Functional Perovskite Inks for 2D and 1D Processing

Abstract: In last decade halide perovskite solar cells have displayed noticeably high photoconversion efficiencies and made them a potential alternative to silicon photovoltaics. While most of the research in recent years focused on developing planar (2D) perovskite devices with superior properties, other morphological variations such as fiber-based perovskite materials have been almost neglected. The attempts on net-shaping of perovskite flexible materials have been elusive until now which is a possible result of the high reactivity and sensitivity of halide perovskites in ambient conditions. Advances in flexible photovoltaics can lead to a new generation of soft electronics for smart applications such as wearable electronics, integrated PV modules in windows or buildings etc. Hence, in our research, initially the idea of electrospun hybrid perovskite fibers was investigated in a polyvinylpyrrolidone (PVP) matrix, which provided flexibility and stability, and fiber dimensions were adjusted by tailoring the PVP content. The PVP/perovskite composite fibers were synthesized by a modified electrospinning method and results revealed reproducibility in fabrication method and promising optoelectronic properties. As a next step, we presented primary research toward an electrospun perovskite solar cell. We used novel structural engineering based on electrospinning of the three main perovskite solar cell components including light-absorber, electron, and hole transport materials with CuSCN/$MAPbI_3$/ZnO-$Zn(OAc)_2$ structure. Although this work does not cover a fully working solar cell fiber, successful integration of all solar cell components in a concentric axial cable prepared via a one-step electrospinning process acts as an aim for further research. In addition, we prepared PVP/$CsPbBr_3$ composite nanofibers by single-step electrospinning for integrating them as active layers in light-emitting devices. In this work, precursor ink was prepared in “green” solvents (H_2O/EtOH/protic ionic liquid) and preparations were carried out under ambient conditions. This approach can facilitate the process for making cost-effective and flexible lead-halide perovskite devices.