Research Topic for the ParisTech/CSC PhD Program

Field (cf. List of fields below): Materials Science, Mechanics, Fluids
Subfield: Mechanical Engineering

Title: Multiscale fully coupled thermo-piezo-mechanical modeling of fiber reinforced piezoelectric actuators accounting for viscous and damage mechanisms

ParisTech School: ENSAM Campus Metz

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Short description of possible research topics for a PhD:
The electromechanical behavior of piezoelectric thermoplastic composites and its sensitivity to temperature variations will be examined in this work. The aim of the proposed Ph.D. is to develop a novel micromechanics framework that accounts for the microstructural complexity, the various nonlinear mechanisms and the thermo-electro-mechanical couplings of the piezoelectric glass fiber composites during cyclic actuation. When considering repeated loading/unloading conditions at relatively high stresses, the activation of viscous mechanisms produce significant intrinsic dissipation, causing in return a strong interaction between thermal, electrical and mechanical fields. This interaction needs to be integrated properly into the proposed homogenization scheme, in order to obtain a better estimation of the macroscopic response of the composite and a more accurate prediction of the various fields that effect the cyclic actuation performance.

Required background of the student: Mechanics of Materials, Continuum Mechanics, Finite Elements, Applied Mathematics and/or Numerical Modeling.

A list of 5(max.) representative publications of the group: (Related to the research topic)

[1] G. Chatzigeorgiou, A. Javili, F. Meraghni, 2018. Micromechanical method for effective piezoelectric properties and electromechanical fields in multi-coated long fiber composites. **International Journal of Solids and Structures**, in press.

[2] G. Chatzigeorgiou, F. Meraghni, A. Javili, 2017. Generalized interfacial energy and size effects in composites. **Journal of the Mechanics and Physics of Solids**, 106, 257-282.

[3] M. Hossain, G. Chatzigeorgiou, F. Meraghni, P. Steinmann, 2015. A multi-scale approach to model the curing process in magneto-sensitive polymeric materials. **International Journal of Solids and Structures**, 69-70, 34-44.

[4] M. F. Arif, N. Saintier, F. Meraghni, J. Fitoussi, Y. Chemisky, G. Robert, 2014. Multiscale fatigue damage characterization in short glass fiber reinforced polyamide-66. **Composites Part B: Engineering**, 61, 55-65.

[5] Z. Jendli, F. Meraghni, J. Fitoussi, D. Baptiste, 2009. Multi-scales modelling of dynamic behaviour for discontinuous fibre SMC composites. **Composites Science and Technology**, 69 (1), 97-103.