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Elucidating of Humidity Effect during Processing on the Slot Die Coated Perovskite Solar Cells

Jueng-Eun Kim[1, 2], Gao Mei[2], Chuantian Zuo[2], Dechan Angmo[2], Hasitha Weerasinghe[2], Nirmal Peiris[1], Monika Michalska[1], Jacek J Jasieniak[1] and Doojin Vak[2]

[1]Department of Materials Science and Engineering, Faculty of Engineering, Monash University, Clayton, VIC 3800, Australia
[2]Commonwealth Scientific and Industrial Research Organisation, Research Way, Clayton 3168, Australia
E-mail: jueng-eun.kim@monash.edu

Perovskite solar cells have been receiving significant attention in the last few years, enabling the power conversion efficiency (PCE) of perovskite photovoltaics to reach over 23% using a simple spin coating approach. This current record efficiency is high enough for commercial applications; however, the technical status of upscaling has been at the very early stage. One of the main issues is manufacturability of the technology. Most demonstrations of scalable processes reported to date have been performed under a strictly controlled processing environment with extremely low humidity or N_2 gas in a glove box. Though keeping manufacturing under dry conditions is technically possible, controlling ambient conditions will add to manufacturing costs. Therefore, achieving a process that is tolerant to variations in the environmental conditions is desirable.

It is widely known that moist air can result in undesirable morphology of the perovskite layer, which affects its long-term stability. A few studies have also reported positive effects of moisture during the processing of the perovskite film [1-2]. The variance across different studies indicates that the intricacies of what occurs within a moist environment during coating processes has not been well understood.

To address this current knowledge gap, here we have investigated the role of moisture on slot-die coated $MAPbI_3$ perovskite films processed with and without solution-additives. For this purpose, all of the solution processed layers were slot-die coated using a 3D printer-based coater (3D-coater) within a humidity controlled environment that was developed to mimic roll-to-roll processing. We have found that through the use of appropriate polymer additives, a humidity tolerant and reliable process can be achieved under optimized conditions. These roll-to-roll coated perovskite films have been further introduced within printed perovskite devices with narrow deviations across their device parameters.

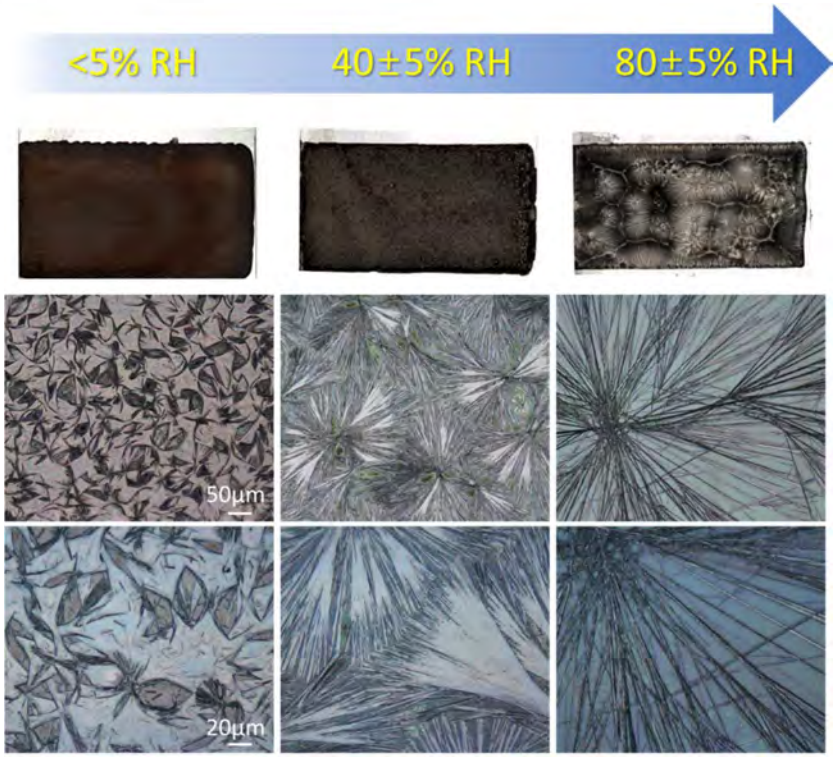

Figure 1. Scanned images and optical microscopy implying the humidity effect on the typical perovskite composition of $MAPbI_3$ film.

References

[1] You, J., Ynag, Y., Hong, Z., Song, T., Meng, L., Liu, Y. Jiang, C., Zhou, H., Chang, W., Li, G. and Yang, Y., 2014, 'Moisture assisted perovskite film growth for high performance solar cells', *Applied Physics Letters*, 105, p183902-183906.

[2] Gong, Y., Li, M., Shi, X., Wang, Z., and Liao, L., 2015, 'Controllable Perovskite Crystallization by Water Additive for High-Performance Solar Cells', *Advanced Functional Materials*, 25, p 6671-6678.