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Orthogonal patterning and processing of organic perovskite semiconductors.[1]

ALEX ZAKHIDOV, Texas State University

Lead halide organic perovskites are promising semiconductors for high-performance, low-cost, printed photonic devices such as solar cells, photodetectors, and light emitting diodes. Organic perovskite inks are made from Earth-abundant, inexpensive precursors and can be printed on plastic foils with resulting the significant reduction of their commercial manufacturing cost. Yet, the progress in organic perovskite photonics is currently hampered by the lack of reliable patterning and processing methods available for other semiconductors such as Si. In this talk, I will present our recent works on patterning and electrochemical processing of methylammonium lead iodide (MAPI) benchmark perovskite using fluorinated, chemically orthogonal solvent class called hydrofluoroether (HFEs). HFEs are non-flammable, non-toxic, green solvents with zero ozone depletion potential. We show that HFE wet processing does not damage the MAPI films and thus enables liquid based processing. We use commercially available HFE-based photoresist to demonstrate high-resolution patterning of MAPI pixels for high-performance photodetectors. We show that isolation of perovskite photodetecting pixels results in a 4.5-fold reduction in the cross-talk between neighboring pixels in the matrix. [1] We also have enabled electrochemical characterization and demonstrated a processing toolset for these materials utilizing HFE based electrolytes solvent. Our results show that chemically orthogonal electrolytes based on HFE solvents do not dissolve organic perovskite films and thus allow electrochemical characterization of the electronic structure, investigation of charge transport properties, and potential electrochemical doping of the films with in situ diagnostic capabilities.[2] **References.** [1]. D. Lyashenko, A. Perez, and A. Zakhidov, Phys. Status Solidi **214**, 1600302 (2017). [2]. M. Hasan, S. Venkatesan, D. Lyashenko, J.D. Slinker, and A. Zakhidov, Anal. Chem. **89**, 9649 (2017).

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