Coaxial Hybrid Perovskite Fibers: Synthesis and Encapsulation *in Situ* via Electrospinning

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Hybrid perovskites (HPs) are quickly approaching the power conversion efficiency of silicon photovoltaics. Low-cost manufacturing and versatile opto-electronic properties are possible through tuning of precursor chemistries. The trade-off to simplistic HP fabrication is the complexity introduced by the operational environment, in which, rapid degradation of HPs is a critical problem. Exposure to humidity[1-2] and UV radiation[2] can lead to rapid degradation of photovoltaic performance. To alleviate this issue, encapsulation has proven to be an effective measure against degradation.[3] Encapsulation via coaxial electrospinning has been demonstrated as an effective means to produce enclosed two-phase media for use in solar cells[4,5] and electrospun polystyrene fibers have demonstrated superhydrophobicity[6].

In this study, hybrid perovskites will be produced in an electrospun fiber with coaxial geometry. The shell of the coaxial structure will be composed of an optical polymer (PMMA or PS) and the core will be composed of HP ($CH_3NH_3PbI_3$). Orthogonal solvents for the HP are selected to confine the HP material to the core of the fiber. Solvents in the core and shell solutions are both good solvents for the optical polymer to minimize precipitation of the polymer prior to fiber draw-down. Additionally, the core and shell solutions were selected to have similar vapor pressure to minimize the non-uniform evaporation between the shell and core leading to porous and beaded fiber geometries[7].

The authors have already demonstrated the feasibility of producing these coaxial fibers, but an optimization of process parameters is needed to produce fibers with a nearly-continuous core and a high yield of HP in the core. Scanning electron microscopy paired with energy dispersive spectroscopy will be used to visualize the morphology of the fibers produced as well as any discontinuities in the core of the fiber. X-ray diffraction and UV-Vis absorbance will be used to identify the presence of the PbI_2 precursor in fibers and allow precursor ratios and concentrations to be tuned to minimize residual precursors left in final fiber morphology.

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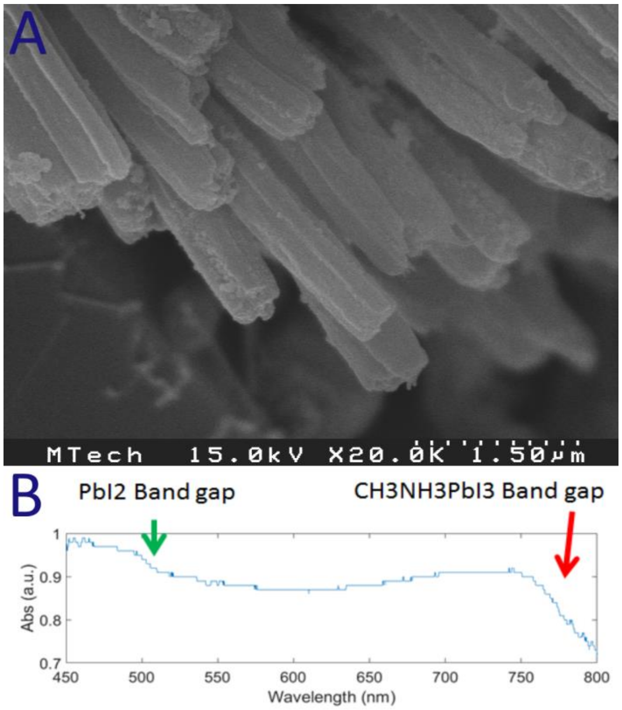

Figure 1. Scanning electron micrograph of a coaxial hybrid perovskite fiber (A). In this preliminary work, successful perovskite formation was confirmed via UV-Vis Spectroscopy (B)

Figure 2. Picture of the perovskite reaction occurring in the coaxial fibers after electrospinning as residual solvent evaporated. A fiber mat immediately after spinning (left) the reaction occurs in a fiber mat five minutes after processing (right).

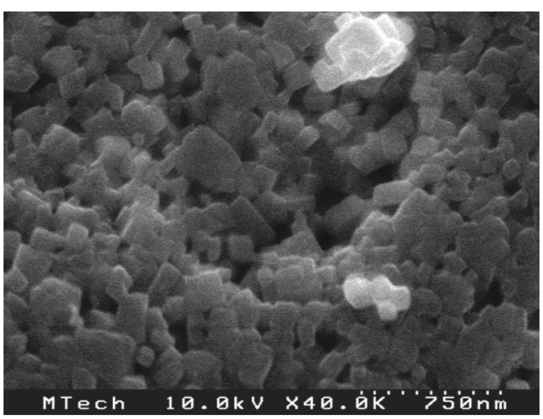

Figure 3. Scanning electron micrograph of hybrid perovskite structure. Hybrid perobskites were synthesized from reactants in the solid state using a sonochemical synthesis technique. Hybrid perovskite in the core of a coaxial fiber will likely exhibit similar morphology.