Graphene oxide and poly(3-hexylthiophene) nanoscale interface interactions probed by KPFM

Elisa Palacios[1], J. Colchero[1], Emin Istif[2], Ana M. Benito[2], **Wolfgang K. Maser**[2]

[1]Departamento Física, Univ. Murcia, E-30100 Murcia, Spain
[2]Instituto de Carboquímica (ICB-CSIC), C/Miguel Luesma Castán 4, E-50018 Zaragoza, Spain
wmaser@icb.csic.es

We recently revealed that graphene oxide critically affects the aggregate structure of poly(3-hexylthiophene) and thus the performance of thin film organic optoelectronic devices [1]. In this work, we prepared discrete ensembles of poly(3-hexylthiophene) nanoparticles and graphene oxide sheets ($P3HT_{NPs}$–GO) as benchmark systems with well defined aggregate structures of either J- or H- type and studied for the first time their photogenerated charge transfer dynamics across their interface by Kelvin probe force microscopy (KPFM) [2]. A distinctive inversion of the sign of the surface potential and surface photovoltage (SPV) demonstrates an important change from H-type to J-type aggregates discernable in ex-situ and in-situ produced samples, respectively. It becomes clear that only J-type aggregates facilitate charge transfer interactions with GO. These enable efficient injection of photogenerated holes from $P3HT_{NPs}$ into GO sheets over a range of tens of nanometers, causing a slow SPV relaxation dynamics, and define their operation as efficient hole-transport layer (HTL). Conversely, H-type aggregates entrust GO sheets the role of charge-blocking layers (CBL). The direct effect of P3HT's aggregate structure on GO's functional operation as HTL or CBL thus establishes clear criteria towards the rational design of improved thin film organic optoelectronic devices structures [2].

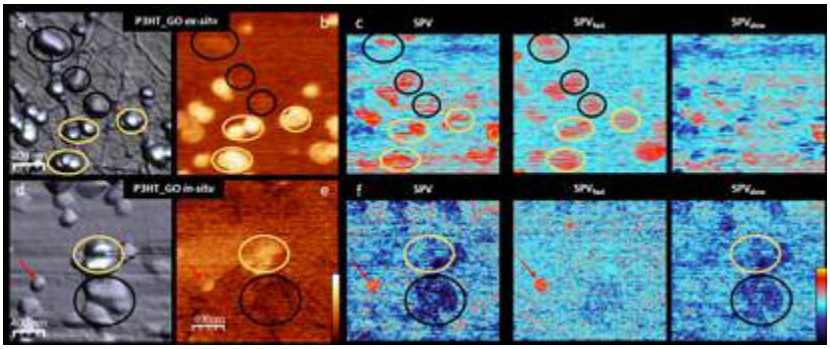

Figure: *Scanning probe images of P3HT-GO ensembles prepared ex-situ (top) and in-situ (bottom): 3D topography (a,d), SP^{dark} (b,e) and SPV (c,f).*

References

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