Internship position

Level : Master 2
Title : Percolation and Cluster Convexification

Location : Institut Lumière Matière (ILM), LYON (http://ilm.univ-lyon1.fr/)
Team : Modélisation de la Matière Condensée et Interfaces
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Keywords: Theory and modeling, non-equilibrium phenomena, statistical physics, nonlinear physics

Summary:

In heterogeneous disordered systems, percolation models predict the conditions under which paths cross the whole system at the macroscopic level. Hence, they allow one to study various transitions, such as isolator-conductor transitions in solids, permeability transitions for the flow of water through porous media which is relevant for geology, or rigidity transitions when paths allow one to connect elastic stresses from particle to particle in granular materials.

Most of percolation models are based on the hypothesis of a static random distribution of the microscopic properties. However, in many relevant cases, local heterogeneities exhibit dynamic reorganization. In this project, we will study a model of local reorganization which has catastrophic consequences at the macroscopic scale. In this model, percolation clusters are convexified iteratively. The aim of the project is to characterize percolation in this model and to study the link between this transition and the transition by which clusters invade the whole system. This problem will be studied first numerically. The interpretation of the results could involve some analytical calultations.

This model can for exemple describe the unbinding of two solids in the presence of a third body in the contact. We will compare our results to the experiments performed in University of Maryland (USA) on the unbinding of graphene induced by the intercalation of nanoparticles [1].
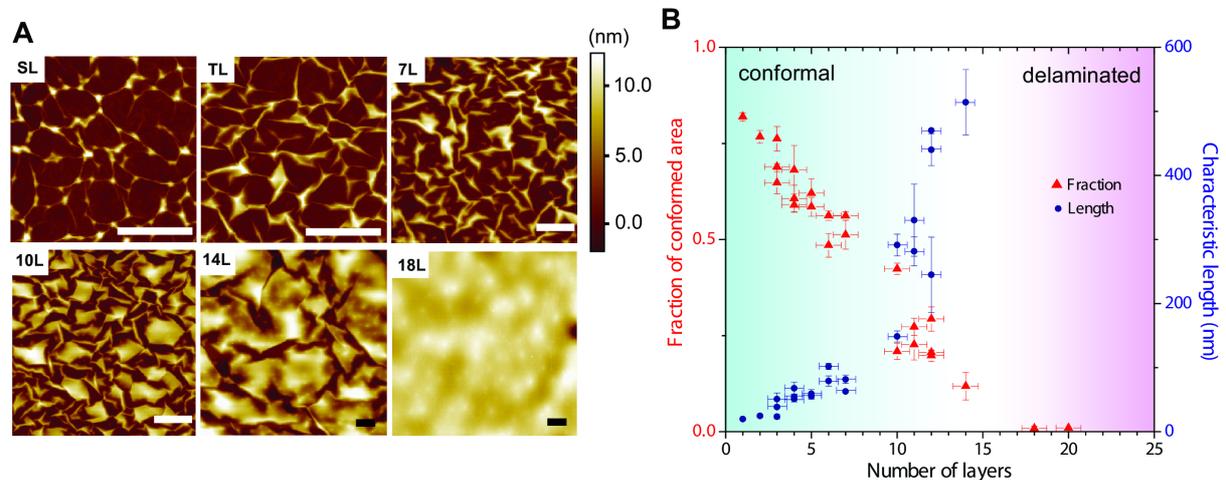
Illustration 1: Transition de décollement du graphène [1]: (a) Images AFM du graphène recouvrant des nanoparticules; (b) Fraction d'aire du graphène en contact direct avec le substrat (symboles rouges), qui indique une transition de décollement.

Reference:
[1] The princess and the pea at the nanoscale: Wrinkling and unbinding of graphene on nanoparticles
M. Yamamoto, O. Pierre-Louis, J Huang, M. Fuhrer, T.L. Einstein, W.G. Cullen, Phys. Rev. X 041018 (2012)

Possibility of PhD : Yes