**Internship Opportunity:** Master 2 – March-August 2025 – ca. 600€ / month – Lyon & St-Etienne

# Mediating the Autoassembly of *Styrenic*-b-*Acrylate* Polymers with Silica NPs: Sol vs. Gel vs. Bulk

## Project Description

Block copolymers represent a fascinating class of materials, with diverse applications across numerous industrial sectors in various forms: (i) Solutions, where molecules are isolated or interact slightly, forming superstructures like "flowers" or micelles; (ii) Gels, where phase separation between incompatible blocks creates a 3D network providing elasticity; (iii) Bulk materials, where phase separation facilitates the creation of thermoplastic elastomers—soft, reshaped rubbers (Fig. 1).

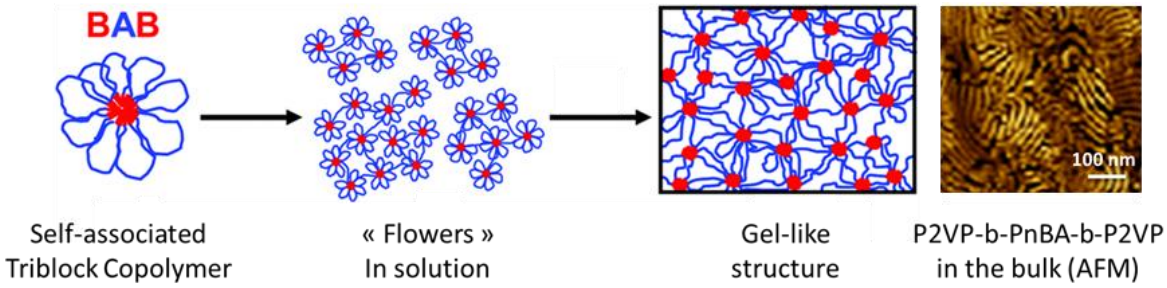


**Fig.1**: Schematic representation of triblock copolymer in various environment: isolated self-assembled flower, solution, gel and bulk (AFM micrograph). Adapted from [1].

The mesostructure and physical properties of linear block copolymers in the bulk state are influenced by multiple factors, such as the number of blocks, their molecular weight, the fraction and chemical nature of each block. For solutions and gels, solvent affinity plays an additional role. In all cases, operating temperature and thermal history are crucial.

This internship is part of the **ANR MANIOC project** [LINK] and focuses on a novel approach—incorporating silica nanoparticles (NPs) to induce selective phase separation at the block copolymer interface. This results in unique mesostructures with specific mechanical and permeability properties. Our approach centers around styrenic-b-acrylate architectures, particularly PS-b-PnBA, P2VP-b-PnBA, and PS-r-2VP-b-PnBA diblock and triblock copolymers. These copolymers, synthesized by our team, are now ready for nanocomposite design with colloidal silica. The use of P2(4)VP blocks is especially notable for its excellent affinity with silica [2].

The internship will investigate the question: How do silica nanoparticles influence the self-assembly of styrenic-b-acrylate block copolymers in solution, gel, and bulk states? To address this, the successful candidate will receive personalized training in low-field NMR, rheology, and scattering techniques, available at the IMP Laboratory, either at UJM-Saint-Etienne or INSA-Lyon. The outcomes of this work will contribute to scientific articles and/or oral presentations and will support the ongoing PhD thesis of Simon Fritz, who is part of the supervision team.

## References :

[1] Biais, Pauline, et al. *Polymer Chemistry* 11.28 (2020): 4568-4578.
[2] Baeza, Guilhem, et al. *Nature Communications*, (2016) 11368

## Contact:

[laboratory website: *https://imp-umr5223.cnrs.fr/*]
guilhem.baeza@univ-st-etienne.fr (Professor @ UJM St-Etienne / IMP lab.)
julien.bernard@insa-lyon.fr (CNRS Research Director @ INSA-Lyon / IMP lab.)
simon.fritz@insa-lyon.fr (Ph.D Student @ INSA-Lyon / IMP lab.)