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Exploring the influence of nanoparticles on the polymer chain conformation: from solution to nanocomposites

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Adding nanoparticles (NPs) to polymer solution or melt is an efficient strategy to improve the macroscopic polymer behavior (viscosity, mechanical reinforcement…) and design hybrid macromolecular materials with enhanced properties. Among the vast literature dealing with NPs and polymer, one fundamental question arises: do NPs modify the global and local polymer chain conformation? Such issue is highly relevant since chain conformation is a central concept in polymer science and its description is essential for understanding the physical and dynamical properties of polymers. While in solution there is a general consensus on chain collapse, it is more controversial in melt for which chain swelling, contraction or no perturbations have been observed.

Small-Angle Neutron Scattering (SANS) can directly answer this question thanks to the Zero Average Contrast (ZAC) method, which is an elegant approach to cancel out the scattering of the NPs by using an appropriate amount of hydrogenated and deuterated polymer in order to only measure the signal of a single polymer chain. Then, the analysis of the scattering spectra gives a radius of gyration from which we can deduce if the polymer contracts, swells or remains unperturbated in the presence of NPs. By investigating the behavior in both solution and melt, we can also figure out if there is a connection between chain conformation in solution with NPs and chain conformation in nanocomposites without solvent. During this talk, I will first present SANS results on both systems (polymer nanocomposites (PNCs) and polymer solution) and show the influence of NP size (from 1 nm to 20 nm), NP concentration and nature of NP/polymer interaction (attractive or repulsive) on the Rg evolution. Then, I will also address the influence of NPs on the chain deformation to get more insights into the mechanical reinforcement in PNCs. For the latter study the D11 spectrometer played a primordial role to access the stretched chain form factor.

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