

Paul Sotta

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**PhD starting spring 2024 at INSA Lyon and Université Paris-Saclay, France:
Experimental study of strain-induced crystallisation in natural rubber (M/F/D)**

Elastomers based on natural rubber are initially amorphous and crystallize under the application of strain. This is the so-called strain-induced crystallization (SIC) phenomenon, which is at the origin of outstanding performances such as self-reinforcement and resistance to failure. Many basic questions are not yet decrypted, such as the kinetic evolution of the microstructure associated with SIC and its impact on the macroscopic mechanical properties, specifically self-reinforcement. The micro-mechanical coupling between the elastomer matrix and the formed crystallites is also a key issue. In the proposed PhD thesis, these questions will be studied experimentally by electron microscopy, by low-field NMR and by performing tensile tests combined with real-time X ray diffraction. The effect of material parameters (crosslink density, reinforcing nanoparticles) and the impact of ageing on SIC will be elucidated. The underlying physical mechanisms will be clarified.

In fact, the importance of understanding crystallization kinetics of polymers submitted to large dynamical strain goes well beyond the particular case of SIC in natural rubber, as this is one basic concept in polymer physics and is relevant in a vast majority of polymer manufacturing processes.

This PhD belongs to the collaborative international project SICX funded by ANR (National Research Agency, France) and DFG (Germany). The project brings together IMP (INSA Lyon), MATEIS (INSA Lyon), LPS (CNRS/Paris-Saclay University) laboratories and the group of Prof. A. Lion and M. Johlitz in the Institute of Mechanics, Munich (Germany). All partners have long-dated, internationally recognized and complementary expertise in polymer physics and mechanics.

The PhD will be based in Lyon (France). Tensile tests coupled with X ray diffraction will be performed at LPS (Saclay) and at Mateis (Lyon). Electron microscopy will be performed at Mateis, NMR at IMP (Lyon). The project thus will require staying in Orsay/Saclay for some extended period(s) during the thesis. The project will also involve close collaboration with German partners. The thesis will be supervised by Paul Sotta, CNRS Senior Researcher at IMP, and co-supervised by L. Chazeau and J.-M. Chenal, INSA Professors at MATEIS.

This experimental PhD 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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