

SHEN WANG DISSERTATION DEFENSE  
NANOENGINEERING PH.D. CANDIDATE  
Laboratory for Energy Storage and Conversion  
*Wednesday, May 30, 2018*  
*11:00am*

***Jack Keil Wolf Auditorium (CMRR)***

***“Function of Hole Transport Layer Components in Perovskite Solar Cells”***

**PI: Dr. Shirley Meng**

**Abstract:** The perovskite solar cell (PSC) is a photovoltaic device. With the tunable bandgap, long carrier diffusion length, and low exciton binding energy of various perovskite materials, power conversion efficiency (PCE) of 22.7% has been achieved. Though PSCs have high energy conversion efficiencies and low manufacturing cost, low device stability limits its further application and commercialization. One of the major bottlenecks hindering the improvement of device stability is the interaction of components in the hole transport layer (HTL): lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) and 4-tert-butylpyridine (tBP). LiTFSI is hygroscopic and accelerates perovskite decomposition. tBP, which evaporates easily, is corrosive to perovskite materials. Previous research has assumed that tBP and LiTFSI have similar working mechanisms in perovskite solar cells as what they performed in solid-state dye-sensitized solar cells (ss-DSSCs). However, due to the different device configurations and functional layers, it is necessary to understand the actual functions of these HTL components in PSCs in order to further improve device stability and efficiency. In our study, a spectrum-dependent mechanism for the oxidation of hole transport material 2,2',7,7'-tetrakis(N,N-di-p-methoxyphenylamine)-9,9'-spirobifluorene (Spiro-OMeTAD) with LiTFSI in PSCs was proposed. The perovskite layer plays different roles in the Spiro-OMeTAD oxidization for various spectral ranges. Regarding tBP, we confirmed its role as a HTL morphology controller in PSCs for the first time. Our observations suggest that tBP significantly improves the uniformity of the HTL and avoids accumulation of LiTFSI. We also observed the formation of tBP-LiTFSI complexes in PSCs. These complexes in PSCs can alleviate the negative effects of tBP and LiTFSI while maintaining their positive effects on perovskite materials. Consequently, a minor change of tBP:LiTFSI ratio displays huge influences on the stability of perovskite. As a result, the PSCs fabricated with our suggested tBP:LiTFSI ratio have decreased efficiency variation with enhanced device stability. Our understanding of the functions of these HTL components and perovskite on a molecular level paves the way for further improvements to PSCs performance.

**Biosketch:** Shen Wang received his B.S. in Chemistry from Peking University (2010) and M.S. in Condensed Matter Physics from the Chinese Academy of Sciences (2013). His previous researches in the Chinese Academy of Sciences focused on liquid and quasi-solid state electrolytes for dye-sensitized solar cells and quantum dot-sensitized solar cells. His current research interests in the Laboratory of Energy Storage and Conversion (UCSD) include the charge transfer/recombination mechanisms in photovoltaic devices, the advanced characterizations of halide perovskite materials and the fabrication of high performance perovskite solar cells.