Master 2

INTERNSHIP PROPOSAL

Laboratory name: F.A.S.T (Fluides, Automatique et Systèmes Thermiques)
CNRS identification code: UMR 7608
Internship director'surname: F Giorgiutti-Dauphiné and L. Pauchard
e-mail:frederique.giorgiutti@universite-paris-saclay.fr Phone number:0169158049
Web page: http://www.fast.u-psud.fr/~fred/
Internship location: Université Paris Saclay Orsay (FAST)

Thesis possibility after internship: YES/~~NO~~
Funding: ~~YES~~/NO If YES, which type of funding:

Evolution of mechanical stresses in nanoparticle hydrogels

Hydrogels are natural or synthetic materials which have a very high porosity; they can thus constitute liquid reservoirs. In addition, they can deform widely when subjected to stress, which makes them very attractive, especially for biomedical applications. In their natural state, we can mention muscles, cartilage…Synthetic hydrogels are often used in the so-called "drug delivery" process, the aim of which is to release an medicine into a defined area, or to simulate the functions of biological tissues such as skin or muscles (see figure). In such applications, it is essential to control the mechanical properties of the gel as well as its adhesion properties on a substrate. We are interested in hydrogels made of silica nanoparticles in order to precisely control the porosity and mechanical properties of the gels. This control is made possible by modifying the physico-chemistry of the systems, that is the interactions between particles. The formation of the gel is induced by the aggregation of the particles due to the interactions but also due to the drying process; the latter induces stresses in the material; we propose to follow the evolution of these mechanical stresses during the drying process by an original method of flexion of a thin plate on which is deposited a thin layer of hydrogel. The objective is to understand and rationalize the behavior of these films under stress and to elucidate the complex interactions between the flow of liquid through the pores of the gel (poro-elasticity), the plasticity of the structure forming a network, and its rupture. The control of the microscopic interactions allows to modify the internal structure of the gel and thus the way the stresses will develop in the gel. The adhesion with the substrate will also be a parameter that we want to play on by modifying the gel-substrate interactions. The drying, the swelling of the gel, and eventually several cycles of drying and swelling, will be studied with a multi-scale approach, gathering structural information at the nano-particle scale, up to the macroscopic scale, by studying in particular the instabilities that develop in the system. The internship will be essentially experimental, based on the use of various multi-scale techniques ranging from optical microscopy, to nanoindentation, to X-ray diffraction techniques. The experiments will be modelled by models based on scaling laws and poro-elasticity theory.