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Synchrotron WAXS/SAXS analysis of CNT fibre based nanocomposites

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The incorporation of nanocarbons (carbon nanotubes (CNTs), graphene) in polymer matrices has been broad studied in the last decades due to its mechanical reinforcement, improvement in electrical/thermal conductivity and emergence of other functional properties. The variation of these properties is largely dependent on the interesting phenomena related to the fact that a large fraction of polymer is close to solid interface, altering the polymer physics.
In this sense, based on CNT fibre, we develop polymer nanocomposites. CNT fibre is directly spun from the gas phase in a CVD reactor at 1250℃ [1] and shows excellent mechanical properties in the range of 1GPa/SG for the specific strength and 40 GPa/SG for the modulus. The fine control of the building blocks at a molecular scale [2] of this high surface area material (~ 170 m2/g), leads to tailor its structure and properties as well as the structure of hierarchical materials through its combination with polymers by hot press process.
Consequently the relation between the structure, such as the CNTs fibres as polymer nanocomposites, and the final properties is one of the main goals. On one hand, WAXS patterns of a macroscopic CNT fibre, gives rise to multi-scale structural information about packing of adjacent nanotubes and the residual catalyst. On the other hand, SAXS gives information about the orientation of the CNT in the fibre and the size and shape of the fibre pores. In the case of composites, the high intensity of synchrotron radiation allows to monitor the melting and crystallization process of the polymer matrix at standard DSC (Dynamic Scanning Calorimeter) cooling and heating rates. For instance, effect in the crystallization process as heterogeneous nucleation, polymorphism, and crystal size variation can be studied by SAXS/WAXS synchrotron studies.
In resume, this work shows the importance of synchrotron experiments in the nanocomposite characterization, which is essential to understand their properties.

References

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