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SANS studies of polymer structure in nanocomposites

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As compared to other techniques of analysis of nanostructures, small-angle neutron scattering has always been way better in terms of design of special contrast situations, and worse for statistics due to inherently low flux. SANS beamlines at ILL, and in particular D11 dedicated to soft matter studies, have allowed to keep the first advantage, while providing excellent experimental conditions respect to, including with respect to flux.
In this talk, I will present some recent studies of polymer structure in nanocomposites. Such materials have striking mechanical and dynamical properties, in particular the dynamics of the polymer close to the nanoparticles has triggered a large body of experimental and theoretical studies. The possible slow-down of the polymer corresponds to higher moduli, and the percolation of any hard phase, particles or slowed-down polymer, has a strong impact on the macroscopic mechanical properties. If one wishes to specifically characterize the structure of the polymer, SANS is one of the best options. By blending hydrogenated and deuterated chains, while matching the filler silica nanoparticles, we have recently provided evidence for chain-mass dependent bulk or interfacial segregation, and modelling and experimental results will be critically reviewed. In a second study, we have characterized the particle dispersion by small-angle scattering and reverse Monte Carlo modelling, and used it to improve the determination of the thickness of the polymer interfacial layer seen by broadband dielectric spectroscopy. Both the general nanoparticle dispersion and the characteristic time of this interfacial layer has been shown to be tunable by surface modification, paving the way for a precise control of mechanical properties of polymer nanocomposites in the future.

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