

University of Liège

Our research composites competencies for
the F-35 Lightning II



LIÈGE université
Interface Entreprises
Research & Innovation



INTRODUCTION

The University of Liège (ULiège) brings together more than 3,300 researchers, scientists and technicians, and thus as many advanced skills in science and technology, humanities and social sciences and life sciences.

ULiège has always promoted to break down the barriers between academia and the economic world, which is essential for economic growth through innovation. Promoting this proximity, Interface Entreprise plays a key role in the mission of Service to the Society of ULiège, which it fulfills by connecting academic research and the needs of innovative companies and accompanying their collaborations in all areas of expertise of the ULiège. It therefore allows companies an easy access to the University's state-of-the-art skills, training and equipment.

Particularly within the framework of Essential Security Interests (IES) and more specifically for essential technological applications to support Belgian IES, ULiège has developed a variety of and specialized skills that it makes accessible by:

- Master's courses such as the Aerospace Masters, Chemistry and Materials Sciences or Space. So many trained and operational engineers ready to integrate companies in the sector as part of internships or first hires;
- The provision of state-of-the-art equipment and infrastructure such as the multidisciplinary wind tunnel, the mechanical testing laboratory for materials and structures, the test facilities of the Liège Space Center (CSL), clean rooms, etc.;
- The creation of spin-off companies, many of which are leaders in their sector: Amos, Samtech, Open-Engineering, etc.

As part of Belgium's participation in the F-35 Lightning II program, this brochure provides a non-exhaustive overview of the skills of the ULiège for Advanced Materials and Components, one of the 5 Key Enabling Technological Defense and Security Applications, and more specifically in the field of Composites. These skills have been classified in five areas of common interest:

1. Next Gen Composites Materials (High Strength & High Toughness, Increased thermal capabilities)
2. Decrease of production costs with Out Of Autoclave Technologies
3. Bonding Metals & Composites (Out of Autoclave, Thermoplastic Composites)
4. Repair Techniques for Composites
5. Integration of Functions, Simplification of assemblies (e.g. combining Injection Molding & continuous Fiber Composites,..)

For ULiège Interface Entreprises,

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Senior Knowledge Transfer Officer, Science & Technology, Aerospace



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PROJECT OPPORTUNITIES AT ULIÈGE

5 Areas of Common Interest:



NEXT GEN
COMPOSITES
MATERIALS



DECREASE OF
PRODUCTION
COSTS WITH OUT
OF AUTOCLAVE
TECHNOLOGIES



BONDING METALS
& COMPOSITES



REPAIR
TECHNIQUES FOR
COMPOSITES



INTEGRATION
OF FUNCTIONS,
SIMPLIFICATION
OF ASSEMBLIES



ULIÈGE'S RESEARCH TEAMS

A&M RESEARCH UNIT

COMPUTATIONAL & MULTI-SCALE MECHANICS OF MATERIALS (CM3)

The CM3 focuses on the developments of multi-scale numerical methods for complex non-linear engineered materials, such as the failure study of composites, foamed materials, and MEMS. The research is achieved through international collaborations with other universities, research centers, and industries; it is financed through national and European projects.



INTEGRATION OF
FUNCTIONS, SIMPLIFICATION
OF ASSEMBLIES



NEXT GEN COMPOSITES
MATERIALS



BONDING METALS &
COMPOSITES

www.ltas-cm3.ulg.ac.be

METALLIC & MATERIALS SCIENCE UNIT (MMS)

The MMS studies the physico-chemical phenomena that governs optimization of metallic materials and determines their properties.

The main focus is concerning thermal treatments, phase transformations at liquid and solid state for aeronautical alloys (Al, Ni, Ti, special steels) and thermophysical properties.

The MMS researches concerns also microstructure obtained through particular processes such as: thixoforming, vacuum coating and deposition of thin foils, friction stir processing, laser cladding, electron beam melting, powder metallurgy.



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www.metaux.ulg.ac.be

COMPUTER AIDED GEOMETRIC DESIGN GROUP

The Computer Aided Geometrical Design group is active in research in CAD/CAM/CAE and the link with novel numerical simulation techniques. Among our research topics, the following have applications in aeronautics:

- Novel simulation techniques like the Extended Finite Element Method (X-FEM)
- Application of the X-FEM to the simulation of composite structures (structural analysis or manufacturing techniques)
- Structural analysis-driven automatic model simplification
- Mesh Generation for numerical simulations



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www.cgeo.ulg.ac.be

NON LINEAR COMPUTATIONAL MECHANICS

Computational Mechanics specializes in tailored software developments and numerical simulation of problems involving large deformations, complex contact situations and multi-physics couplings. Our finite element based software METAFOR can deal with complex material behaviors including damage and fracture propagation for both metallic and composite materials. Domains of application are:

- Impact simulation and crashworthiness
- Hot and cold metal forming processes
- Tire mechanics & rubber
- Biomechanics

These numerical models result from many collaborative projects with industry. These projects are funded by the European Community, the Walloon Region and the Marshall Plan.



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metafor.ltas.ulg.ac.be

MECHANICAL VIBRATIONS LAB (LTAS-VIS)

The field of expertise of the LTAS-VIS research group relies in the theoretical and experimental dynamic analysis of jet engine mechanical components. The main topics on which LTAS-VIS has developed a strong research expertise are the following:

- Structural design of aircraft engines
- Turbomachinery rotordynamics
- Vibration testing and modal analysis

Research developments are performed with the aim of implementation in industrial finite element programs such as Samcef and/or Oofelie. Experimental activities are closely related to the setting-up of vibration testing facilities.



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MULTIBODY & MECHATRONIC SYSTEMS LABORATORY

The main research activities are simulation methods for the analysis of complex dynamic systems, with a particular focus on the kinematic and dynamic analysis of mechanical systems, advanced numerical solvers, model order reduction techniques, optimization methods, motion and vibration control, mechatronics, multiphysics systems, biomechanics and human motion analysis.

The Multibody & Mechatronic Systems Laboratory develops computer-aided tools for the mechanical and control design of deployable space structures, large telescopes, robots, machine tools, wind turbines, vehicle suspensions, powertrains. The team is also involved in the Laboratory of Human Motion Analysis of the University of Liège.

www.ltas-mms.ulg.ac.be



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AUTOMOTIVE ENGINEERING

Automotive Engineering & Structural Optimization Group has developed a great expertise in the design of lightweight structures including multimaterial and composite solutions for automotive and aircraft problems. Based on the unique research expertise in topology, shape, and parametric optimization, the Automotive Engineering and Structural Optimization group has developed advanced CAE solutions based on simulation and optimization. The design tools provide a creative design framework enabling to carry out efficiently preliminary design and design studies for high performance structures accounting, as soon as the preliminary design stages, for the manufacturing constraints. The researchers carry out research projects in close collaboration with major industrial partners from automobile, aeronautics, and defense industry. The research is typically driven by unsolved industrial problems and aims at bringing new theoretical contributions to solve efficiently the real-life engineering problems. Recent research projects have dealt with topology optimization applied to the design layout of composite structures of airplanes (VIRTUALCOMP, H2020 HFLE), topology optimization of aeroengine components made by additive manufacturing (AERO+, FAFIL), design of lightweight automotive components (LIGHTCAR, LIGHT VEHICLE 2025), fluid flow channels in high performance fuel cells (INOXYPEM)...

www.ingveh.ulg.ac.be



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URBAN AND ENVIRONMENT ENGINEERING RESEARCH UNIT

MATERIALS AND STRUCTURES MECHANICS (M&S)

The M&S offers possibilities for aeronautical firms to carry out mechanical tests on different types of aircraft components like rods, lubrication groups, bearing supports, flaps actuator parts, engines composite or metallic carters. The equipment park includes hydraulic and electro-mechanic machines with a load capacity from 10 kN to 2500 kN. On a test floor, movable static hydraulic jacks (50 to 1000 kN) and movable dynamic hydraulic jacks (100 to 1000 kN) can be used.



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www.uee.uliege.be

CHEMICAL ENGINEERING RESEARCH UNIT

NCE - NANOMATERIALS, CATALYSIS & ELECTROCHEMISTRY

The NCE laboratory is active in the development of nanostructured materials for various applications such as catalysis, electrochemistry and functionalized coatings. The specificity of NCE's research lies in their transversality, through which materials science and chemical engineering are approached in an integrated way.

www.chemeng.uliege.be



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CESAM - COMPLEX AND ENTANGLED SYSTEMS FROM ATOMS TO MATERIALS

GREENMAT

GREENMat - a chemistry research laboratory from ULiege - is specialized in the optimization of materials, the development of formulations (suspensions, slurries and pastes) and the processes related to the manufacturing and shape forming of (composite) material parts or devices using pressing, casting and 3D printing. GREENMat has also an extended expertise in the characterization of these parts and materials.



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CERM

CERM was founded in 1993, is constituted by 25-30 researchers and has a worldwide recognition in polymer science, more particularly in:

- macromolecular engineering using controlled polymerization techniques, thus in the precision synthesis of polymers that fit the target application. These researches include (i) the development of new (sustainable) polymerization processes, including monomers synthesis, catalyst design and mechanistic investigations, and (ii) the full structural and thermo-mechanical characterizations of the polymers by state-of-the-art analytical tools;
- the chemical transformation of carbon dioxide (CO₂) into novel sustainable CO₂-sourced functional polymers (polycarbonates, polyurethanes) and materials, and the use of CO₂ as a green medium for preparing or processing materials;
- the development of innovative applications for polymers and nanocomposites: biomaterials (implants, supports for cell culture, etc.), microcellular foams as electromagnetic interference (EMI) absorbers or for thermal insulation, multifunctional coatings (antibacterials, antifouling, indoor air purification, etc.), solid electrolytes for battery applications, organic batteries, etc.



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NEXT GEN COMPOSITES
MATERIALS



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FACULTY OF APPLIED SCIENCES

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AEROSPACE & MECHANICAL ENGINEERING RESEARCH UNIT

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CHEMICAL ENGINEERING RESEARCH UNIT

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FACULTY OF SCIENCES

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CESAM - COMPLEX AND ENTANGLED SYSTEMS FROM ATOMS TO MATERIALS RESEARCH UNIT

www.cesam.uliege.be

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LE FONDS SOCIAL EUROPÉEN ET LA WALLONIE
INVESTISSENT DANS VOTRE AVENIR