Comparison Studies on Various Perovskites Fabricated on Transparent Conducting Oxide Free Substrates

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The replacement of indium tin oxide as anodic electrode in p-i-n type perovskite solar cell (PSC) devices have gained attention recently. The reason for increasing interest in transparent conducting oxide (TCO) free PSCs was mainly due to the limitation of TCO devices in terms of fabrication and flexibility. PSCs with TCO employing high temperature and high energy processes which are not compatible with flexible devices due to its rigidity. TCO free PSCs offer various advantages such as low processing temperature and also serving as functional electrodes in flexible devices [1-3]. Organic based and hybrid-metallic organic electrodes have been chosen as substitute for TCO electrodes. They are generally flexible and easy to process. In this research, various types of perovskite devices, i.e. lead, tin-lead and tin perovskites were fabricated on TCO free substrates and their performance were evaluated via various characterisations. The electrodes were fabricated with poly(3,4-ethylenedioxylenethiophene):poly(styrene sulfonate) (PEDOT:PSS, PH1000) and treated with ethylene glycol (EG) and dimethyl sulfoxide (DMSO) mixed at various concentrations. The surface treated electrodes has enabled the perovskite to adhere to the surface of the electrodes due to the change in the hydrophobic to hydrophilic behavior of the surface [1], simultaneously boosting the performance of the devices. The fabrication of lead (over 10% efficiency) and tin-lead TCO-less perovskite manage to yield high performance devices. However, the tin based Tco-less perovskite performance were way poorer than the others. In addition, the ability to retain their (TCO free devices) efficiency as opposed to their counterpart devices fabricated on TCO was higher in lead and tin-lead PSCs. The impedance spectroscopy studies revealed the difference in terms of charge transfer mechanisms in TCO and TCO free devices. Based on these results, it is hopeful that better device configurations yielding higher performance will be realized in the near future.

References

1. Liu, T., Zuo, L., Ye, T., Wu, J., Xue, G., Fu, W., & Chen, H. (2015). Low temperature processed ITO-free perovskite solar cells without a hole transport layer. *RSC advances*, *5*(115), 94752-94758.
2. Xu, C., Liu, Z., & Lee, E. C. (2018). High-performance metal oxide-free inverted perovskite solar cells using poly (bis (4-phenyl)(2, 4, 6-trimethylphenyl) amine) as the hole transport layer. *Journal of Materials Chemistry C*, *6*(26), 6975-6981.
3. Peng, R., Song, W., Yan, T., Fanady, B., Li, Y., Zhan, Q., & Ge, Z. (2019). Interface bonding engineering of a transparent conductive electrode towards highly efficient and mechanically flexible ITO-free organic solar cells. *Journal of Materials Chemistry A*, *7*(18), 11460-11467.