

Laboratoire MatéIS, UMR 5510

Bât. B. Pascal, 5^e étage 7, Avenue Jean Capelle
69621 Villeurbanne cedex

Physical theory for the plastic properties of glassy polymers***PhD starting in fall, 2023******at the MatéIS Laboratory (INSA de Lyon, France)***

The physics of the mechanical and dynamical properties of polymers close to and below the glass transition is a subject of utmost fundamental importance for which our group is at the forefront of research [1-3]. We have developed over the past years a microscopic theoretical description and the associated numerical/simulation tools for describing these properties, from the linear up to the so-called strain hardening of glassy polymers at large deformations amplitudes, based on the most advanced concepts of statistical and condensed matter physics. Strain hardening is a major challenge on the application side, as it strongly impacts the toughness of polymers [4]. The aim of the PhD is to further develop the theoretical and numerical approaches. This subject is part of a French/German project PoSH funded by the ANR (Univ. Lyon, Univ. Paris-Saclay) and the DFG (Univ. Halle) with the aim to develop jointly theoretical/numerical and experimental studies for describing quantitatively the relaxation mechanisms on the monomer scale under various deformation and thermal histories. The prediction of the theory will be confronted in detail to experimental results obtained by X-Rays and NMR for which we already have theoretical predictions. The objective is to establish connection between microscopic specificities of the considered polymers (rigidity of the backbone, specific monomer interactions,...) and how the related quantities evolve, in conjunction with their macroscopic mechanical properties. Our approaches are those of statistical physics, condensed matter physics and polymer physics and the associated numerical simulations for solving the theoretical model.

[1] Conca et al, Acceleration and Homogenization of the Dynamics during Plastic Deformation, *Macromolecules* (2017) <http://pubs.acs.org/doi/full/10.1021/acs.macromol.7b01391>

[2] Long et al, Dynamics in glassy polymers: The Eyring model revisited, *Phys. Rev. M* (2018), <https://doi-org.insis.bib.cnrs.fr/10.1103/PhysRevMaterials.2.105601>

[3] Hem et al, Microscopic Dynamics in the Strain Hardening Regime of Glassy Polymers, *Macromolecules* (2022), DOI 10.1021/acs.macromol.2c00802;

<https://www.inp.cnrs.fr/fr/cnrsinfo/la-reponse-des-plastiques-aux-etirements-extremes>

[4] Djukic et al, <https://doi.org/10.1021/acs.macromol.0c00534> *Macromolecules* (2020)

The MatéIS Laboratory is a joint research unit between CNRS, INSA de Lyon and Université Claude Bernard, Lyon I dedicated on materials science. The applicant should have a master degree in condensed matter and/or polymer physics or in theoretical physics or in materials science and also have a taste for numerical simulations.

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

Didier Long

Email : didier.long@insa-lyon.fr

tel: +33(0)6 67 05 77 71

Claudio Fusco

Email : Claudio.fusco@insa-lyon.fr

tel: +33(0)4 72 43 61 30

