Multi-Scale Modelling and Simulation (MSME)

UMR 8208 - UPEC/UPEM/CNRS

Key words
Molecular and quantum chemistry • Convective mass and energy transfers • Micro-structured materials • Dynamics of structures • Stochastic process • Mechanics of living materials

The laboratory is located on both campuses on the University Paris-Est (Créteil and Marne-la-Vallée). The biomechanics team belongs to the faculty of science and technology on the Créteil campus. The laboratory is a member of the laboratory of excellence ("Labex") MMCD (Multi-Scale Modelling and Experimentation of Materials for sustainable Construction).

Objectives and research topics

The laboratory covers a wide range of research topics from molecules to macroscopic systems and combines static description and dynamic analysis of complex systems. It aims at gathering skills in theoretical chemistry, mechanics, heat transfer, material transfer as well as biomechanics.

These various skills help to develop methodologies and scale changing concepts that are key-points in multi-physics analysis.
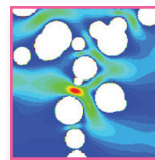
The laboratory is structured around four teams:
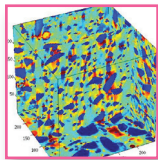
❯ Theoretical chemistry
- Electronic structure and spectroscopy
- Reactivity and molecular dynamics
- Interactions between molecules and their vicinity
- Biomolecules and bioluminescence

❯ Mechanics
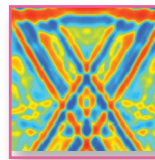- Micro-structured materials and interfaces
- Nonlinear dynamics and coupled systems
- Stochastic modelling of uncertainties
- Advanced numerical analysis

❯ Heat and materials transfers
- Biphasic media
- Convection in complex media
- Thermo-convective instabilities
- Transport in porous media

❯ Biomechanics
- Adaptation, remodeling and growth
- Characterization of living tissues
- Imaging driven modelling
- Bio-engineering

Technical equipments

- 60 workstations running on Linux, totaling a hundred CPU per 1.000 cores, with a maximum of 256 Go RAM per station.
- Software:
- Simulation tools for solid and fluid mechanics or heat and matter transfers: Comsol Multiphysics, FEAP, SfePy, FreeFem++, SPECFEM, NASTRAN, ASTER, FLUENT
- For chemical simulation: LAMMPS, DL-POLY, CRYSTAL
- For imaging: Simpleware
- For wave propagation simulation: DISPERSE
- Matlab, Mathematica

- Mechanical and material testing devices • Strain gauges • Temperature measurement • Observation devices (microscope, polisher, microdurometer) • Non-standard tests (biaxial tensile test bench, tensile and shear test bench, delamination) • Machining platform • Mechanical impact testing bench • Fine preparation tools for samples analysis (histological analysis, imaging, ultrasonic measurements, mechanical tests...) • Ultrasonic measure bench • 2D ultrasonic imaging device