Optimisation of performance and reliability of metal oxide based Electron Transport Layer (ETL) in Organic Solar Cells: from lab-scale to industrial-scale

Arthur Chadaigne [1, 2] Charline Arrivé [2], Nicolas Barreau [1], Ludovic Arzel [1],
1 : Institut des Matériaux Jean Rouxel - CNRS : UMR6502
2 : ASCA SAS

Organic photovoltaics (OPV) progressed to a power conversion efficiency (PCE) of 18.2% recently for lab-scale solar cells [1]. However, performance losses are observed while processes are transferred from laboratory scale to industrial implementation and several routes are explored to reduce this gap. The present contribution addresses part of this issue through the investigation of metal oxide based electron transport layer (ETL) and its impact on the photovoltaic performance and reliability.

ETL plays a crucial role to achieve high efficiency in OPV. Amongst the properties required for a performing ETL [2], one can mention that it should (*i*) improve electron extraction and transport toward back electrode, (*ii*) have energy-level of bands adapted to the active layer, (*iii*) be chemically compatible with the active layer, (*iv*) show high transparency and (*v*) be stable.

Furthermore, additional specifications are needed for industrial-scale, such as lateral homogeneity and process compatibility with large-scale implementation. Also, some well-known OPV-specific problems like the “light-soaking” issue [3] still represent a problem for industrials and need to be addressed.

Herein, characterization techniques (MEB, AFM, KPFM, XPS, UV-Vis absorption, Raman, Photoluminescence, conductivity measurements, ...) have been set to explore links between material properties and device performance and thereby gain reliability while upscaling fabrication processes. Different deposition techniques and ETL materials have been used to access deeper understanding of key parameters yielding efficient ETL. Some issues directly related to ETL in OPV devices, like “light-soaking” effect, were investigated.

[1] NREL, Best Research-Cell Efficiency Chart (2021), https://www.nrel.gov/pv/cell-efficiency.html

[2] ZnO cathode buffer layers for inverted polymer solar cells, Liang Z, Zhang Q et al. 2015

[3] Light-soaking issue in polymer solar cells: Photoinduced energy level alignment at the sol-gel processed metal oxide and indium tin oxide interface, Kim J, Kim G, Choi Y et al. 2012