NEW MATERIALS FOR ORGANIC PHOTOVOLTAIC DEVICES

Mark E. Thompson, M. Dolores Perez, Kristin Mutolo, Cody Schlenker, Stephen R. Forrest, Rhonda Salzman, Elizabeth Mayo

Department of Chemistry, University of Southern California, Los Angeles, CA USA
Departments of Electrical Engineering and Physics, University of Michigan, Ann Arbor, MI
Global Photonic Energy Corporation, Ewing, NJ

There has been a great deal of interest in developing new materials for the fabrication of light emitting diodes (OLEDs). We have prepared a range of intensely metal complexes, which have found application in both monochromatic and white OLEDs. Our approach has involved a systematic study of a range of different materials. We have used a similar approach to develop materials for organic photovoltaic devices (OPVs). I will discuss the development of new materials as donors, acceptors and buffer layers in OPVs. I will discuss the use of metal complexes and subthalocyanines as donor and acceptor materials in organic solar cells and M(β-dikenotate)$_3$ complexes as buffer layers in OPVs. We have prepared a family of subphthalocyanine complexes to investigate the connection between the OPV open circuit voltage (V_{oc}) and the energy difference between the donor HOMO and acceptor LUMO energies (I_g). These molecular orbitals are the ones that carry the holes and electrons, respectively. This study shows that there is a clear connection between the V_{oc} and the I_g. A high I_g leads to a high V_{oc}. We have explored the use of metal porphyrin complexes as donor materials in OPVs. The complexes we have chosen have high nonplanar structures in the ground state and excited state. I will discuss the use of both Pt and Pd complexes, illustrating how these materials can be used to enhance both the efficiency and V_{oc}. Lastly, I will discuss our studies of a family of Ru(β-dikenotate)$_3$ complexes. We have reported the use of Ru(acetylacetonate)$_3$ as a buffer material and have now extended to this to a range of Ru complexes with different HOMO energies. The performance of OPVs made with this family of materials show a strong dependence on the HOMO energy of the Ru(β-dikenotate)$_3$ layer in the device (device = ITO/CuPC/C_{60}/ Ru(β-dikenotate)$_3$/Al). This supports the model we proposed for Ru(acac)$_3$ in which the hole in the majority carrier in this family of buffer materials.