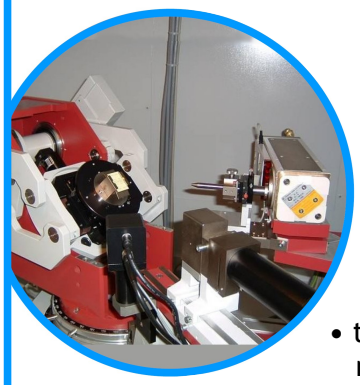
Research institute in Civil and Mechanical Engineering

Mechanical States and Microstructure Group

Institut de Recherche en Génie Civil et Mécanique
UMR CNRS 6183



Multi-scale analysis of the mechanical states experienced by heterogeneous materials

The team studies the relationship existing between the internal mechanical states experienced by heterogeneous composite or metallic materials and their microstructural properties. The investigated research topics are:

- the durability of organic matrix composite materials submitted to environmental conditions,
- the study of the thermo-mechanical behaviour of heterogeneous metallic materials, especially in plasticity.

Both research axes are based on multi-scale approaches either for the purpose of achieving modelling (through Finite Element Modelling or scale transition models) or characterization (through X-ray diffraction, neutrons diffraction, Environmental Scanning Electron Microscope, fields method, in situ experiments).

Involved persons

- **10 Researchers – Teachers**
- **1 Research engineer**
- **2 Technician et secretary**
- **≈ 4 new PhD students and postdocs** welcomed per year.

Contacts

Group manager
Frédéric Jacquemin
☎ +33 2 40 17 26 22
frederic.jacquemin@univ-nantes.fr

Secretary
Sabrina Samson
☎ +33 2 40 17 26 20
Fax: +33 2 40 17 26 18
emm-gem@univ-nantes.fr

Address
EMM - GeM, CRTT
37 Boulevard de l'université
BP 406
44602 Saint-Nazaire Cedex
FRANCE

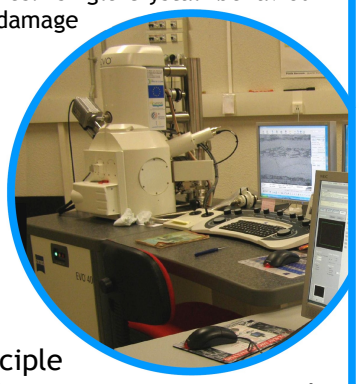
Web Site
http://gem.ec-nantes.fr

Durability of composite structures

- Modelling and simulation of multi-scale internal stresses induced by combined mechanical, thermal and hygroscopic loads (coupling between internal stresses and moisture diffusive behaviour).
- Modelling and simulation of the multi-scale mechanical states induced by the forming of organic matrix composite structures.
- Application of multi-scale characterization methods:
  In situ internal strains measurements by optical fibers coupled to numerical processing methods of the collected measurements / Fields methods through Speckle interferometry and digital image correlation / Hygro-thermal aging (controlled moisture and temperature).
- Characterization and thermo-mechanical modelling of sandwich composite structures:
  Slamming analysis on sandwich hulls for racing yachts / Dimensional stability analysis of structures submitted to thermal cycling / Residual strength of sandwich samples submitted to pyrolysis.

Thermo-mechanical behaviour of metallic materials

- Investigation of the relations between the forming processes of industrial alloys and the resulting microstructural properties:
  Cold rolling of hexagonal alloys plates and tubes / Experimental analysis and modelling of laser-assisted direct deposition.
- Micro-mechanical modelling through scale-transition approaches: single-crystal behaviour laws, elasto-plastic behaviour (accounting for strain and damage mechanisms).
- Intergranular heterogeneities (dislocations microstructure - precipitates) influence on the effective behaviour of materials.
- Use of laboratory X-ray diffraction sets (for residual stresses, textures and line profiles) and neutrons and synchrotron radiations: multi-scale analysis of the mechanical states fields.



A multi-physic and multi-scale approach for an enhanced understanding of materials behaviour

The materials are investigated through a multi-scale approach which principle essentially aims to identify and optimize their properties from the analysis of their microstructure and behaviour laws. This methodology is based on a close interaction existing between multi-scale modelling and characterization methods. Our work is precisely located at the crossroads of these two research axes.

The GeM is a joint research laboratory of the Ecole Centrale, the University of Nantes, and the CNRS. The GeM involves 170 persons and federates in the places of Nantes and Saint-Nazaire researchers working in the fields of structural mechanics, materials science and civil engineering. Organized around 6 research groups, the laboratory has an active role in many structuring projects in the fields of implementation processes of composite matters (Technocampus EMC2 notably), and civil engineering (PGCE notably).

Director : Arnaud Poitou arnaud.poitou@ec-nantes.fr
Secretary : Katia Coussin katia.coussin@ec-nantes.fr ☎ +33 2 40 37 25 32
Laboratoire GeM, ECN, 1 rue de la Noë, BP 92101, 44321 Nantes cedex 3 France

UNIVERSITÉ DE NANTES
Centrale Nantes