlight. The Center for Advanced Molecular Photovoltaics has plans for raising the efficiency and making the cells stable for ten years or more. Highlights of recent research will be presented.

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**9:10 a.m. CT-17 New Materials for Organic Photovoltaic Devices**

M.E. Thompson, M.D. Perez, K. Mutolo, and C. Schlenker, Department of Chemistry, University of Southern California, Los Angeles, CA

We have begun a systematic study of a range of different materials for organic photovoltaic devices. This talk discusses the development of new materials as donors, acceptors and buffer layers in OPVs. We have investigated a family of Ru(beta-diketonate) complexes. We have investigated a range of Ru(acetylacetonate)<sub>3</sub> as a buffer material, several subphthalocyanine complexes have been used to investigate the connection between the OPV open circuit voltage (Voc) and have explored the use of metal porphyrin complexes as donor materials in OPVs. The complexes we have chosen have high luminance efficiencies and long lifetimes. We expected that these two parameters would lead to long exciton diffusion lengths. Both Pt and Pd complexes make good red absorbing donor materials in OPVs. Unfortunately, our initial hypothesis that these materials would give long exciton diffusion lengths was wrong. We believe that this is due to a combination of both poor spectral overlap and a self quenching process that severely shortens the exciton lifetimes in thin films of these materials.

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**9:30 a.m. CT-18 Advanced Processing of New Materials for Extended Operational Lifetime of Polymer Solar Cells**

S. Gevorgyan and F. Krebs, Risø National Laboratory for Sustainable Energy, Technical University of Denmark, Roskilde, Denmark

The current performance in the state-of-the-art polymer solar cell is most often reached through processing methods post-film formation i.e. using solvent or thermal annealing. We present new fully roll-to-roll compatible processing methods and demonstrate that they can be used for improving the power conversion efficiency. Power conversion efficiencies in excess of 1.5% by processing novel materials in these manners will be presented. The operational lifetime is improved through choice of device geometry and materials such that exceptional resilience towards oxygen and water is achieved enabling operation without encapsulation.

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**9:50 a.m. CT-19 Stability Investigations of Organic Photovoltaic Cells**

J.A. Hauch, A. Seemann, F.R. Kogler, and P. Schilinsky, Konarka Technologies GmbH, Nuremberg, Germany

Stability of OPV cells is one of the key properties needed for commercialization. Despite some recent work showing that organic solar cells made with P3HT:PCBM have very promising lifetimes under various conditions, there still is not much known about the degradation mechanisms of organic solar cells. We use a novel cell architecture to investigate the influence of water and oxygen on cells in operation, allowing us to separate the degradation effects. Our results can be used to further develop packaging technology for organic solar cells, and to further improve their lifetimes.

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**10:30 a.m. CT-20 Modification of Nanomorphology in Polymer: Fullerene Blends-Route Towards High Efficiency Polymer Solar Cells**

Y. Yang, Department of Materials Science and Engineering, University of California Los Angeles, Los Angeles, CA; G. Li and V. Shrotriya, Solarmer Energy Inc., El Monte, CA; and Y. Yao, H.Y. Chen, and S. Sista, Department of Materials Science and Engineering, University of California Los Angeles, Los Angeles, CA

*Invited 40 min. Talk*

Extensive research is going into polymer solar cells because of their advantage of ease of fabrication, low cost, ability to make large area devices and mechanical flexibility. Optimizing the morphology on a molecular level is essential for achieving high performance polymer solar cells. Optimal nanomorphology leads to optimized exciton dissociation efficiency which is determined by the donor/acceptor interface area and optimal charge transport efficiency through percolating pathways for carriers. In this presentation, we discuss three strategies to manipulate the nanomorphology of regioregular poly(3-hexylthiophene) (rr-P3HT): [6,6]phenyl-C61-butyric acid methyl ester (PCBM) blends viz. thermal annealing, solvent annealing and mixed solvent approach, all of which lead to improved photovoltaic performance. It has been shown that all three strategies lead to better ordering of the P3HT domains and hence good polymer crystallinity. The effect of these strategies on the blend morphology, polymer crystallinity, absorption and charge carrier mobility will be discussed and will be related to the photovoltaic performance of the device.

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**11:10 a.m. CT-21 Supramolecular Approaches for Polymer-Based Solar Cells**

B.C. Thompson, University of Southern California, Los Angeles, CA

Composite solar cells based on conjugated polymer donors and fullerene acceptors represent the current state-of-the-art in organic photovoltaics, where blends of poly(3-hexylthiophene) (P3HT) and [6,6]-phenyl C61-butyric acid methyl ester (PCBM) exhibit efficiencies approaching 5%. Despite the excellent performance of these systems, there is a great deal of room for improvement in not only the electronic properties of the polymer, but also in the thermal stability of the composite material. Without a precise control over donor-acceptor interfaces within the composite material, little progress can be made in improving solar cell performance. Here, several novel approaches toward polymer based solar cells will be described in which control over the supramolecular organization of the donor and acceptor components is targeted as a primary mechanism of improving the electronic properties of the solar cells. Further, steps toward achieving stable composite materials based on supramolecular approaches will be described. The ultimate goal of this work is to develop stable donor-acceptor composites in which the morphology is accurately controlled to maximize device performance and lifetime and to increase the potential for generating effective, low cost, solution processable, and flexible solar cells.

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**11:30 a.m. CT-22 Alternative Hole Transport Layers for Organic Photovoltaics**

D.C. Olson, J.J. Berry, N.E. Widjonarko, M.S. White, M.O. Reese, and D.S. Ginley, National Renewable Energy Laboratory, Golden, CO

Improvements in the lifetime and efficiency of organic photovoltaics are critical to its development as a viable technology. One of the important interfaces in OPV devices is between the transparent electrode and the organic active material, where an interfacial material can aid in charge extraction. In our typical OPV devices we employ a glass/indium tin oxide (ITO) substrate with an interstitial layer of PEDOT:PSS to modulate the interface between the ITO and active P3HT:PCBM bulk heterojunction (BHJ) region. The PEDOT:PSS material serves as the hole transport layer (HTL) in the devices, but has numerous drawbacks with respect to morphology, chemistry, stability and scalability. Here we report on our use of alternative HTLs based on mixed metal oxides and commercially available organic HTLs. We compare the results from P3HT:PCBM BHJ devices using these alternative HTLs with traditional devices employing PEDOT:PSS. Changes in device efficiency, as well as work function, pH, and conductivities are quantified as a function of the HTL employed. In addition, we will employ transparent electrodes other than ITO that are not accessible when using PEDOT:PSS as the HTL. We also report on initial device degradation studies, which examine the correlation between the HTL used and time dependent changes in device efficiency.

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**11:50 a.m. CT-23 Large Scale Demonstrations of Polymer Solar Cells as a Tool for Innovation, Cost Analysis and Market Development**

T. Nielsen and F. Krebs, Risø National Laboratory for Sustainable Energy, Technical University of Denmark, Roskilde, Denmark

Polymer solar cells have a long history approaching two decades and commercialization is imminent. There has been a large interest in establishing a firm comparison with existing solar cells technologies under conditions of large scale production and real life demonstration. In this presentation, examples of large public demonstrations of polymer solar cells produced industrially on a large scale will be detailed. The performance was significantly below the current state-of-the-art for laboratory cells but sufficient for demonstration purposes. The total process time for complete modules comprising five solution processed layers and module areas of ~100 square centimeters was as low as 12 seconds. This has allowed for extensive innovation that will be detailed along with a firm cost analysis of the technology. The market possibilities for the technology as it can be produced via the methods presented are detailed.