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New bio-sourced hole tranporting materials for perovskite solar cells

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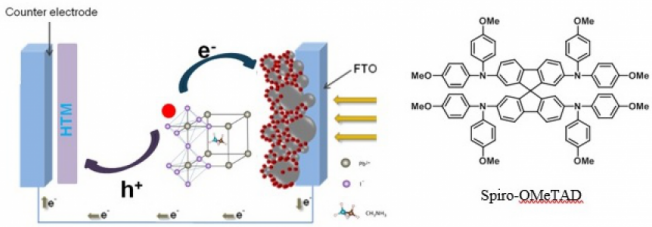
PURPOSE OF THE ABSTRACT

Perovskite solar cells (PSC) have been developed in the late 2000s and their performances have only increased since then. Nowadays, the photoconversion efficiency in PSCs exceeds those of amorphous silicon to reach 23.3% (NREL) [1]. Such hybrid devices are typically made of a lead perovskite layer deposited on a n-type semiconductor (generally titanium dioxide) and a hole-transporting material (HTM) such as doped spiro-MeOTAD (figure 1). The functioning of such cells relies on a photoelectrochemical principle. Perovskite absorbs a photon to jump to the excited state and can convey an electron in the conduction band of TiO2. The electron is conducted to the external circuit via the FTO-anode (fluorine-doped tin oxide). The hole-transporting material (HTM) allows the release of holes to the counter electrode (Au) to close the circuit. The lead perovskites most commonly used in PSCs are PbI3CH3NH3 (=MAPbI3). Because of the good efficiency of photoconversion, spiro-OMeTAD is widely used in PSCs. However, due to a multi-step synthesis with poor yield and from costly reagents, such HTM is very expensive and limits the development of PSCs to a larger scale.

Nowadays, in order to improve the stability of PSCs and to lower the implementation costs, efficient HTM must be conceived without dopants, in simple devices and obtained in a few steps with good synthesis yields. The chosen syntheses must also, insofar as possible, lay within the range of green chemistry and lead to a low-polluting long-term production process.

In this context, we synthesized, under green conditions, new hole-transporting materials (HTM) based on dibenzofurane figure 2). Our strategy involves few synthetic steps and the use of cheap [2], readily available and bio-sourced starting building blocks. Those new HTM have triarylamine moieties on the outer part, such pattern being well known to enable a good mobility of holes [3]. The key step of the syntheses was a palladium-catalysed Buchwald-Hartwig coupling to create the C-N bond or Suzuki-reaction for more extensive conjugated systems. In the literature, the syntheses of materials for photovoltaic devices are often described with non green chemistry compatible conditions (organostannic compounds, large catalyst loads, benzenic solvents). Besides, (organo)metallic residues (Pd, Sn) contaminating the synthesized materials lower their performances in electronic devices [4]. Thus, such coupling steps were developed and optimized with the aim to limit the formation of metallic wastes and to use greener conditions.

FIGURES



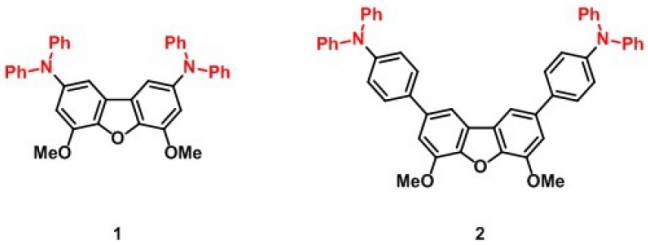


FIGURE 1

Perovskite solar cells

Representation of a perovskite solar cell (with MAPbI3) and structure of spiro-OMeTAD.

FIGURE 2

benzodifurane targets

Target structures of new HTM

KEYWORDS

Perovskite solar cells | bio based materials | hole transporting materials

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