Master 2: INTERNSHIP PROPOSAL

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Internship location: ENS

Thesis possibility after internship: YES
Funding: NO

Reversible adhesion versus wetting

Instead of relying on a chemical reaction, as in the case of common household adhesives, pressure-sensitive adhesives stick under simple physical contact with a substrate. To be effective, they must exhibit a highly compliant response – similar to that of a liquid – in order to maximize the contact area. Their adhesive performance results from the resistance to peeling off of the substrate. Strong adhesion implies abundant energy dissipation during de-bonding, produced in most polymeric materials by fingering instabilities, cavitation and fibrillar deformation. However, from a theoretical perspective, pioneering models have considered the opposite limit of weak adhesion, for which the de-bonding is interfacial, reversible, and the adhesives remain weakly deformed. Animals with adhesive pads are ubiquitous in nature and have inspired numerous designs of artificial reversibly adhesive materials.

In this internship you will investigate the latter situation of reversible adhesion: a problem that combines viscoelasticity and capillarity and closely resembles a wetting problem. The experiment consists of slowly ungluing a rigid solid, in the shape of a spherical cap, from an initially flat gel. The goal is to measure dissipation during de-bonding as a function of velocity, and to relate the observed response to the known linear viscoelastic properties of the polymeric fractal gel we use. Simultaneous visualization of the detailed shape of the interface close to the contact line (the edge of the adhesive patch on the solid) will provide direct access to the capillary-dominated region, whose geometrical singularity is thought to provide the dominant contribution to dissipation. Later, we aim to investigate the role of geometrical or chemical heterogeneities on adhesive properties by patterning the solid substrate in a controlled fashion.

The internship/thesis has both experimental and theoretical components and requires the mastery of various techniques: from the fabrication and characterization of gel samples, fine optical measurements and – on the theoretical side – the resolution of mixed non-local problems. This work is part of a collaborative project founded by an ANR grant, in collaboration with the PMMH laboratory at ESPCI.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Macroscopic Physics and complexity: YES
Quantum Physics: YES/NO Theoretical Physics: YES/NO