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Efficient bulk heterojunction organic solar cell: effect of the morphological stability on the device lifetime

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Abstract – We address the crucial requirement, in the development of organic electronics, of device morphological stability. An original *in-situ* Energy Dispersive X-ray Reflectivity (EDXR) technique was applied, together with Atomic Force Microscopy (AFM), to study *the real-time* morphological changes of organic photovoltaic devices in working conditions.

Organic solar cells, although much less efficient than silicon cells, exhibit a unique combination of interesting properties, including: low cost, flexibility and the ability to cover large surfaces. Ultrafast photoinduced electron transfer from a donor to an acceptor material provided a molecular approach to rather high efficiency photovoltaic conversion[1], leading to the development of bulk heterojunction organic solar cell, with efficiencies exceeding 6%[2]. Nevertheless, further improvement of power conversion efficiency, stability and lifetime of such devices is required before commercial use can be considered. In particular, it appears extremely useful to monitor the changes experienced by the cells morphological parameters (i.e. the thickness and roughness of the various layers), in order to reveal the occurrence of possible uncontrolled interface phenomena[3]. In this framework, the time resolved EDXR technique - a variant of the conventional x-ray reflectometry, sensitive to surfaces and interfaces at the angstrom resolution - was applied *in-situ* to study the devices morphological changes.

The bulk heterojunction devices investigated are based on an active layer of poly(3-hexyl thiophene) blended with methano-fullerene, combining good PV performances with promising stability. The *in-situ* time-resolved EDXR technique was applied to working organic PV cells (in order to follow the morphological variations under operating conditions), in combination with AFM and photocurrent measurements. The experimental results directly correlate the real-time morphological evolution of the active layer, and of its interface with the metallic electrode, to the device performances fading.

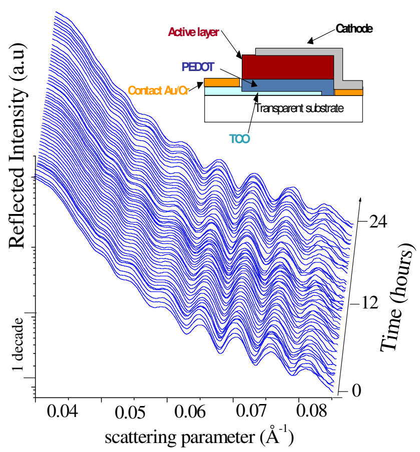

Figure 1: In situ EDXR measurements on a working PV cell. In the insert a sketch of the device structure

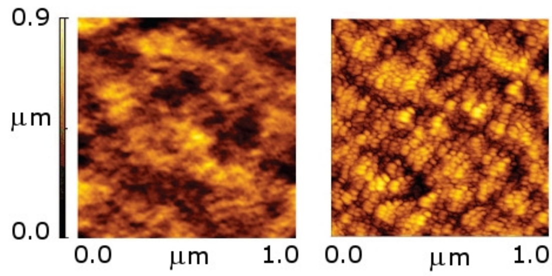

Figure 2: AFM images acquired on a P3HT:PCBM active layer: (a) as deposited sample and (b) after annealing and illumination.

References

[1] N. S. Sariciftci, L. Smilowitz, A. J. Heeger, F. Wudl, *Science,* **258**, 1474, 1992.
[2] K. Kim, J. Liu, M. A. G. Namboothiry, D.L. Caroll, *Appl. Phys. Lett.,* **90**, 1635112007.
[3] B. Paci, A. Generosi, V. Rossi Albertini, P. Perfetti, R.de Bettignies, M. Firon,J.Leroy, C. Sentein, *Appl. Phys. Lett.*, **89**,043507, 2006.