RESEARCH GROUP

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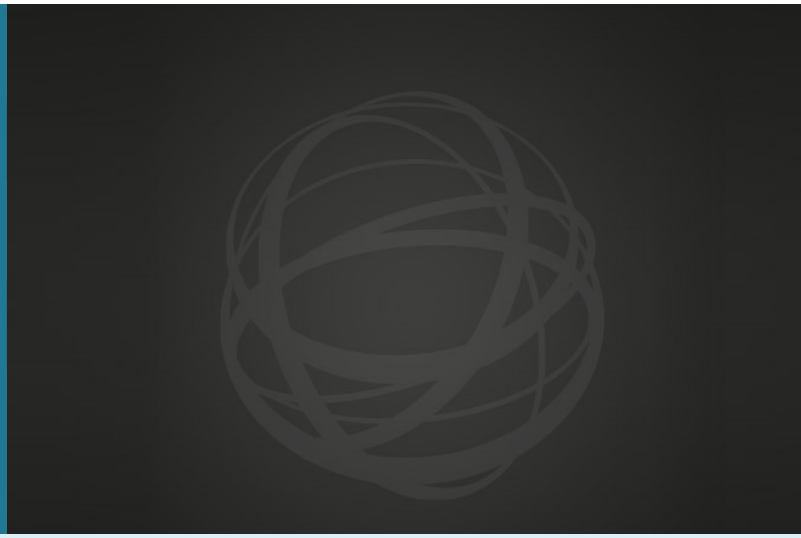
Fibre-based Composites & Interfaces

The main research expertise of this research group is on the development of functional interfaces that will incorporate new generations of multifunctional and ultrahigh-performance composites.



Interfaces between two dissimilar materials play a key role in many areas such as aerospace, aeronautic and automotive sectors. This is particularly the case for fibre-reinforced polymer composites whose performances are mainly driven by the interface and interphase integrity. In this area, the challenge is to develop functional interfaces to contribute to developing the new generation of composites materials.

Main expertise fields

Our activities span from the characterization, design and development of high-performance fibre-reinforced polymer composites with special focus on performance tailoring of interfaces / interphases.
Surface and interface engineering:

- Fibre-matrix adhesion and compatibilization of composite constituents
- Fibre/filament/tape surface activation and chemical treatment
- Adhesion promotion
- Nanostructured interphases

Multifunctional composites through tailored interfaces:

- Interface durability
- Thermal & electrical management
- Responsive interfaces
- Self-healing coatings

Composites characterization and analysis:

- In-situ characterization of constituents & interfaces
- Surface characterization
- Filament/tape/coupon testing
- Full-field strain measurement (Digital Image Correlation)
- Microstructural analysis and fractography (SEM, Computed Microtomography)

Research challenges

- Development of surface treatment approaches to promote adhesion, integrity and functionality of fibre-matrix interfaces, filament/tape/ply and multi-material interphases.
- Development of structural disassembly and debonding on-demand, as well as recycling routes for composites.
- Development of experimental techniques to characterize interfaces/interphases of composites and connect the nano/micro information to the macro behaviour of composites.

Application areas

- Interfacial layers in high performance CFRP composites
- Interphases with (coupled) mechanical, thermal, electrical, debonding capabilities
- Improved polymeric Cord-rubber interface for tire applications
- Innovative joining of hybrid systems / dissimilar materials
- Reuse/repair/recycling of composites materials

Main assets

- Eco-friendly coatings dedicated to fibre-matrix compatibilization of thermoplastic/thermosets with carbon/glass/natural fibres
- Adhesion promoters for metal/polymer assembling
- Antistatic thermoplastic composite
- Thermal dissipative thermoplastic composite
- Functional barrier Coatings (fire, gas, bacteria, water)
- Debonding-on demand solutions
- Self-healable polymer composites
- Advanced multi-scale and multi technique characterization methodologies

Equipment

- Enabling surface treatment technologies: wet and dry processes

Selected publications

- Sebastien Depaifve, David Ruch, Sophie Hermans, Abdelghani Laachachi. Nitrene functionalization as a new approach for reducing the interfacial thermal resistance in graphene nanoplatelets/epoxy nanocomposites. Carbon, 2020.
- C. Mugemana, P. Grysan, R. Dieden, D. Ruch, N. Bruns, P. Dubois, *Macromolecular Chemistry and Physics* 2020, 221, 1900432. Self-healing *metallo*-supramolecular amphiphilic polymer conetworks
- P. Hirchenhahn, A. Al-Sayyad, J. Bardon, A. Felten, P. Plapper, L. Houssiau, Highlighting chemical bonding between nylon-6.6 and the native oxide from an aluminum sheet assembled by laser welding, Accepted in ACS Applied Polym. Mater. (2020)
- Bardon J, Martin A, Fioux P, Amari T, Mertz G, Delmée M, Ruch D, Roucoules V, 2018. Reinforcement of a dodecylacrylate plasma polymer by admixture of a diacrylate or a dimethacrylate cross-linker. Plasma Processes and Polymers, 15(11), p.1800031.
- G. Mertz, M. Delmée, J. Bardon, A. Martin, D. Ruch, T. Fouquet, V. Roucoules, "Atmospheric pressure plasma co-polymerization of two acrylate precursors: Toward the control of wetting properties" Plasma Processes and Polymers (2018), 15(10), 1800073
- G. Mertz et al., Correlation between (nano)-mechanical and chemical changes occurring during photo-oxidation of filled vulcanised Styrene Butadiene Rubber (SBR), polymer Degradation and Stability, 2012 10.1016/j.polymdegradstab.2012.08.008
- B. Brüster, F. Addiego, F. Hassoun, D. Ruch, J.-M. Raquez, Thermo-mechanical degradation of plasticized poly(lactide) after multiple reprocessing to simulate recycling: Multi-scale analysis and underlying mechanisms, polymer degradation and stability

Partners

Goodyear Technical Centre, Thales Alenia Space , e-Xstream Engineering, Anisoprint , SOCOMORE

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