MIE Graduate Student Seminar

Professor François Barthelat

McGill University, Canada

Architectured Materials in Engineering and in Nature

Architectured materials are characterized by specific structural features which are larger than what is typically considered microstructure (i.e. grains) but smaller than the size of the component. This class of materials includes lattice materials and foams, but also dense materials composed of building blocks of well-defined size and shape. While the deformations of the blocks typically remain small and within elastic limits, their interfaces can channel cracks and undergo large deformations. These features lead to building blocks which can slide, rotate, separate or interlock collectively, providing a wealth of tunable mechanisms. Well-designed architectured materials can therefore generate new and attractive combinations of properties which are unattainable in monolithic materials.

In this talk, I will outline some striking analogies between emerging architectured materials and hard biological materials such as bone, teeth or mollusk shells. I will particularly discuss nacre and fish scales, two examples of architectured natural materials which demonstrate how the interplay between the properties, shape, size and arrangement of the building blocks and nonlinear behaviors at the interfaces generate high properties. Duplicating these structures and mechanisms into engineering materials is very attractive, but the assembly of building blocks from the bottom-up and into highly ordered structures still presents major challenges.

I will present how we are attacking this problem from the top-down, by carving weak interfaces within the bulk of hard materials such as glass. This architectured/bio-inspired approach leads to materials with highly unusual combinations of properties which usually conflict, such as high stiffness and high toughness in a nacre-like glass or hardness and flexural compliance in fish-scale-inspired coatings.

Tuesday, November 10th, 2015
2:00pm to 3:00pm
EV 2.260

MIE Graduate Student Committee
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Concordia University
Engineering and Computer Science
Department of Mechanical & Industrial Engineering (MIE)

Francois Barthelat obtained his B.Eng from Ecole Nationale Supérieure d'Electricité et de Mécanique (France), his Master from the University of Rochester and his PhD from Northwestern University. Over the course of his studies Dr. Barthelat examined the mechanics of multilayered ceramics, lattice materials, growth plate cartilage and mollusc shells. In 2006 he joined McGill University, where he started the Biomimetic Materials Laboratory whose mission is to explore the structure, mechanics and performance of natural materials and to develop new bio-inspired materials and systems.

Dr. Barthelat won the Murphy and the Smith scholarships from Northwestern University, the Hetényi Award for the best paper in *Experimental Mechanics*, Best Paper Awards from the 12th International Conference of Fracture (ICF12) and the Society for Experimental Mechanics Annual Conference. He was also the recipient of a Discovery Accelerator Supplement Award from the Natural Sciences and Engineering Research Council of Canada.