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Designing of Carbazole-based hole transporting materials for stable and efficient perovskite solar cells: from molecular to oligomeric and polymeric materials.

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Designing organic molecules efficient for charge extraction and transport when integrated in optoelectronic devices remains a great challenge for many advanced applications. In perovskite solar cells (PSCs), the hole extraction/transport and the device stability are strongly dependent on the molecular structure of the hole transporting material (HTM).

In this communication, we present our recent works on development of carbazole-based HTM covering from small molecules to dendritic oligomers and polymers. We have engineered a dendritic core carbazole based HTM, which combines the advantages of both small molecules and polymeric materials. We have investigated the relationship between the chemical structure of the HTM and both the photovoltaic efficiency and the device stability. The development of new HTMs alternative to Spiro-OMeTAD and the understanding of the role of doping agents on these layers are also important research axes in the field. It requires the use of appropriate characterization tools enabling to discriminate the bulk and interface effects. In the present work, we fully analyze the effect of HTM doping and of the material on the impedance response of PSCs. It has been shown that the dendritic core is a promising approach leading to both enhanced device performance and stability. The new HTM has been proved to act as a good barrier and protect satisfactorily the perovskite surface. The power conversion efficiencies (PCE) increase from 11.5% for the simple model compound to a promising 14.6%. Additionally, the normalized PCE of carbazole-based PSC decreased by only 5% after more than three weeks of storage under ambient conditions meanwhile the cell using the most popular HTM (Spiro-OMeTAD**)** dropped off by more than 40%. The presented results demonstrate that introducing dendritic concept is a simple strategy to design HTM for efficient and stable PSC. We also show that the impedance spectroscopy is of high practical interest for the development of new HTMs and for the optimization of the layer doping. In the continuity of the work, we will present some latest advances in our work concerning oligomeric and polymeric carbazole HTM with PCE higher than 18 %, overcoming the performance and the stability of the Spiro-OMeTAD based device.

Reference

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