Séminaire PIMM
Jeudi 13 mars 2014 à 14 heures
Amphi A
Arts et Métiers ParisTech, 151 bd de l'hôpital, 75013 Paris

14h00
Justin Dirrenberger
Maître de Conférences PIMM (COMET)

TOWARDS GIGANTIC RVE SIZES FOR 3D STOCHASTIC FIBROUS NETWORKS

Microstructural heterogeneities play a critical role on the macroscopic physical properties of materials. One common way to account for this underlying complexity is resorting to homogenization techniques. Many approaches, including analytical and computational, are available for determining the homogenized properties of random media. Most of them necessitate the existence of a representative volume element (RVE). Assuming ergodicity for the heterogeneous media considered, Kanit et al. (2003) proposed a method based on a statis- tical analysis for computing the minimal RVE size for a given physical property Z and precision in the estimate of effective properties. The computed RVE size is proportional to the integral range (Matheron, 1971), which corresponds to a volume of statistical correlation. This approach was implemented in many papers, in which the authors usually resort to periodic boundary conditions (PBC) since Kanit et al. (2003) showed from computational experiments that mean apparent properties obtained with PBC converge faster towards the effective properties than with the Dirichlet and Neumann-type boundary conditions. The rate of convergence of the mean value for apparent properties, with respect to the volume of the system, is related to the size of the statistical RVE. For example, a microstructure with slow rate of convergence would yield large RVE sizes. The definition of the RVE is problematic in the case of percolating porous media. Moreover, computational homogenization techniques are usually unable to deal with voids at the boundary of the RVE. Nevertheless, the statistical method of Kanit et al. (2003) could be used for determining RVE sizes in the case of porous media, given a proper BC treatment. Furthermore, one could also think of porous media with infinite integral range. This pathological morphology could give rise to gigantic RVE sizes, maybe even no RVE at all. For instance, it could be the case for a tridimensional stochastic network made of infinitely long fibers. Although infinite fibers do not exist in nature, they can be considered a limit case representative of sintered long-fiber non-woven materials, such as those studied by Mezeix et al. (2009). No one ever assessed the question of RVE size for 3D infinite randomly oriented fibrous media, or for porous random media with infinite integral range. This is the main goal of this study, as well as testing the approach of Kanit et al. (2003) for an extreme model of random structure: Poisson fibers. This model corresponds to a 3D stochastic network composed by randomly oriented and distributed infinitely-long interpenetrating rectilinear fibers. It exhibits an infinite integral range (Jeulin, 1991), i.e. an infinite morphological correlation length; this medium is non-periodizable without modifying its morphology. Computational homogenization for thermal and elastic properties is performed through finite elements, over hundreds of realizations of the stochastic microstructural model, using uniform and mixed boundary conditions. The generated data undergoes statistical treatment, from which gigantic RVE sizes emerge. The method used appears robust and effective for determining RVE sizes even for pathological media, i.e. with infinite integral range, interconnected percolating porous phase and/or infinite contrast of properties.

14h45

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LES MODIFICATIONS DE SURFACES DE POLYMERES PAR LA TECHNIQUE DES PLASMAS FROIDS

La technique des plasmas froids permet de modifier des surfaces et de déposer des couches minces de diverses natures. Dans ce dernier cas, la technique est alors appelée PECVD pour *Plasma Enhanced Chemical Vapor Deposition.* Cette technique, comparée aux méthodes de modifications plus conventionnelles (chimique ou électrochimique), présente notamment l'avantage d'être propre car n'utilisant pas de solvants.

Nous nous intéressons ici à la modification de surfaces et au dépôt de polymères. Après une présentation de la technique, les différents traitements plasma des matériaux polymères seront développés, à savoir : la fonctionnalisation, la dégradation, l'activation et le dépôt en prenant appui sur les résultats obtenus au laboratoire. Des exemples d'applications de ces matériaux traités plasma dans les domaines de la détection de gaz et de l'adhésion seront donnés.

15h30

Café