

Séminaire de Biomécanique  
Mardi 3 mars 2015, 10h, salle P2-331

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**Higher gradient and micromorphic continuum models: applications to microscopically highly inhomogeneous composites and growing tissues**

Composites and living tissues show many interesting similarities: they have a complex behaviour at macro-scale which is usually related to their micro-structure. One can also easily establish which are the most relevant differences between these two class of materials: both differences and similarities deserve to be carefully considered and studied as understanding them will allow a serious advancement of knowledge. Indeed composites and living tissues share many features in their respective multiscale structure and both show at micro-level high contrast in physical and geometrical properties. On the other hand living tissues are able to change their constitutive equations by means of re-modelling processes, which are controlled by tissue resorption and tissue formation as driven by mechanically driven biological stimuli.

Some numerical, theoretical and experimental results which were recently obtained will be presented showing that fibrous fabrics must be modelled by means of second gradient continua (at least) and that one can conceive to design new and efficient metamaterials whose performances can be really exotic. We show also how growth of reconstructed bones can be greatly influenced by the microstructure of bone tissue and reservable material (which again can be modelled by means of second gradient models) and therefore we suggest that the lattice pantographic microstructure conceived to design aforementioned metamaterials could be fruitfully used to conceive bone scaffolds.

A digression on the concept of generalised contact forces in higher gradient continua and on the boundary conditions naturally arising in the theory of generalised continua will be necessary to consistently present the obtained result. This digression shows some of the the limits of standard continuum mechanics as conceived by Cauchy and motivates the conceptual effort (based on the Lagrangian Principle of Virtual Work) which has been started by Gabrio Piola, continued by Toupin, Mindlin and Germain and recently re-started by several research groups to found the correct conceptual frame for generalised continuum mechanics.

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