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Characterization, assessment and optimization of polymer nanostructures using synchrotron radiation

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Controlling nanostructure formation in polymeric materials is a key aspect for the development of several applications in nanotechnology, such as organic photovoltaic cells or non volatile memories. Current synchrotron radiation sources with high flux, high energy resolution, energy tunability, and small beam size provide some of the most appropriate tools to characterize them and understand the formation process. In the first part of the talk, the use of grazing incidence small angle X-ray scattering (GISAXS) in combination with atomic force microscopy (AFM) and GISAXS modelling for the characterization, assessment and optimization of polymer nanostructures will be discussed. This approach will be applied to laser induced periodic surface structures (LIPSS) in thin polymer films [1] as well as polymer replicas of silicon moulds obtained by nanoimprint lithography (NIL) (Figure 1) [2]. In the second part, microfocus beam small and wide angle X-ray scattering (μSAXS and μWAXS) experiments in nanorods of polymer and single wall carbon nanotubes (SWCNTs)/polymer composites will be presented [3]. The preparation method via infiltration in nanoporous alumina templates influences strongly the resulting crystalline structure. In fact, in the bulk material the orientation is isotropic (Figure 1b) whereas the nanorods present a clearly oriented pattern (Figure 1c). This orientation is caused by the intense interaction of the alumina with the polymer, an interaction that prevails over the templating effect of the SWCNTs in the case of the composites. All in all, the studies presented here go one step further towards controlling nanostructure formation through a deep understanding of the parameters that influence this process.

References

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Caption (s) - Add figures as attached files (2 fig. max)

Figure 1. AFM topography images (5 x 5 μm2, top) and GISAXS patterns (bottom) of (a) LIPSS on polymer thin film, (b) silicon mould with stripe-like motifs and (c) polymer replica fabricated by nanoimprint lithography (NIL). Figure 2. (a) Scanning electron microscopy image of the cross section of a polymer infiltrated in a nanoporous alumina membrane. μWAXS patterns of the polymer (a) outside the membrane and (b) inside.

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