Tailoring block copolymer mesophases: molecular design, microstructure and non-linear rheology.

[1] D. Yamaguchi, M. Cloitre, P. Panine, L. Leibler, "Phase behavior and viscoelastic properties of thermoplastic elastomer gels based on ABC triblock copolymers", Macromolecules, 38, 7798, 2005
[2] E. Di Cola, C. Fleury, P. Panine, L. Leibler, M. Cloitre, "Shear flow alignment of lamellar-forming ABC copolymers : orientation, defects and disorder", Preprint submitted to Macromolecules.
[3] N. Merlet, E. Di Cola, M. Cloitre, "Shear thickening in copolymer micellar solutions", Poster presented at the 2007 ESRF Users Meeting.

Block copolymers are well known for their ability to self-assemble into nanostructures with fascinating properties. Self-assembly can also take place in solutions, leading to various ordered mesophase structures. This property is widely used to impart unique properties to complex formulations used in applications, such as emulsion and colloidal stabilization, rheology control, surface modification, active molecules carriers and drug delivery. In addition, block copolymer mesophases exhibit rich and complex dynamics when subjected to external mechanical fields, which complicates the use and the processing of these materials. In practice, the rational design of new block copolymers devoted to specific applications requires to predict and to control the interplay between flow-induced phenomena and macroscopic rheology.

While a lot of attention has been paid to amphiphilic block copolymers in water, much less is known about block copolymer mesophases in apolar solvents. Yet the possibility to finely tune the solvent selectivity and the copolymer architecture is at the origin of a very rich phenomenology. We shall present recent results obtained in three different fields: (1) Self-healing elastomer gels[1]; (2) Shear-induced alignment of lamellae-forming triblock copolymer mesophases[2]; (3) Shear-thickening phenomena in concentrated micellar solutions[3]. In all these studies the RheoSAXS techniques developed at ID2 have proved to be powerful tools to simultaneously probe the structure and of the linear/non-linear viscoelastic behavior of mesophases at steady-state and in out-of-equilibrium situations.