RESEARCH GROUP

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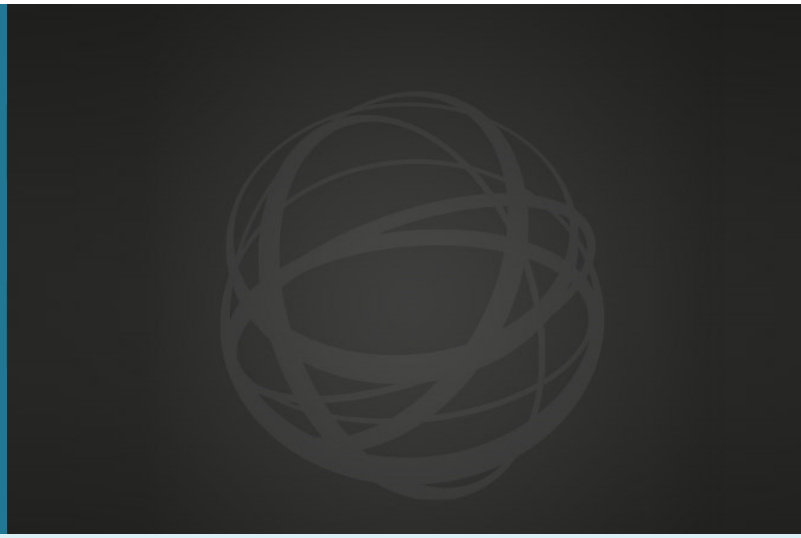
Design & Durability



Understanding the mechanical behaviour, damage tolerance and durability of composite materials and structures within harsh “multiphysical” environments has become vital for applications where the ability to keep structural health during operational life is a top priority.

Our research challenges

At the Luxembourg Institute of Science and Technology (LIST), our research aims at at contributing to build up knowledge and numerical tools to address the following scientific and industrial challenges:

- Improved knowledge about damage and durability: Durability and damage onset and propagation in these composite are influenced by the mechanisms acting at smaller scales. In service conditions, the fatigue damage of composite materials, for instance, is a combination of mechanical, thermal and chemical damage. This requires an accurate local as well as multifield analysis in order to understand damage evolution and accumulation and a complete description of the composite behavior.
- Microstructure and related damage mechanisms: This calls for the development of a consistent theory to study the microstructure properties relationships and computational design methods and tools that account for the multiscale and coupled multi-physics at the interface/interphase levels. This microstructure level methodology needs to be supported by experimental characterization techniques to understand the anchoring damage mechanics and to design pre-determined interfacial layer geometry, microstructure and properties for optimized composite properties.
- Multi-scale and multi-field modeling and simulation: There is a need to implement multi-scale methods to bridge the different length and time scales and this will be truly obtained only if the design process effectively integrates the multi-physics couplings.
- Integrating manufacturing process modeling within a material design process: Since material composite design is intimately associated with the manufacturing process, attention must be given to link composite material design and manufacturing in a systematic integrated approach.
- Multilevel multidisciplinary design optimization: This calls for the ability to optimize concurrently composite material microstructure contextually with the effective use of materials models at different scales in the selection procedure.
- Reliability analysis: The design of composite material and composite structures in the presence of multi-physics couplings is governed/dominated by uncertain parameters. The effect of uncertain parameters with respect to uncertain output parameters must be accounted for. This statistical variability is essential for design, and forms the basis for code implementation, and, most importantly, for emerging standards.

Our competencies

The research team is part of the SUSMAT Research Unit that addresses composite material technologies under a fully integrated and transversal approach by focusing on the complete life cycle of material. The activities of the research group cover:

- Material constitutive modelling: identification and Finite Element Implementation.
- Mechanical description of material behaviour through modelling of the micro or nanostructure of the material Connecting macroscopic continuum response with driving micro scale behaviour.
- Simulation of complex responses of physically coupled multiscale models.
- Advanced tools for the design/virtual testing of production processes and component or assembly performance involving multiscale modelling of material behaviour.
- Advanced modelling of multi-layered structures: beams, plates and shells (static, dynamic and failure analyses).

Key partners

A number of collaborative research projects have been or are being performed with ArcelorMittal, Codipro, IEE, Rotarex, Saint-Gobain, Tarkett, Euro-Composites, Gottsholl-Alcuilux, SIMAFORM, Goodyear, CODIPRO, AIRBUS, SIEMENS, ASTRIUM, etc.

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