Development of Wide Bandgap Organic Solar Cells for an Integration in Organic/Silicon Tandem Cells

S. Waiprasoet[1,2], S. Chambon[1], M.E. Gueunier-Farret[1], G. Wantz[1], L. Hirsch[1], L. Vignau[1], J. Alvarez[3,4], J. Connolly[3,4], J.P. Kleider[3,4], P. Roca I Cabarrocas[4,5], P. Pattanasattayavong[2]

[1] Univ. Bordeaux, CNRS, Bordeaux INP, IMS, UMR 5218, F-33400 Talence, France
[2] Vidyasirimedhi Institute of Science and Technology (VISTEC), Rayong 21210 Thailand
[3] Laboratoire de Génie Electrique et Electronique de Paris (GeePs), CNRS, CentraleSupelec, Université Paris-Saclay, Sorbonne Université, 91190 Gif-sur-Yvette, France
[4] Institut Photovoltaïque d'Ile de France (IPVF), 91120 Palaiseau, France
[5] Laboratoire de Physique des Interfaces et des Couches Minces (LPICM), CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, 91120 Palaiseau, France

Organic photovoltaics (OPVs) composed of bulk heterojunctions (BHJ) by blending donor and acceptor material have many exclusive features to be a promising renewable energy technology such as low-cost solution processing, lightness, non-toxicity, and semi-transparency. However, OPVs have been facing huge challenges in further improvement due to the large intrinsic energy loss, thus lower efficiency compared to other PVs technologies [1]. Recently, with the use of non-fullerene acceptors (NFAs) improving the absorption, stability, and reducing the energy loss, OPVs efficiency has reached a high record power conversion efficiencies (PCE) of 19% in single junction device [2-4]. Due to the versatility of chemical structures for organic semi-conductors, wide-bandgap (WBG) NFAs have also been designed with well suited energy diagram and absorption to be used as the sub-cells in tandem PV cells [5,6]. The association of a WBG organic cell with silicon in a 3-terminal tandem configuration is the objective of the ORGANIST project supported by the French Research National Agency.

Only a few WBG-NFAs-based OPV cells exhibit good photovoltaic performance [4] and we present here the first results obtained on an organic single-junction utilizing an active layer made of a WBG NFA and conjugated donor polymer, GS-ISO and PDBD-T-2F respectively, that has been identified as a potential top cell partner of the c-Si. We show that changing the intermolecular interaction of BHJ results in a great impact on the device performance. We have also optimized further the OPV devices by (i) understanding the influence of different additives on the film morphology, (ii) comparing direct and inverted structures and (iii) using different sets of interlayers (HTL and ETL). An improvement of the Fill Factor will be one key point for our first cells which exhibit an 8% PCE and an open-circuit voltage (Voc) up to 1.15 V.

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