NANOPHASE SEPARATION IN LASER INDUCED PERIODIC SURFACE STRUCTURES (LIPSS) ON BULK HETEROJUNCTION PHOTOVOLTAIC THIN FILMS AS REVEALED BY RESONANT SOFT X-RAY SCATTERING

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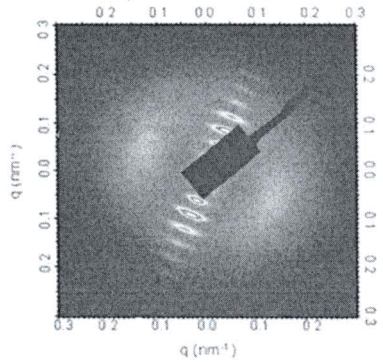
Organic photovoltaics have raised a great deal of attention as an alternative to the well-established photovoltaic solar cells based on silicon[1]. In this respect, the most efficient polymer cell design is based on the so called bulk heterojunction architecture (BHJ) which are blends formed by two organic phases, one being the electron donor and the other being the electron acceptor[2]. Besides new materials, one strategy to further improve solar cell performance consists of the fabrication of periodic micro and nanostructures on the surface of the BHJ in order to improve light harvesting by enhancing both optical path length and light trapping[3]. LIPSS have been recently applied to produce grating-like nanostructures on the surface of a BHJ[4]. LIPSS can be an alternative to lithography processes avoiding the necessity of using clean rooms, high vacuum systems or mask fabrication[5]. In addition to the effort in the development of new approaches, it is evident that further advance requires also the ability to characterize the nanomorphology typically exhibiting a complex hierarchy of length scales. If the characterization of the intrinsic nanomorphology of BHJ is still a cumbersome issue it becomes even more complicated upon dealing with extrinsically nanostructured BHJ systems.



In this work, Resonant Soft X-ray Scattering at the carbon K edge is shown to be an adequate approach to evaluate the phase segregation between donor and acceptor phases across the grooves of a Laser Induced Periodic Surface nanostructure on a paradigmatic poly(3-hexylthiophene)/fullerene bulk heterojunction. The results provide direct evidence that the formation of the nanostructure on the surface of the BHJ induces not only additional phase separation of the two components but also a preferential directional arrangement of the different phases.

Figure 1. 2D RSoXS pattern of the LIPSS P3HT/PC71BM thin film at E= 284.2 eV.

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