Bio-based Carbon Hole Transporting Material Obtained from the Extract of Invasive Species of Aagaya Thamarai Plant (*Eichhornia crassipes*) for Cost-Effective Carbon Based Perovskite Solar Cells

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Abstract

Herein, we report a novel and naturally extracted carbon based hole transporting material (HTM) for perovskite solar cells (PSCs) synthesized using an eco-friendly and cost-effective ancient Indian method. Also in this work, the low-cost and bio-based carbon suitable for PSCs have been prepared by a facile brush painting technique and their structural, morphological and electrical properties have been investigated at two different annealing temperatures 850 and 1000 °C. At these temperatures, the obtained carbon exhibited similar structural and morphological properties and are favourable for the PSCs as both HTM and top contact layer. The current density-voltage (J-V) characteristics of the fabricated perovskite device with structure FTO / c-TiO_2 / mp-TiO_2 / $CH_3NH_3PbI_{3-x}Cl_x$ / Methylammonium Iodide + Carbon / Carbon counter electrode has been studied and the device fabricated using the bio carbon annealed at 1000 °C achieved a higher power conversion efficiency (PCE) of 8.52% with current density (J_{SC}) of 23.49 $mAcm^{-2}$, open circuit voltage (V_{oc}) of 0.672 V and fill factor (FF) of 54.01%. Further, the J-V performance of the perovskite cell with aagaya thamarai plant processed carbon based HTMs annealed at 850 and 1000 °C have been compared with the solar cells fabricated using commercially available carbon paste HTMs. Although our invasive plant species-processed natural carbon HTM based solar cells show a moderate photovoltaic efficiency they exhibited higher air-stability and better long-term stability.

Keywords: Bio-based processed carbon, Perovskite solar cells, Carbon HTMs, Brush painting technique, Carbon electrodes