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Concurrent energy harvesting and charge storage using conducting polymer composites

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Given the sustainable, clean, and abundant nature of solar energy, studies on photovoltaic devices for energy conversion to electric energy have been extensive. However, due to large variation of the solar energy availability in a day, energy storage is required in many applications when solar cells are used. Conventionally, the harvested energy is stored in an external device (i.e. batteries or supercapacitors) which adds substantially to the costs of solar energy systems, requires additional charging circuitry, and needs regular maintenance and replacement. The result is a relatively expensive and bulky system that is not ideal, particularly for portable, off-grid applications. Recently, we have found that a combination of a conducting polymer (PEDOT:PSS) and a photoactive material can be used as an electrode in a photoelectrochemical cell to generate electric charge from solar energy and store the charge in the device. The structure of the device is very similar to a supercapacitor, while the conducting polymer-dye composite film behaves likes a photoactive electrode. The device is able to generate up to 0.49 V under the open circuit conditions upon AM1.0 solar radiation. A charge stability (in dark) of more than 2 hours has been achieved after charging the device with light for 20 min. The organic photoactive supercapacitor can deliver currents up to 0.12 mA/cm^2. The electrochemical study suggests a photoelectrochemical reaction at the composite film. Hence, the charge storage is likely due to the change in the polymer oxidation state.

Speaker Biography

Dr. Arash Takshi is an Associate Professor of Electrical Engineering and a faculty affiliate in the Clean Energy Research Center (CERC) at the University of South Florida. Before joining USF, Dr. Takshi was working as a Research Assistant at the University of Maryland, where he collaborated with a research group to develop an energy harvesting system for wireless sensors. From 2007 to 2009, he was a Research Scientist at the University of British Columbia, working on the development of Organic/Bio photovoltaic devices. Dr. Takshi has more than forty publications in scientific journals and ten pending and granted patents. Dr. Takshi's research group at USF was established in fall 2010. His group is active in the field of advanced energy materials, using conducting polymers, nanomaterials (Ag NW, Zn O NW, TiO2 nanoparticle, graphene), and biomaterials (i.e., proteins) for energy conversion and storage in electrical devices such as solar cells and supercapacitors. His research activities cover from materials synthesis/process to device fabrication/characterization/optimization.

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