Simple hole transporting materials based on bis(2,4-dimethoxyphenyl)carbazole for perovskite solar cell

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Abstract: Hole transporting materials (HTMs) are important in the perovskite solar cell (PSC) because they enhance the device efficiency by extracting the holes and transporting these charges to the electrode. Commonly used spiro-OMeTAD is expensive and required a complex synthesis. Here we report simple small organic molecule HTMs based on triphenylamine and triazine cores substituted with (2,4-dimethoxyphenyl)carbazole. C3 and C6 active sites of carbazole unit were protected with an electron donor 2,4-dimethoxyphenyl group which would improve the charges transport, electrical properties and electrochemical stability. Tris(4-(3,6-bis(2,4-dimethoxyphenyl)-9H-carbazol-9-yl)phenyl)amine (diOMeCbz-TPA) and 2,4,6-tris(4-(3,6-bis(2,4-dimethoxyphenyl)-9H-carbazol-9-yl)phenyl)-1,3,5-triazine (diOMeCbz-TAZ) were synthesized via Suzuki and Ullmann coupling reactions. The band gap of 3.33 eV for diOMeCbz-TPA and 2.73 eV for diOMeCbz-TAZ were obtained from UV-Vis analysis. HOMO energy level in solution measured by cyclic voltammetry was found at -5.25 eV and – 5.33 eV for diOMeCbz-TPA and diOMeCbz-TAZ, respectively, which higher than that of perovskite (-5.43eV), hence favouring the hole injection and transport. Moreover, both of materials showed the amorphous phase in XRD and high glass transition temperature in TGA-DSC measurement. So, these new materials could be comparable to spiro-OMeTAD for high efficiency PSC.

Keywords: Perovskite solar cell; HTM; Carbazole derivative; Triphenylamine; Triazine