Laboratoire de Mécanique des Solides

# Jean Mandel Symposium

**Thursday, June 19, 2025**

Amphithéâtre – Bâtiment 104

Pôle de mécanique
École Polytechnique

The Jean Mandel Symposium is open to all students, researchers and scientists interested in the proposed topic. It combines, in an informal setting, a keynote presentation by an internationally renowned scientist and talks given by young researchers associated with the laboratory.

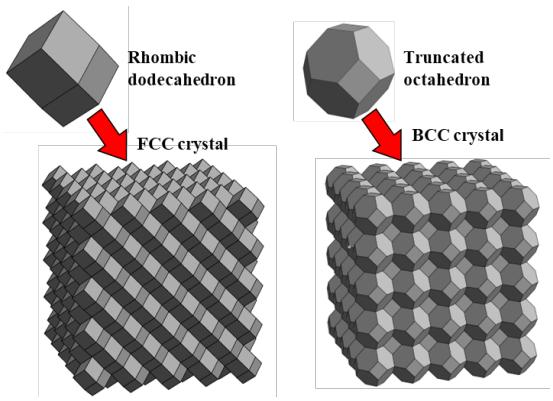
Free and mandatory registration at
**https://evento.renater.fr/survey/jean-mandel-symposium-2025-6u41hedv**
before 2025, June 12
Contact: vignesh.kannan@polytechnique.edu

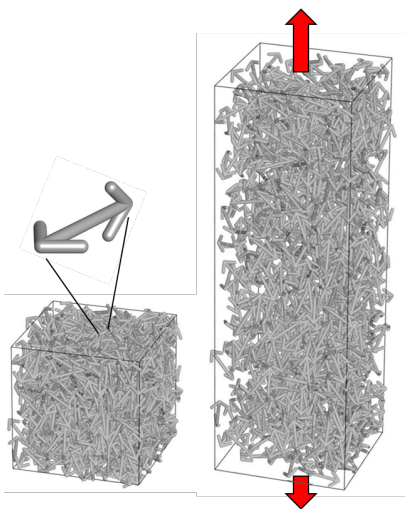
# Plenary Lecture

by Francois Barthelat

## Two examples of granular materials “engineered” for strength: Granular crystals, entangled matter.

Over the past two decades, our research group has been focusing on the development of new structural materials that combine high strength and high toughness. We are particularly interested in fully dense “architectured” materials and structures made from stiff building blocks of controlled shape and size. In these designs - some of then inspired by nature - the interplay between stiff and strong building blocks, geometry and weaker interfaces gives rise to a wealth of tunable mechanisms and precise structural properties. In our effort to expand some of these designs, our research trajectory recently intersected the field of granular mechanics. Our playground still includes geometry, mechanics and structural properties, but our building blocks are now individual grains or particles and we use vibrations as an assembly tool. In this talk I will discuss two types of “engineered” granular materials of interest to us. The first one is fully dense granular crystals made of space filling polyhedral grains. These “macroscale” crystals are 10 times stronger than traditional granular materials, and they display a rich set of mechanisms: Nonlinear deformations, crystal plasticity reminiscent of atomistic mechanisms, geometric strain hardening, micro-buckling. Our other granular material of interest is engineered entangled matter. For these systems we create particles with barbs and hooks that can latch with other particles. I will discuss the experiments we use to measure entanglement and strength as function of particle geometry, and how we capture entanglement mechanisms at multiple length scales using Monte Carlo simulations and discrete element models. We interpret granular crystals and entangled matter as “engineered” granular materials, which we use as platforms to explore new mechanisms of deformation and failure, and which also provide new combinations of strength, toughness and recyclability that will rival the capabilities of existing structural materials.



# Francois Barthelat

Department of Mechanical Engineering
University of Colorado Boulder

Francois Barthelat obtained his PhD from Northwestern University in 2006, and was a Faculty at McGill University from 2006 to 2019. Since 2019 he has been Professor of Mechanical Engineering at the University of Colorado Boulder. Francois Barthelat founded the Laboratory for Advanced Materials and Bioinspiration to explore key structures and mechanisms in natural materials, and to develop new high-performance materials including architectured materials, bioinspired materials and engineered granular materials.

He leads the *Laboratory for Advanced Materials and Bioinspiration* and an independent research program on natural and bio-inspired materials. The laboratory focuses on the study of the structure and mechanics of natural materials, which aims to mimic them in novel high-performance engineering materials. Representative projects are:

- *Mechanics of deformation and fracture in biological materials*: Structure-mechanics-performance-function relationships in high-performance natural materials such as bone, teeth, structural proteins, seashells, fish scales and fish fins. Combination of multiscale experiments and modeling.

- *Design, fabrication and testing of novel biomimetic materials*: New bio-inspired materials and structures for high toughness materials and morphing capabilities. Applications in bioengineering, aerospace, construction, electronics.

- *Mechanics of biological and bio-inspired interfaces*: Cohesive behavior of proteins involved in blot clotting (fibrin) and in bone toughening (osteopontin). Biomimetic interfaces: polyelectrolytes, chitosan, architectured interfaces.

- *Mechanics of engineering granular materials*: New ways to exploit granular structures: vibration-driven assembly of strong granular crystals, bio-inspired entanglement mechanisms

- *Novel Experimental techniques*: Subset splitting digital image correlation for measuring strains near cracks and shear bands, rigid double cantilever beam for the direct determination of cohesive law, high-resolution in-situ microscopy loading setup for tensile tests on individual collagen fibrils.

# Program Thursday, June 19, 2025

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| 08:30 - 08:55 am | *Registration and Welcome Coffee* |
| 08:55 - 09:00 am | **Welcome Address** by **Andrei Constantinescu** |
| 09:00 - 10:00 am | **Plenary Lecture – Francois Barthelat** |
| 10:00 - 10:20 am | *Coffee Break* |
| 10:20 - 10:40 am | **Philipp Eisenhardt**<br>Identification of Gaussian Random Field Based Surrogate Microstructure Generators with Applications to Porous Materials |
| 10:40 - 11:00 am | **Alexandre Daby-Seesaram**<br>Digital Twin of Human Lungs: Towards Real-Time Simulation and Registration of Soft Organs. |
| 11:00 - 11:20 am | **Katerina Skardova**<br>Finite Element Neural Network Interpolation : Interpretable and Adaptive Discretization for Solving PDEs |
| 11:20 - 11:40 pm | **Paolo Iaccarino**<br>Across the Multiple Scales of Polymer Foams |
| 11:40 - 12:00 pm | **Thomas Merlette**<br>Numerical Study of the Behavior of Hyperelastic Foams under severe Compression |
| 12:00 - 14:00 pm | *Lunch* |
| 14:00 - 14:20 pm | **Vivek Singh**<br>Asymptotic Homogenization of rough Boundaries |
| 14:20 - 14:40 pm | **Yury Nevenchannyy**<br>Continuum Theory of Surface Accretion and Some Applications |
| 14:40 - 15:00 pm | **Xavier Bruant**<br>Chemomechanics of Phase Transformation in Amorphous Silicon |
| 15:00 - 15:20 am | *Coffee Break* |
| 15:20 - 15:40 pm | **Damien Artières**<br>Effect of heat treatments on the microstructure of 316L single-bead walls produced by two wire-based additive manufacturing process**es** |
| 15:40 - 16:00 pm | **Marjolaine Sazerat**<br>Wire Arc Additive Manufacturing for the Repair of Aeronautical Components in Waspaloy : Microstructure, Mechanical Properties and Metallurgical Ageing |
| 16:00 - 16:20 pm | **Alain Twisungemariya**<br>The role of B-Sn anisotropy in electronics solder modeling |
| 16:20 - 16:30 am | ***Final discussion*** |

# Jean Mandel

## Founder of the Laboratoire de Mécanique des Solides

After brilliant secondary studies, Jean Mandel went on to École Polytechnique in 1927 and later to École des Mines. In 1932 he became a professor at École des Mines de Saint-Étienne and in 1948 at École des Mines de Paris. From 1951 to 1973 he was professor of mechanics at École Polytechnique.

Jean Mandel's research career was devoted mainly to the mechanics of solids and the strength of materials. In 1961 he created the Laboratoire de Mécanique des Solides, a laboratory common to École Polytechnique, École des Mines de Paris, École des Ponts et Chaussées and associated to the Centre National de la Recherche Scientifique. In October 1964 he founded and became the first president of the Groupe Français de Rhéologie. In 1980 he became "honorary member" of this group.

The scientific work of Jean Mandel covers a very wide field with a bibliography listing more than 150 articles and 5 books. He presented original ideas on the buckling of beams and shells, the finite deformations of solids, laminar flow in porous media, the bearing capacity of shallow foundations, the punch resistance of a two-layer medium, the stability of underground cavities, the plastic flow of metals, and the effect of cyclic loading on structures, as well as contributions to the fields of thermodynamics, rolling friction and homogenization.

But Jean Mandel's influence extended far beyond the field of his personal research. A good many students were trained, under his direction, in the Laboratoire de Mécanique des Solides. A fine teacher and a constant stimulus to his research group, he gave his time generously to study the details of manuscripts that were sent to him and to suggest the minor modifications he deemed necessary. Those who had the privilege of working with him were left with an impression of palpable scientific passion and moral rigor that will continue to be an example for generations to come.

Jean Mandel passed away on the 19th of July 1982, the victim of a tragic accident at the very height of his intellectual prime.

Text by Pierre Habib