PÔSTER - RESUMO - DISPOSITIVOS OPTOELETRÔNICOS

INFLUENCE OF METALLIC NANOPARTICLES AND SMALL MOLECULES ON THE PERFORMANCE OF ORGANIC SOLAR CELLS

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The search for clean and renewable energy sources has positioned photovoltaic technologies as essential for the future global energy scenario. Among emerging alternatives, Organic Solar Cells (OSCs) stand out due to their lightweight nature, mechanical flexibility, and potential for low-cost fabrication. Significant progress in OSC efficiency has been achieved through Bulk Heterojunction (BHJ) architectures employing Non-Fullerene Acceptors (NFAs), particularly the PM6:Y6 system, which represents one of the most efficient and extensively studied donor–acceptor blends. Despite these advances, device performance is still limited by losses arising from the competition between charge extraction and bimolecular recombination, a process that can be quantitatively described by analytical models based on charge-transport figures of merit, including second-order recombination effects.

This work investigates the influence of metallic nanoparticles (NPs) and small-molecule interlayers on the performance of PM6:Y6-based BHJ-OSCs, aiming to improve photovoltaic parameters through interface engineering of the device multilayers. Different Hole Transport Layers (HTLs) were evaluated, comparing the conventional polymeric PEDOT:PSS with the small molecule Br-2PACz.

Each HTL was combined with interlayers containing gold nanoparticles synthesized via Pulsed Laser Ablation in Liquid (PLAL), as an alternative strategy to previously reported optimized nanoparticle-modified PEDOT:PSS systems (Gavim et al., 2025).

Steady-state current density–voltage (J–V) characterization demonstrated that the Br-2PACz/Au NP configuration provides superior photovoltaic performance compared to PEDOT:PSS-based devices. Improvements were observed mainly in fill factor (FF) and power conversion efficiency (PCE), indicating enhanced charge extraction and reduced recombination losses. To elucidate the underlying mechanisms, charge carrier dynamics were analyzed through Transient Photocurrent (TPC), Transient Photovoltage (TPV), and Photo-CELIV measurements. By correlating these experimental techniques with an analytical photocurrent model, we verified that nanoparticle incorporation increases carrier mobility and improves charge balance.

The optimization is quantitatively supported by a significant reduction in the charge-transport figure-of-merit parameter ?o, which is directly correlated with FF and PCE. The results confirm that the synergistic action of Br-2PACz and Au nanoparticles mitigates recombination losses and facilitates hole extraction at the interface. These findings validate the multilayer interface-engineering strategy as an effective approach to enhancing charge transport and overall efficiency in organic solar cells.

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Palavras-chave: organic solar cells; metallic nanoparticles; hole transport layer; efficiency.