RESEARCH GROUP

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Design & Manufacturing of Advanced Composites

The Design & Manufacturing of Advanced Composites (DMAC) research group is dedicated to impactful, high-quality research and technological advancements in composite manufacturing. By strategically combining expertise in numerical methods, design, and advanced composite manufacturing technologies, the DMAC research group aims to drive innovation while prioritizing high-performance and sustainability. Our mission is to lead in cutting-edge research and innovation in the field, contributing to the development of lightweight high performance and sustainable composite materials and structures. The research group integrates computational science and technology, and composite material science to advance sustainable composite manufacturing practices.

Main expertise fields

1. Advanced manufacturing of structural composite
   - Liquid composite molding of sustainable composite (reactive thermoplastic, Vitrimer)
   - Structural welding of (hybrid composite) by Infrared Welding or co-curing

- Computational Design optimization and performance evaluation
  - Microstructure reconstruction, generation, analysis and optimization
  - Predictive multiscale material relations that bridge microstructures with the continuum concurrently via statistical averaging and monitoring the microstructure/defect evolutions (i.e., manufacturing processes)
  - Materials-Process Relationships to truly close the loop between as-designed and as-manufactured composites material, products and structures

Research and innovation challenges

The DMAC research group is at the forefront of addressing the complex challenges in the field of high-performance and sustainable composite manufacturing. DMAC multidisciplinary is committed to developing ground-breaking new solutions that seamlessly integrate cutting-edge materials science, sophisticated manufacturing processes, and innovative thinking. DMAC research spans the entire lifecycle of composite materials, from sustainable material development to advanced manufacturing processes and efficient end-of-life management through recycling. Embracing the digital age, we integrate Industry 4.0 technologies into our manufacturing processes for enhanced precision, quality control, and scalability. With a keen eye on cost-effectiveness, we strive to balance high-performance requirements with affordability and accessibility. Our dedication to the development of multifunctional composites, and the integration of digitalization position us as leaders in the quest for sustainable solutions in the composite manufacturing landscape.

Application areas

The expertise and research conducted by DMAC group open up a multitude of potential application areas. Here are some key domains where DMAC's knowledge and capabilities can make a significant impact:

1. Aerospace Engineering
   - Structural design and manufacturing of advanced composite components
   - Innovative approaches to reduce weight and enhance performance

- Automotive Industry
  - Development of lightweight and high-strength composite materials for automotive components.
  - Sustainable manufacturing processes for the production of composite parts in the automotive sector.

- Defence and Military Applications
  - Development of composite materials for lightweight and strong military structures.
  - Design and manufacturing of components for military vehicles and equipment.

- Emerging Technologies
  - Exploration of novel applications in emerging technologies, including Urban Air Mobility (UAM) and electric mobility.

Main assets

- Internationally leading and talented researchers with proven track record offering knowledge in mathematical modelling, optimization techniques, numerical methods, high-performance and parallel algorithms and large-scale scientific computation.
- Long-term collaborations with world-leading companies and research groups.
- Wide range of in-house software capabilities.
- Proficient use of scientific software tools and programming languages: Abaqus, COMSOL, MATLAB, Simulink, Scilab, Fortran, C/C++ and Python.
- Multiple patented assembly and welding proprietary processes.
- Patented chemical functionalization of acrylics-based resin system for multi-material welding
- Structural composite welding and co-curing (PEEK/Epoxy) through physical treatment (i.e. atmospheric plasma)
- Multiscale characterization methodologies to identify, understand and predict material behaviours during processing.

Selected Recent publications

- Simultaneous characterization of preform expansion and permeability in vacuum assisted resin infusion. Polymer Composites, 43(6), 3560-3573.
- Experimental determination of the permeability of engineering textiles: Benchmark II. Composites Part A: Applied Science and Manufacturing, 61, 172-184.
- On the hot-plate welding of reactively compatibilized acrylic-based composites/polyamide (PA)-12. Materials, 16(2), 691.
- Three-dimensional transient finite element analysis of the selective laser sintering process. Journal of materials processing technology, 209(2), 700-706.
- Modeling and validation of the large deformation inelastic response of amorphous polymers over a wide range of temperatures and strain rates. International journal of solids and structures, 44(24), 7938-7954
- Effective conductivity in isotropic heterogeneous media using a strong-contrast statistical continuum theory. Journal of the Mechanics and Physics of Solids, 57(1), 76-86.
- Material Twin for composite material microstructure generation and reconstruction. Composites Part C: Open Access, 7, 100216.

Partners

DAHER, GRADEL, Euro-Composites, Arkema, Airbus, ThalÃ¨s AlÃ©nia Space, Toyota, Mahytec Hensoldt, Goodyear Technical Centre, ArcelorMittal, Siemens-Samtech, Saint Gobain Research, Dow Europe, Alcuilux, Weber, ESA (European Space Agency), IEE, Luxembourg, Tarkett, Saint-Gobain, Abrasives, Luxembourg

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