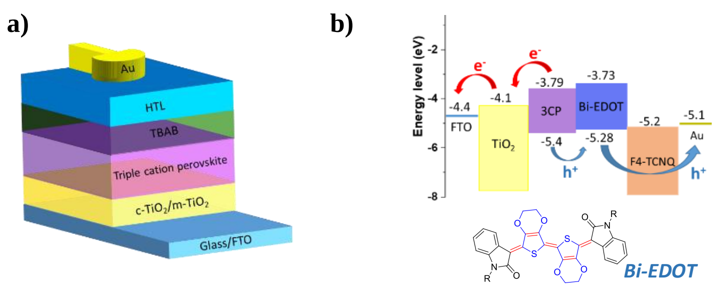
Evaluation of Indophenine-Based Quinoidal Small Molecules as Hole Transporting Layer in n-i-p Perovskite Solar Cell modules

Amir Hossein Habibi and Abderrahim Yassar

Laboratoire de physique des interfaces et couches minces CNRS, Ecole Polytechnique-France

amirhossein.habibi@polytechnique.edu

Photovoltaic (PV) systems are appealing because they produce electricity without polluting the environment by directly converting a free and infinite energy source, solar power, into electric power. Photovoltaic modules are becoming more affordable, and their performance is increasing. This type of renewable energy that can transform future energy infrastructure into clean, secure, scalable, and inexpensive. During the past few years, triple cation perovskites ($Cs_{0.05}(MA_{0.17}FA_{0.83})_{0.95}Pb(I_{0.83}Br_{0.17})_3$) solar cells have received lots of attention owing to their excellent stability and photovoltaic performance of 25.5%, which is comparable to silicon-based solar cells. In a typical perovskite solar cell (PSC) device structure, a layer of an n-type and a p-type semiconductor is required at the front or back of the perovskite material to assist charge separation and transport, respectively. The overall performance of PSCs primarily depends on the quality of the perovskite active layer itself, as well as its electron or hole interface layer. So far, only two organic hole-transport materials have led to state-of-the art performance in these solar cells: poly(triaryla mine) (PTAA) and 2,2′,7,7′-tetrakis(N,N-di-p-methoxyphenylamine)-9,9′spirobifluorene (spiro-OMeTAD). However, these materials have several drawbacks in terms of commercialization, including high cost, the need for hygroscopic dopants that trigger degradation of the perovskite layer and limitations in their deposition processes. In this research, a new conjugated molecule based on quinoidal indophenine structure called Bi-EDOT are proposed to form a hole-transporting layer in a conventional device structure of n–i–p PSCs. We herein present a study of the molecular design, synthesis, characterization and applications of novel quinoidal indophenine molecules, as a hole-transporting material. In addition, have compared the photovoltaic performance of this indophenine molecule pristine and F4TCNQ doped film, which this is more beneficial to enhance ohmic contact between layers and then to improve device performance. The best solar cells have achieved PCE of 9.2%, which this performance compares favorably with reference devices using P3HT fabricated under the same conditions and have obtained PCE of 8.1 %.



Device structure of the n-i-p perovskite solar cell (a). Energy level diagram of the components of the n-i-p perovskite solar cell. (b).