

# Polymer Structure and Dynamics Under Confinement

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## Abstract

Polymer materials are often filled with inorganics to improve their properties. Nevertheless, their behaviour when they are close to surfaces or when they are restricted in space can be very different from that in the bulk. In this work, we investigate the influence of nano-confinement on the polymer structure and dynamics for hydrophilic hybrids of PEO with sodium montmorillonite, Na<sup>+</sup>-MMT or silica nanoparticles as well as of hyperbranched polymers with multiple functional groups with Na<sup>+</sup>-MMT. In the case of the layered silicate nanocomposites, X-ray diffraction (XRD) shows that intercalated structures are formed for all systems. Fig. 1 shows the XRD measurements of a hyperbranched polymer, H2O with Na<sup>+</sup>-MMT in different compositions. The shift of the main diffraction peak towards lower angles compared to the one of the pure inorganic material verifies the chain intercalation and the formation of monolayers and bilayers of polymers within the inorganic galleries. Similar structure is observed for the linear PEO / Na<sup>+</sup>-MMT nanohybrids.

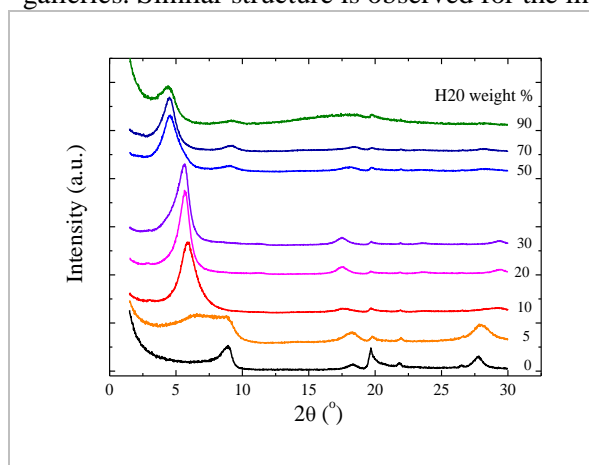


Figure 1: X-ray diffractograms of H2O/Na<sup>+</sup>-MMT nanohybrids. The curves have been shifted vertically for clarity.

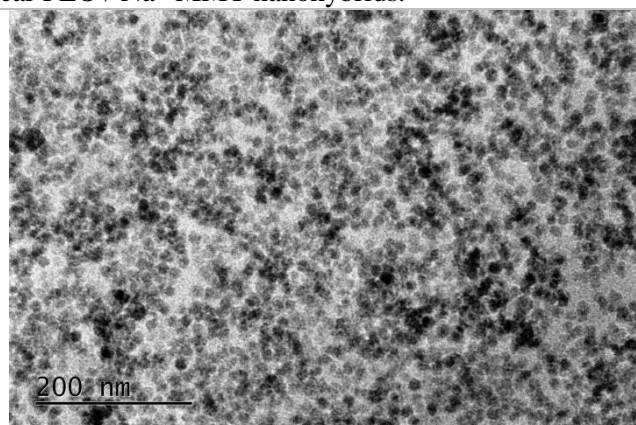


Figure 2: TEM image of a hybrid with 80wt% PEO and 20wt% silica nanoparticles

In the case of PEO / silica nanohybrids, Transmission Electron Microscopy, TEM, verified the good dispersion of the nanoparticles (Fig. 2). In the case of semi-crystalline PEO, the morphology and crystallization behaviour of the hybrids were investigated with XRD, Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC) and Polarised Optical Microscopy (POM). Confinement is shown to modify the polymer structure and crystallinity with the effect being qualitatively different for the different types of confinement. The dynamics was investigated by Quasielastic Neutron Scattering (QENS) and Dielectric Relaxation Spectroscopy (DRS). The very local rotation of side groups seems to be unaffected by the confinement unless there are restrictions that modify the motion even in the bulk polymers. Moreover, the segmental dynamics of the confined polymers depend very strongly on the polymer / inorganic interactions varying from much faster to much slower or even frozen dynamics as the strength of the interactions increases.

## ACKNOWLEDGEMENTS:

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