

Paul Sotta

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**PhD starting in fall 2023 at INSA Lyon, France:
Experimental study of the strain hardening of glassy polymers (M/F)**

Some amorphous, glassy polymers with high molecular weights exhibit a strain hardening regime at large deformations in plastic flow, during which the stress increases. Understanding strain hardening is a major challenge in polymer physics, as well as a key problem on the application side, as strain hardening strongly impacts the toughness of polymers. Our recent theories suggest that strain hardening would be associated with the orientation of polymer chains at a nanometric scale. In the proposed PhD, a combined experimental approach will be developed to relate the mechanical response of an amorphous polymer in the glassy state under different strain levels and various thermomechanical loading histories to microscopic characterizations of the material. How the elastic energy stored in the sample is released when the material is heated above the glass transition will also be studied by calorimetry (DSC). The microscopic orientation of the polymer chains and its relaxation will be monitored by X-ray scattering.

This PhD is part of the collaborative project PoSH funded by ANR (National Research Agency, France) and DFG (Germany), focused on physical mechanisms of strain hardening in amorphous polymers in the glassy state. The project brings together IMP (INSA Lyon), MATEIS (INSA Lyon), LPS (CNRS/Paris-Saclay University) laboratories and the group of Prof. K. Saalwächter at Martin Luther University, Halle (Germany). IMP (Ingénierie des Matériaux Polymères) is a CNRS/INSA Lyon joint research unit in which a multi-scale and multidisciplinary engineering approach is implemented to design environment-friendly, functionalized polymer materials with controlled architectures.

Mechanical and calorimetric measurements will be carried out at MATEIS and at IMP (both located on INSA campus in Lyon), wide-angle X-ray scattering experiments at LPS Laboratory (Paris-Saclay). This will require staying in Orsay/Saclay for some extended period(s) during the thesis. The project will also involve close collaboration with other partners. The thesis will be supervised by Paul Sotta, CNRS Senior Researcher at IMP, and co-supervised by Renaud Rinaldi, Lecturer at MATEIS.

This experimental thesis project is suitable for candidates with a Master's degree in polymer physics, physico-chemistry or materials science. A good ability to work in a team bringing together researchers with various fields of expertise (physics, mechanics, materials science) is expected. A good level of written and spoken English is required.

Applications (detailed CV, application letter) should be sent to

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