PMMA/P3HT を用いるヨウ化鉛メチルアンモニウムペロブスカイト太陽電池の耐久性向上を目指した層構成の検討

Enhancing Stability of Perovskite Solar Cells Using PMMA/P3HT Mixed Polymers as a Hole Transport Layer

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Organo-lead halide perovskite solar cells (PSCs) are well known for exceptionally cost-effective and promising candidate for the next-generation photovoltaic technology as the power conversion efficiency (PCE) surpassed 20% in just 9 years. Such steep rise in PCE is credited to outstanding optoelectronic properties such as absorption coefficient, long charge carrier diffusion length, high carrier mobility and favorable bandgap in relation with visible light. However, its commercial use is statically improved owing to the poor-long term stability in combination with spiro-OMeTAD (widely used hole transport layer (HTL)) against high temperature and humidity condition. Recent study reported the used of poly(methyl methacrylate) (PMMA)/reduced graphene oxide (rGO) composite as protection layer, giving the hydrophobicity effect to hinder direct exposure to moist air [1]. In addition, as improving moisture stability by PMMA/P3HT based hole-transport layer has been reported [2], attentions for the appropriately mixed encapsulation have increased. Herein, we report an attempt to address the stability issue by PMMA:P3HT mixed-polymers under distinct temperature and humidity environment. A device architecture of FTO/$MAPbI_3$/P3HT/PMMA:P3HT/Au is shown in Figure 1.

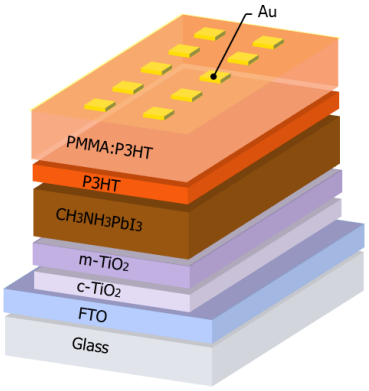

Figure 1. Schematic of device architecture

These mixed-polymers act both as HTL as well as encapsulating layer to reduce PSCs sensitivity to humidity, heat stress and enhance long-term stability. By using PMMA (Mw ~15000, Sigma-Aldrich), and P3HT (several different molecular weight, TCI), different PMMA:P3HT ratios were investigated with exposure to high temperature (60, 80, 100, 120ºC) and high humidity (85%). Furthermore, through light beam induced current (LBIC) analysis, we identify an accurate current-concentrated area that correlates with the device output. Using combination of device measurement, scanning electron microscope, and LBIC, we generate a strategy to improve stability through optimized PMMA:P3HT mixed polymer.

[1] Gill Sang Han, et al., *J. Mater. Chem. A*, **2017**, 5, 14733.

[2] Kundu Soumya, et al., *Mater. Chem. Frontiers*, **2018**, 2, 81.