PÔSTER - RESUMO - DISPOSITIVOS OPTOELETRÔNICOS

AIR-PROCESSED PEROVSKITE SOLAR CELLS AND MODULES WITH CARBON ELECTRODES IMPROVED BY AU NP–DOPED P3HT AS HTL

Francineide Lopes De Araújo (franlaraujo@gmail.com)

Andreia Gerniski Macedo (agmacedo@professores.utfpr.edu.br)

Ana Flavia Nogueira (anafla@unicamp.br)

Despite the remarkable progress in the power conversion efficiency (PCE) of perovskite solar cells (PSCs), now exceeding 27% [1], their large-scale deployment remains limited by the use of costly materials that require complex synthesis, sophisticated deposition techniques, and controlled fabrication environments. To address these challenges, carbon-based counter electrodes and semiconductor polymer hole-transport layers (HTLs) have emerged as promising low-cost alternatives to noble-metal electrodes and conventional HTLs, such as 2,2',7,7'-tetrakis(N,N-di-p-methoxyphenylamine)-9,9'-spirobifluorene (spiro-OMeTAD) and poly[bis(4-phenyl)(2,4,6-trimethylphenyl)amine] (PTAA), which are largely responsible for the high cost of these devices [2,3]. Among polymer materials, poly(3-hexylthiophene) (P3HT) is a particularly attractive HTL for PSCs with carbon electrodes (c-PSCs) due to its low-cost synthesis, thermal stability, and compatibility with scalable fabrication processes. However, P3HT-based devices typically suffer from reduced PCE, mainly due to limited hole mobility and poor interfacial contact with the perovskite absorber layer and the carbon electrode, leading to enhanced recombination losses and reduced open-circuit voltage (VOC) and fill factor (FF) [4]. In this work, we propose an strategy to enhance the performance of P3HT as the HTL in fully air-processed c-PSCs with an n–i–p-type architecture (glass/transparent conductive layer/electron transport layer/perovskite/passivation layer/HTL/Carbon), by incorporating gold nanoparticles (Au NPs) dispersed in chlorobenzene into the P3HT layer. The Au NPs were synthesized via laser ablation in liquids (LASiS) using a Q-switched Nd:YAG laser (Raycus RFL-P50QB, 1064 nm). Structural, morphological, and optoelectronic characterizations were used to investigate the impact of Au NP incorporation into the P3HT layer. As a result, small-area c-PSCs based on pristine P3HT (control device) achieved a PCE of 15.1%, whereas P3HT:Au NP-based devices exhibited a significantly enhanced PCE of approximately 17%. Furthermore, perovskite solar modules (PSMs) fabricated using Au NP-modified P3HT reached a PCE of 15.34%, with a Voc of 5.39 V for a 25 cm² module composed of five series-connected sub-cells. In conclusion, doping the P3HT layer with Au nanoparticles has been demonstrated as an effective strategy to enhance the performance of PSCs and PSMs employing carbon electrodes. This approach offers a promising pathway toward the development of low-cost, efficient, and scalable solar energy technologies.

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Palavras-chave: fully air-processed psc; carbon counter-electrode; au np-doped p3ht.