Internship proposal 2009-2010

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How do soft things break ?
– Fracture of hydrogels : mechanism and instabilities –

Hydrogels are "liquids that do not flow"… Indeed, a small fraction of polymer chains, suitably self-assembled into a network, are sufficient to prevent solvent from flowing out : gels are elastic solids. Food and tissue engineering are making an increasing use of these materials (eg. gelatin of agar gels). Although many applications requires load bearing capability (eg. gels as scaffolds for replacement tissue culture), understanding the physical mechanisms responsible for the mechanical strength of hydrogels is still in its infancy. We are interested in identifying these microscopic mechanism as well as understanding their macroscopic consequences such as crack front instabilities (branching,…)

The project might be one of the folowing :

1. Fracture of a nanocomposite, thermoresponsive hydrogel
A recently synthetized system consists of exfoliated clay platelets linked by acrylic polymer chains. The resulting hydrogel shows an amazing resistance to rupture (it can indeed sustain 1000% stretching without breaking). The origin of such a behavior remains however poorly understood. We propose to perform well controlled fracture experiments on steady propagating cracks in order to unravel the dissipative mechanisms at work.
Moreover, these gels are thermoresponsive: upon heating they undergo a fast and reversible swelling transition. We propose to investigate a possible dynamical coupling between the heat flow released by crack propagation and the swelling transition in the near-tip region.

2. Branching instability in polymer networks.
We have recently proposed a simple mechanism, akin to a convective instability, for side-branching of a slow crack propagationg in a very soft solid. This model relies upon the existence of a mesoscopic length, characterizing the extent of a near-tip zone where the gel, though elastically deformed, is everywhere on the verge of cracking. The existence of such a zone, its size, and its relevance to crack front instability, is a actively debated issue. We propose to investigate the conditions for the existence of a convective branching instability and its dynamical characteristics for slow propagating cracks in several model network systems (gels or elastomers).

Techniques in use : Home-buit, versatilemechanical testing apparatus, image processing.

Applicant skills : Taste for 'light' experimental physics. Basic notions of elasticity of solids.

Granted internship :yes (400 €/month)
C'nano IdF laboratory (France only) : no
Possibility for a thesis : yes(type of grant : ministry of research grant)