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CHALLENGES IN PERIODIC COMPOSITES AND EXTENSIONS OF THE HOMOGENIZATION THEORY

Présentée par

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à l'ENSAM campus de METZ devant le jury composé de :

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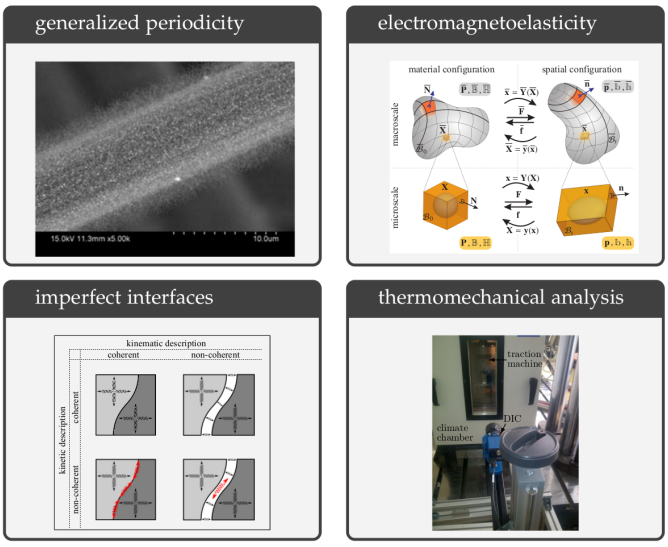

Challenges in periodic composites and extensions of the homogenization theory

George Chatzigeorgiou, Chargé de Recherche CNRS

Synopsis

The principal objective of my research is the study of composite media, mainly with periodic microstructure, that present complex geometries, interfacial irregularities between constituents and multiphysics aspects of composites. My plan of the research activities is divided in four axes:

Composites with irregular periodicity. In irregular periodic media, like for instance the multilayered tubes, the wavy layered structures and the interface of fuzzy fiber composites (composites consisting of carbon fibers coated with radially aligned carbon nanotubes), the unit cell is not always constant and cannot be described directly as a cube or rectangular structure. This issue causes several theoretical and numerical problems, that require proper investigation.

Composites subjected to magnetomechanical fields. When dealing with magenetomechanical composites subjected to large deformation processes, the main question that arises in homogenization is which are the "proper" quantities for measuring mechanical and magnetic fields. Once a proper pair of magnetomechanical fields is defined, then one needs to design a robust and accurate computational framework for the RVE and the overall structure.

Composites with imperfect interfaces in the microstructure. The "problematic" region in the majority of the composite materials is usually the interface between the material constituents, which is not always perfect. The presence of displacement jumps at the interfaces are accompanied by debonding and premature failure at the level of the microstructure. To account for these types of mechanisms in a micromechanical scheme is not trivial and certain theoretical aspects in the homogenization theory need to be reconsidered.

Thermomechanical analysis of dissipative composites. The majority of nonlinear materials dissipate energy upon mechanical loading. Taking into account the complexity in the description of the nonlinear mechanical response, it becomes a challenging task to identify proper microscopic and macroscopic variables and to design a homogenization scheme that considers thermomechanical loading paths for dissipative composites.

During my research studies over the years, my scope was to address these challenges and develop efficient theories and numerical strategies that can provide answers to non-typical homogenization problems, where the complexity of the geometry and/or the material response of the constituents is the leading parameter in the design of a composite.