'Physique et Chimie des Matériaux' – ED 397 – année 2018

Proposition pour allocation de recherche

Unité de recherche (nom, label, équipe interne): Sciences et Ingénierie de la Matière Molle (SIMM), UMR 7615 (ESPCI Paris/Sorbonne Université/CNRS)
Adresse : ESPCI, 10 rue Vauquelin, 75231 Paris Cedex 05
Directeur de l'Unité : Christian Frétigny
Etablissement de rattachement : Sorbonne Université / ESPCI Paris
Nom du directeur de thèse (HDR) : Alba MARCELLAN, 01 40 79 46 82, alba.marcellan@espci.fr
Co-directeur : Mickael TANTER, Institut Langevin
Nombre de doctorants actuellement encadrés et années de fin de thèse : 2 thèses co-encadrées à 33% (fins prévues : 09/2018 et 04/2019) et une thèse co-encadrée à 50 % (fin prévue : 09/2019).
Thème C : Matériaux polymères : organisation et propriétés, nouvelles architectures

Gel fracture: from gel design to crack propagation imaging

Context. Gels are fascinating materials in the field of materials science and engineering. Gels behave like soft elastic solids despite being water-based, containing typically 90 wt% of water. Based on gel's remarkable features of absorption, storage or release of water, gels have become essential in engineering applications, such as the development of superabsorbent materials, soilless agriculture, tissue engineering... Also, gels are key players for the design of flexible actuators, valves, and sensors. However, their generally weak mechanical performances and inherent difficulties in assembling them limit their applications. Many efforts are devoted to overcoming the intrinsic fragility of gels, altogether improving their rigidity. By exploring original macromolecular topologies, we designed tough nanocomposite (NC) gels either by using silica nanoparticles[1-2] (in bulk or at the interface for adhesion), or more recently, developing phase separated gels[3] that behaves as responsive organic NC gels.

Aims of the Ph.D project. The goal of this project is to investigate the underlying local mechanisms during crack propagation using ultrasound imaging technique. Recently, we pioneered the use of ultrasound imaging technique for the assessment of NC gel viscoelastic properties[4]. By coupling ultrasound imaging technique with conventional large strain mechanical tests, we expect to map the region of an advancing crack. Identifying the significance of dissipation and the relevant parameters that enable the effective enhancement of the fracture energy is invaluable to guiding the design of gels with advanced mechanical responses. At the ***interfaces of chemistry, materials science and mechanics***, this project seeks to develop an innovative experimental methodology dedicated to gels to meet the next challenges in the field of gel design together with developing the description of biological tissues in terms of elastic and dissipative components.

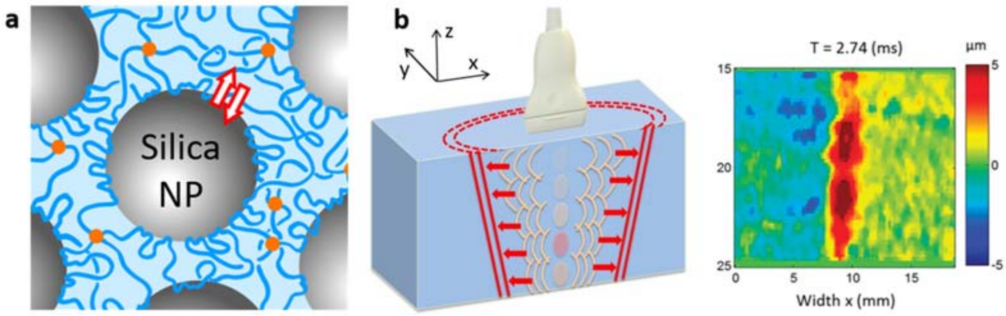

Figure | From Ref.4. a, Schematic view of NC gels. b, By using ultrafast ultrasound imaging, a movie of the propagating shear wave is recorded and permits the mapping of viscoelastic dissipative processes.

1 Rose, S; Dizeux, A; Narita, T; Hourdet, D; Marcellan, A / Macromolecules (2013)
2 Rose, S; Prevoteau, A; Elziere, P; Hourdet, D ; Marcellan, A ; Leibler, L. / Nature (2014)
3 Guo, H ; Sanson, N ; Hourdet, D ; Marcellan, A / Advanced Materials (2016)
4 Gennisson, JL; Marcellan, A; Dizeux, A; Tanter M. / IEEE Trans. Ultrasonics Ferr. & Frequency Control (2014)