Type of presentation: Oral

IT-14-O-1831 Exploring the Local Photovoltaic Mechanisms in Organic Bulk Heterojunction Nanostructures by means of Scanning Probe Microscopy

Sebaihi N.[1], Moerman D.[1], Letertre L.[1], Douhéret O.[2], Lazzaroni R.[1,2], Leclère P.[1]

[1]Laboratory for Chemistry of Novel Materials, Center for Innovation and Research in MAterials and Polymers (CIRMAP), Research Insitute for Materials Science and Engineering, University of Mons (UMONS), Mons, Belgium, [2]Materia Nova R&D Center, Mons, Belgium.

Email of the presenting author: philippe.leclere@umons.ac.be

Recent research and progress in organic photovoltaic (OPV) repeatedly insist on the importance of the molecular organization of the compounds forming the active bulk-heterojunction (BHJ) blends. The morphology of the blend has been to tremendously affect both the charge transfer at the donor-acceptor interface and the carrier transport to the electrodes. And still, for each material combination, much remains to be understood to fully assess its specific and ultimate morphology. For this purpose, high resolution characterization methods are of primary interest to locally depict the different electrical mechanisms ruling the photovoltaic process. Conductive Atomic Force Microscopy (C-AFM) and Kelvin Probe Force Microscopy (KPFM) have already proven to be of significant help to yield nanoscale two-dimensional mapping of electrical properties.

C-AFM and related PeakForce TUNA emerged as powerful technique to electrically evidence phase separation in blends. An additional key feature lies in local I-V curve providing useful information about the charge transport mechanisms within the materials forming the blends. Quantitative measurements leading to local determination of hole mobility have already been reported. It appears that upon illumination the technique has shown to be sensitive to photocurrent. With photoconductive-AFM (pc-AFM), a dedicated external calibrated module has been recently introduced allowing full quantitative mapping of photovoltaic mechanisms. In this study, we will present and discuss the obtained results on two well-known samples: (i) poly(3 hexyl thiophene)(P3HT):[6,6]-phenyl-C61-butyric acid methyl ester (PCBM) and (ii) poly[2-methoxy-5-(3′,7′-dimethyloctyloxy)-1,4-phenylenevinylene])(MDMO-PPV):[6,6]-phenyl-C61 -butyric acid methyl ester (PCBM).

KPFM is mainly used to delineate phase separation and potential variations at interfaces. Upon illumination, photovoltage can also be evidenced. Yet, in organic electronics, KPFM still suffers from harsh operating environment (ultra-high vacuum and low temperature) to reach satisfactory spatial resolution and lacks for modeling for quantitative measurements. Augmenting KPFM with the PeakForce TappingTM technology allows a drastic improvement in the spatial resolution for KPFM measurements in ambient conditions. With the additional external calibrated illumination module, mapping of photovoltage in BHJ blends can be obtained, opening the doors of local characterization of charge transfer at donor-acceptor interfaces, where crucial processes are occurring in photovoltaic devices.

Acknowledgement: Research on conjugated polymers in Mons is supported by the Science Policy Office of the Belgian Federal Government (BELSPO PAI 7/05), the OPTI2MAT Excellence Program of Région Wallonne, and FNRS-FRFC. Ph.L. is Research Associate of F.R.S.-FNRS (Belgium).