ESPCI PARIS
EDUCATION SCIENCE INNOVATION

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Master thesis proposal

SIMM

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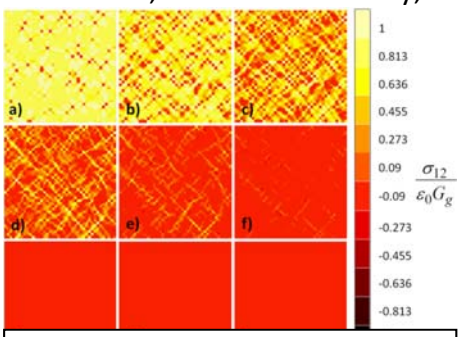
Title: Macroscopic measurement and microscopic modeling of the mechanical properties of amorphous polymers

Keywords: Statistic physics, Mechanics, Polymer, Glasses

Scientific description: In the forthcoming years, polymer materials will become increasingly used in the particular field of high-performance materials, particularly in the field of transport and aeronautics. To predict their mechanical behavior, it is important to understand the physical properties that govern their mechanical behavior.
The latest advances in the physics of the glass transition suggest that these materials have a very heterogeneous dynamic. In the preceding years, the Out of Equilibrium Soft Matter team developed a mechanical model based on theoretically predicted dynamical heterogeneities. This model, solved numerically, foresees a depercolation of the slowest zones. It also very satisfactorily predicts the viscoelastic behavior observed experimentally. [1,2]



Microscopic stress field in the mechanical model during a macroscopic stress relaxation.

The aim of this work is to test this model in the nonlinear regime for various types of mechanical solicitations - creep, stress relaxation, in traction and compression. The candidate will perform both mechanical experiments and finite element numerical calculations on a computer code already in operation [3]. We expect to reveal specific scaling laws for the macroscopic nonlinear response that are related to the intrinsic mechanical response of heterogeneities and the mechanical coupling occurring at this length scale.

[1] Masurel, R. J.; Cantournet, S.; Dequidt, A.; Long, D. R.; Montes, H.; Lequeux, F., *Macromolecules* **2015**, *48*, 6690-6702.
[2] Masurel R.J.; Gelineau P.; Long. D. R.; Dequidt A.; Cantournet S.; Lequeux F.; Montes H., *Phys. Rev. Lett.* , **2017**, *118*, 047801
[3] Masurel R.J.; Gelineau P; Lequeux F ; Cantournet S.; Montes H., Eur. Phys. J. E **2017 40,** 116

Techniques/methods in use: Mechanical measurements, Computer simulation, polymer physics
Applicant skills: Thorough and Curious
Industrial partnership: in the frame of the DEEP chair ESPCI/Mines/Hutchinson
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Internship location: ESPCI -PARIS

Possibility for a Doctoral thesis: Yes, already financed