Computational Mechanics Group
Prof. Dr. Laura De Lorenzis
www.compmech.ethz.ch

Master's thesis / Semester project

Coupling mechanics with spinodal decomposition phenomena

Spinodal decomposition is process where a homogeneous mixture is thermodynamically unstable, and it phase separates into two or more stables phases. This is often seen in metal alloy or polymer blends. The architecture of microstructures generated by spinodal decomposition come up with fascinating mechanical, acoustical and optical properties among others. However, controlling the spatial correlation of these microstructures remains a challenging task. One current investigated approach is to mechanically control and arrest spinodal decomposition through phase separation in monitored stiff elastic crosslinked polymer networks.

Our task is to formulate a numerical model to simulate spinodal decomposition and the effect of the polymer deformation on controlling the morphology's pattern and characteristic length. The numerical model will then suggest which parameters should be tuned to arrest the spinodal decomposition and reach a desired morphology; e.g. the stiffness of the polymer, the diffusivity of the species etc.…. The model's predictions will then be verified experimentally.
Different topics can be defined upon meeting, depending on the student's interest as well as the current research state. Topic examples would be:

- Role of long range interaction terms in arresting spinodal decomposition.
- Influence of surface tension.
- Effects of gradient elasticity.
- Mechanical characterisation under external loads.
- …

a. Spinodal decomposition in cross linked polymer

b. FEM simulation of spinodal decomposition

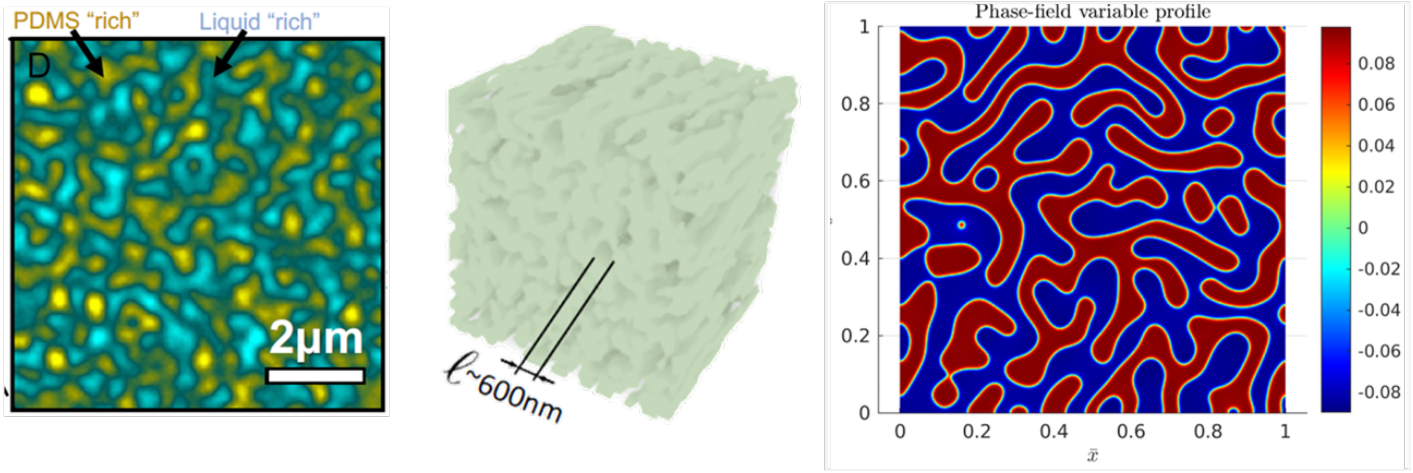

Figure: a. Experimental* and b. simulated spinodal decomposition in cross linked polymer

*Source: Fernández-Rico et al., (2021), *Putting the Squeeze on Phase Separation*, JACS Au. https://doi.org/10.1021/jacsau.1c00443

Contact
Hamza Oudich
Computational Mechanics Group
Tannenstrasse 3, CLA J 17.2
E-mail: houdich@ethz.ch