Metal Halide Perovskites for Photovoltaic Applications

Arezo. Mahdavi Varposhti,[1]* Ivy M. Asuo[2], Joshua A. Robinson[1,2], and Nutifafa Y. Doumon[2]

[1] Engineering Sciences and Mechanics, Penn State University, University Park, PA 16802
[2] Materials Science and Engineering, Penn State University, University Park, PA 16802

Abstract: Organic-inorganic metal halide hybrid perovskites, featuring a 3D structure of ABX_3, along with 3D/2D variants, have garnered significant global attention as remarkable materials for outdoor and indoor photovoltaics[1–3]. Metal halide perovskites exhibit remarkable optical and electrical properties, making them promising materials for optoelectronic applications Moreover, their tunable bandgap and excellent charge transport characteristics offer great potential for advancing solar cell technology. In this study we seek to achieve a compact, pinhole-free, and uniform perovskite layer for indoor photovoltaics. First, we focus on optimizing formamidine-based metal-halide perovskite crystal quality and microstructure via additives and solvent-antisolvent treatment techniques. We also employed a range of characterization methods, such as FESEM and XRD, to gain insights into the morphological and crystalline structure of the thin films. The results showed improved morphology and crystallinity by utilizing our modified solvent treatment of the perovskite thin films. Thus, a decrease in the density of pinholes, leading to a compact and uniform perovskite thin-film layer are observed. Finally, we intend to fully optimize this process for fabricating high-performance perovskite photovoltaics for indoor/outdoor applications.

References

1. Asuo, I. M. *et al.* Ambient condition-processing strategy for improved air-stability and efficiency in mixed-cation perovskite solar cells. *Mater. Adv.* **1**, 1866–1876 (2020).
2. Asuo, I. M. *et al.* Tunable thiocyanate-doped perovskite microstructure via water-ethanol additives for stable solar cells at ambient conditions. *Sol. Energy Mater. Sol. Cells* **200**, 110029 (2019).
3. Xu, W., Yao, X., Wu, H., Zhu, T. & Gong, X. The compositional engineering of organic–inorganic hybrid perovskites for high-performance perovskite solar cells. *Emergent Mater.* **3**, 727–750 (2020).