

Les compétences de l'Université de Liège pour le Pôle Greenwin



**GREEN
WIN**
CHEMICAL ENGINEERING & MATERIALS IN WALLONIA



INTRODUCTION

L'Université de Liège (ULiège) regroupe plus de 3 300 chercheurs, scientifiques et techniciens, et donc autant de compétences pointues en sciences et techniques, sciences humaines et sociales et en sciences du vivant.

Depuis toujours, l'ULiège prône un décloisonnement entre le monde universitaire et le monde économique, décloisonnement indispensable à la croissance économique par l'innovation. Favorisant cette proximité, l'Interface joue ainsi un rôle-clé dans la mission de service à la Société de l'ULiège, qu'elle remplit en connectant recherche universitaire et besoins des entreprises innovantes et en accompagnant leurs collaborations dans tous les domaines de compétences de l'Université. Elle permet donc aux entreprises un accès facilité aux compétences, formations et équipements de pointe de l'ULiège.

Particulièrement dans les secteurs de la chimie, les biotechnologies, la construction et l'environnement, l'ULiège a développé des compétences variées et pointues qu'elle rend accessible par :

- Les formations de type Master telles que les Masters en Sciences et gestion de l'environnement, Génie chimique et sciences des matériaux, Chimie et Bio-industries ou encore Master ingénieur civil des constructions. Autant d'ingénieurs formés et opérationnels prêts à intégrer les entreprises du secteur dans le cadre de stages ou de premières embauches
- La mise à disposition d'équipements et d'infrastructures de pointe tels que le Sensor Based Sorting Lab, le laboratoire de matériaux de construction, les réacteurs de synthèses chimiques à l'échelle pilote, l'Ecotron, etc.
- L'implication dans l'innovation ouverte, qui encourage les partenariats de recherche avec les entreprises d'une part, mais aussi le transfert de technologies par licence et la création d'entreprises spin-off (Odometric, Opal-Systems, Eliosys, etc.)

Cette brochure donne un aperçu non exhaustif des compétences de l'ULiège sélectionnées selon les 9 domaines stratégiques du Pôle Greenwin et les deux domaines transversaux :

- Chimie : Chimie Verte | Transformation du CO₂ | Biotechnologies
- Construction : Matériaux durables | Stockage et Efficacité énergétique | Systèmes constructifs
- Environnement : Recyclage | Sols et sédiments | Eaux et boues, air et émissions
- Transversal : Economie Circulaire | Numérique

Dans une vision systémique globale, nous proposons également des compétences en sciences humaines et sociales liées à ces thématiques.

Nous sommes convaincus que ces compétences pourraient être un atout précieux pour les membres du Pôle dans leur croissance économique et leurs besoins d'innovation technologique et souhaitons explorer avec le Pôle d'éventuels partenariats.

Dr. Ir. Michel Morant
Directeur Interface Entreprises
Université de Liège

Contact Pôle Greenwin

Ir. Laurence Druet
Technology Transfer Officer
T +32 4 349 85 22 | M +32 475 63 25 58 | l.druet@uliege.be



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LES DOMAINES DU PÔLE GREENWIN

Domaines stratégiques

Chimie



CHIMIE VERTE



TRANSFORMATION
DU CO₂



BIOTECHNOLOGIES

Construction



MATÉRIAUX
DURABLES



STOCKAGE ET EFFICIENCE
ÉNERGÉTIQUE



SYSTÈMES
CONSTRUCTIFS

Environnement



RECYCLAGE



SOLS
ET SÉDIMENTS



EAUX ET BOUES,
AIR ET ÉMISSIONS

Domaines transversaux



ÉCONOMIE
CIRCULAIRE



NUMÉRIQUE



SCIENCES
HUMAINES ET SOCIALES

LES LABORATOIRES DE L'ULIÈGE

1. CESAM Research Unit

CENTRE D'ETUDE ET DE RECHERCHE SUR LES MACROMOLÉCULES - CERM

CERM, founded in 1993, has a worldwide recognition in polymer science and in the preparation/characterization of advanced organic materials. The group is specialized in macromolecular engineering, thus in the preparation of polymers of precise structure and functionality that fit the target application.

CERM covers :

1. the design of new tools for the precision synthesis of innovative polymers,
2. the transformation of carbon dioxide (CO₂) into polymers,
3. the preparation, processing and characterization of advanced (biodegradable) polymers and,
4. the development of more sustainable routes for their production.

With a multidisciplinary approach, CERM works on both fundamental and applied research projects with applications in the fields of biomaterials, functional coatings, energy storage and environment protection.

www.cerm.ulg.ac.be/



GROUP FOR RESEARCH AND APPLICATIONS IN STATISTICAL PHYSICS - GRASP

Fascinating natural patterns are observed in systems composed of many particles subject to non-linear laws. Statistical Physics aims to create a link between the microscopic properties of the particles and some macroscopic variables. The Group of Research and Applications in Statistical Physics (GRASP) at the University of Liège was founded in 1999 to address those questions in Soft Matter.

The GRASP projects are dedicated to the study of nano particles, suspensions, monolayers, biosensors, self-assembling systems, powders, colloids, granular systems, droplets, antibubbles, microfluidics, soap films, emulsions, foams, complex fluids, active matter, rheology, chaos and non-linear phenomena.

Green applications of GRASP studies concern for example the capture and transport of water in arid regions thanks to fog nets, the efficiency of handling granular materials in industry, the development of microfluidics systems as tiny chemical reactors, ...

www.grasp.uliege.be



GROUP OF RESEARCH IN ENERGY AND ENVIRONMENT FROM MATERIALS – GREENMAT

The GREENMAT group is a research laboratory specialized in the development and characterization of inorganic materials. The group develops powders, bulk materials or coatings for applications related to energy, environment, health or protective coatings. In most projects, it pays special attention to the control of microstructure, porosity and interfaces in order to optimize the material properties.

While maintaining a strong expertise in structural ceramics (stabilization of suspensions, shaping and densification), the main activity is in the field of functional materials (especially oxides) providing higher

added value. In order to meet our objectives, GREENMAT relies on a wide panel of modern synthesis and characterization tools.

The group is proud to put its expertise and equipment in collaborative projects of all kinds, from pioneering research in academic networks to innovative applied research in academia-industry consortia. It also carries out contract research for industrial partners.

www.greenmat.uliege.be



QUANTUM MATERIALS - Q-MAT

The group Q-MAT gathers the expertises of 4 laboratories active in the physics of Quantum Materials and is organised around two complementary platforms. One platform is related to the growth and characterization of nanostructures. The other is related to the atomistic modelling of materials properties from first-principles in relation with the ABINIT software project.

The group combines complementary activities on various types of materials:

- Electronic and spintronic materials
- Thermoelectric materials
- Phase-change materials
- Ferroelectric, piezoelectric and pyroelectric materials
- Photovoltaic materials
- Magnetic and magneto-electric materials
- Optical materials
- Superconductors
- 2D materials like graphene

for a wide variety of potential applications in the field of energy, information technologies and sensing (also screening of alternative “green” materials for specific applications).

www.cesam.uliege.be/cms/c_3301798/en/cesam-q-mat



2. SPHERES Research Unit

BUILDING ENERGY MONITORING AND SIMULATION – BEMS

The BEMS team addresses the energy performance of buildings with a systemic approach using monitoring and numerical simulation. The team focuses on two areas of research.

Rational use of energy and energy management in buildings

- Study of low temperature heating systems or high temperature cooling systems
- Study of zero-energy houses
- Development of in situ verification methods of building performance with consideration of the influence of occupant behavior
- Participation of building thermal systems in the management of smart grids
- Buildings and air conditioning system simulation

Use of renewable energy sources in buildings

- Solar thermal energy storage
- Study of micro-cogeneration solutions (biomass)
- Optimization and management of solar heat storage systems from a thermo-chemical process
- Management of micro-CHP installations, particularly in the context of smart grids

www.bems.ulg.ac.be/



MATÉRIAUX
DURABLES



STOCKAGE ET EFFICIENCE
ÉNERGÉTIQUE



NUMÉRIQUE

EAU - ENVIRONNEMENT - DÉVELOPPEMENT – EED

The EED team is interested in the complex relationship of water in its environment, especially the impact on humans and their development. It conducts many studies in developing countries and uses remote sensing. The team focuses on three areas of research.

Agrometeorology

The team aims to better understand the soil - plant - atmosphere relationship in space and time and contributes to its better management

- Water balance management at the level of agricultural parcels, watersheds or country
- Monitoring and forecasting agricultural production and cereals diseases
- Monitoring and control of agri-environmental measures
- Monitoring the degradation of the environment, in particular the desertification process

Integrated and participative water management

The team contributes to the development and analysis of integrated and participative water management (GIPARE) methods at the local watershed scale. Conducted in different contexts, the studies of the EED team aim to identify sustainable development trends in the water sector.

Wastewater management

Researchers develop appropriate technologies for water and leachate treatment at waste landfill facility:

- Tools and methods to quantify biochemical processes in natural and man-made aquatic ecosystems
- Simulation models of aquatic ecosystems to optimize their treatment performance
- Aerated lagoons, sand filters, algal channels, membrane reactors, individual sanitation systems, photobioreactors...

www.eed.ulg.ac.be/



SOLS
ET SÉDIMENTS



EAUX ET BOUES,
AIR ET ÉMISSIONS

ENERGY AND SUSTAINABLE DEVELOPMENT – ENERGYSUD

The EnergySud team focuses on the energy and environmental performance of existing and future buildings. It focuses on two areas of research.

Development of tools for construction professionals

The team creates and develops tools (pre-sizing tables and graphs, technical brochures, books, Excel sheets, software) allowing the design team (architect, design office engineer, PEB managers ...) to evaluate and manage the energy and environmental performance of a building to be built or existing throughout its

life cycle. These tools take into account the energy and environmental performance from the preliminary stage of design to the building constructed (or renovated) as well as its evolution until its final demolition.

Monitoring and support of PEB regulations, PEB certification and energy and environmental labeling of buildings

- «PEB-Facilitator» and «PEB Certification-Facilitator» mission (guidance applied to concrete cases encountered by construction professionals)
- Trainings for designers and companies
- Scientific support for innovative processes, techniques and products not yet taken into account in the criteria and calculation methods

www.energysud.ulg.ac.be/fr/



MATÉRIAUX
DURABLES



STOCKAGE ET EFFICIENCE
ÉNERGÉTIQUE



RECYCLAGE



ÉCONOMIE
CIRCULAIRE

SENSING OF ATMOSPHERES AND MONITORING – SAM

The SAM team specializes in environmental metrology of polluted atmospheres. Since 1995, it has dedicated its research to the metrology of polluted atmospheres, in particular gaseous compounds, at a local level. The team focuses on four areas of research.

Olfactory pollution management

- Odor monitoring
- Development of electronic noses and decision support indicators for operators and policy makers
- Integration of local residents in a participative management approach
- Modeling atmospheric dispersion
- Measurement of odor intensity (compared to a reference scale)
- Dynamic Olfactometry for measuring odor concentration

Characterization of indoor air quality and materials emissions

- Physicochemical characterization of emissions after sampling
- Measurement of olfactory perception and odors of materials
- Low cost sensor tracking
- Development of simple and fast tools for the classification of materials
- Rapid diagnosis and continuous monitoring of indoor air quality
- Participation as an expert in the standardization and regulation of the subject

Organic waste recovery processes follow-up

- Development of simple tools for continuous monitoring of processes such as bio-methanisation and composting
- Physico-chemical characterization of the parameters in relation to gaseous emissions of these processes
- Environmental impact assessment of these processes, for example olfactory pollution

Assessing the air quality at the neighborhood level and smart cities

- Low cost sensor tests for the realization of air quality cadastres at district scale
- Olfactory impact study
- Development of tools and methods for assessing olfactory discomfort and air quality
- Development of data crossing tools for decision support

www.sam.ulg.ac.be/index.php/fr/



EAUX ET BOUES,
AIR ET ÉMISSIONS

SOCIO-ECONOMIE ENVIRONNEMENT ET DÉVELOPPEMENT - SEED

The SEED team is developing research on social transformations resulting from the consideration of environmental issues and sustainable development. The team focuses on four areas of research.

Biodiversity and agroecology

The idea of a co-evolution of species and habits questions the conservation of nature, agricultural biodiversity and the management of protected areas. The approach developed by SEED favors complementarities between skills and collaboration between actors in a living management perspective.

Researcher-Public Interactions

In managing environmental problems, researchers interact with all relevant stakeholders who express their concerns, participate in controversies, collaborate in defining research questions and collecting data. SEED captures these interactions through approaches ranging from ethnographic observation to intervention research.

Reflective governance and transition

Addressing environmental issues involves collective action. Scientists must find their place in these mechanisms often co-created by researchers, public and private actors. Collective experimentation and the inclusion of research into action have become management tools full-blown.

Managing complexity as a training issue

The implementation of participative and sustainable management systems requires training in the complexity and uncertainties proper to environmental management. This requires mastering management tools and a critical approach to environmental issues.

www.seed.ulg.ac.be/enseignement/campus-darlon/



3. Aerospace & Mechanical engineering (A&M) Research Unit

MECHANICS OF BIOLOGICAL AND BIOINSPIRED MATERIALS LABORATORY - MBBM

The main research topics of the laboratory are the following:

- Bio-inspired hierarchical composite materials by 3D printing
- Mechanics of biological interfaces
- Bone mechanics, remodeling and mineralization

www.biomat.ulg.ac.be/



THERMODYNAMICS LABORATORY

For more than 30 years, the Thermodynamics Laboratory of the University of Liège has been carrying out numerical and experimental research activities in the field of thermal and energy systems. The main fields of research are refrigeration, positive displacement machines (compressors and expanders), building physics and HVAC systems, combustion, internal combustion engines, heat exchangers and small and medium scale Organic Rankine Cycles.

www.labohtap.ulg.ac.be/cmsms/



WIND TUNNEL LABORATORY

The Wind Tunnel Laboratory operates a **multi-disciplinary subsonic** tunnel, with a maximum airspeed of 65m/s in atmospheric conditions. The singularity of the facility is its **modularity**: the wind tunnel is composed of two test-sections and several dedicated systems to investigate the field of **low speed aerodynamics** (Mach < 0.15).

The dimensions of the test sections and available instrumentation enable to study several types of engineering applications: **aircraft systems** (UAVs, rotorcrafts), **wind Energy systems** (wind turbines, energy harvesting), **building** aerodynamics and aeroelasticity, **vehicles** aerodynamics ...

labos.ulg.ac.be/wind-tunnel-lab/



STOCKAGE ET EFFICIENCE
ÉNERGÉTIQUE

4. Chemical Engineering Research Unit

NANOMATERIALS, CATALYSIS, ELECTROCHEMISTRY - NCE

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.

Shaping and scaling-up

Beyond design and synthesis of nanostructured materials, shaping processes are developed and optimized. Thus, the materials produced are used in the form of powders, films, beads, monoliths, etc.

An important aspect of the research is to demonstrate the feasibility for scaling-up of both synthesis methods and shaping processes at an industrial scale. Studies are therefore devoted to their development at an intermediate pilot scale, between the laboratory and the industrial scales.

Examples include the production of microbeads from powders through the microencapsulation process developed by BRACE GmbH, the deposition of photoactive nanometric films by roll-coating for steel industry and in commercial devices for water purification, the production of electrodes by spray-coating...

Catalysts for specific applications

The use of Sol-Gel process for the preparation of supported catalysts allows, unlike usual routes for the preparation of these materials, to gather in one single step the formation of the support and the introduction of the active sites. In several heterogeneous catalysis or photocatalysis applications, the materials obtained have remarkable performances in terms of activity, selectivity, stability and diffusion of reactants and products.

Numerous materials, with various shapes, have been developed for their use in processes of industrial and/or environmental interest: hydrogenation, hydrodechlorination, (photo)-oxidation for the degradation of pollutants in air or in water and microorganisms or for the synthesis of organic compounds, synthesis of carbon nanotubes, biogas purification, ...

Synthesis of nanostructured materials

Since the morphology of a material at nanoscale is critical for its performances, research studies aim at developing methods for the controlled synthesis of nanostructures dispersed, or not, within porous matrices.

The methods developed mainly concern wet syntheses among which, the Sol-Gel process.

Many inorganic, inorganic-organic hybrid and carbon-based materials are synthesized for specific applications, in particular in the fields of catalysis and electrochemistry (fuel cells, batteries, supercapacitors, ...).

www.chemeng.uliege.be/cms/c_2275228/en/chemical-engineering-nanomaterials-catalysis-electrochemistry-nce



CHIMIE VERTE



STOCKAGE ET EFFICACITÉ
ÉNERGÉTIQUE



Eaux et Boues,
Air et Émissions

PRODUCTS, ENVIRONMENT, AND PROCESSES - PEPS

The PEPs group is active in the fields of (bio-) chemical reaction engineering, thermal and mechanical unit operations, process simulation, low carbon energy systems and sustainable development. This includes the corresponding fundamentals, especially mass and energy transfers, and multi-phase fluid dynamics. A strength of our approach is to link the different scales in time and space:

- starting from microscopic and even molecular level
- having a strong focus on the equipment level in experiment as well as modelling
- reaching up to the simulation of entire processes
- and evaluating the favored large-scale deployment pathway

Products

- Product and bio-product engineering
- Characterization of porous materials by X-ray microtomography

Environment

- Solid waste and flue gas treatment: sludge treatment, aerosol capture, VOC adsorption
- Life Cycle Assessment, EPDs
- CO₂ capture and re-use

Processes

- Hydrodynamics in multiphase systems
- Mixing in stirred tank (bio)reactors
- Convective drying of deformable materials
- Solvent and reactive extraction, separation of dispersions
- CAPE – Computer-Aided Process Engineering incl. economic and exergetic evaluation

Some more details about specific topics:

- Life cycle assessment: Determination of the environmental impact associated to products or processes, support to ecodesign, implementation of environmental product declarations
- Sludge management: Optimization of wastewater sludge treatment from conditioning and dewatering to drying
- Drying of materials: Study of the drying kinetics and textural changes of materials using several drying technologies and advanced characterization tools such as X-ray microtomography to follow shrinkage and cracks
- Solvent and reactive extraction: Develop and validate a design tool for extraction columns based on the drop-based simulation of the columns, where the parameters of the drop models are determined from lab experiments
- Coalescence, liquid-liquid phase separation, and settlers: Settler design based on single-drop modelling, where the coalescence parameters are determined from a lab-scale settling experiment

- Exergetic evaluation and advanced thermodynamic modelling: Exergo-economic comparison of entire process routes and individual process steps is performed, especially for bio-based substances advanced thermodynamic models are derived
- Reactor design: Experimental characterization and modelling of flow and mass transfer in stirred tank and packed bed (bio)reactors. Modeling of their global performances. Scale-up and scale-down models.
- Advanced experimental techniques: Development and adaptation of noninvasive visualization techniques to characterize hydrodynamics and mass transfer in (bio)reactors.
- Product-oriented engineering: Fabrication of porous polymer materials with controlled end-use properties based on the mastering of their microstructure through an optimal selection of the fabrication conditions.
- CO2 capture: Experimental study of solvent stability and optimization of the post-combustion CO2 capture process for emissions reduction in large industries and power plants. Negative CO2 emissions with air capture and bio-CCS.
- Power-to-fuel: Integration of CO2 capture with water electrolysis and synthesis of liquid fuels whose high energy density allows for long term energy storage from variable renewables.
- Process simulation, optimization and economic evaluation: Steady-state and dynamic modeling of large and complex processes to evaluate and improve their energy efficiency, environmental sustainability and financial viability.

www.chemeng.uliege.be/cms/c_2638038/fr/chemical-engineering-products-environment-and-processes-peps



5. Electrical Engineering & Computer Science (Montefiore Institute) Research Unit

SYSTEMS AND MODELING – SYSTMOD

The research unit consists of 10 faculty members and more than 50 researchers with diversified and interdisciplinary research interests spanning.

- Systems and control
- Machine learning and optimization
- Bioninformatics, systems biology and neurodynamics, and
- Power systems.

www.montefiore.ulg.ac.be/systmod/



6. Urban and Environmental Engineering (UEE) Research Unit

FIRE AND TIMBER ENGINEERING

The research group FIRE AND TIMBER ENGINEERING has been active in the field of structural fire engineering since 1982. The group has participated in numerous European research projects on fire development and

on the behaviour of structures subjected to fire (LOCAFI, TRAFIR, etc.) and developed the software SAFIR which is now used by more than 200 research centres and design offices throughout the world for the modelling of structures subjected to fire.

Activities are carried out in the following area:

- Modelling of concrete and concrete structures in fire
- Steel constitutive model for considering local buckling in beam finite elements
- Hybrid fire testing
- Travelling fire

The fire testing lab has an extensive expertise in experimental modelling of structural elements in fire conditions, in a traditional furnace testing environment. This lab is being used for certification of industrial products (under accreditation, under ISO 17025) as well as for national or European research projects.

www.uee.uliege.be/fireandtimberengineering



LOCAL ENVIRONMENT MANAGEMENT & ANALYSIS - LEMA

LEMA is a research group attached to the Department of Architecture, Geology, Environment and Construction (Argenco) at the University of Liège. LEMA develops its researches in the domain of the local environment, in both its physical (urban quarters, housing, public spaces), cultural (cultural heritage, tourism), perceptive (townscape, visual and thermal comfort) and social (quality of life, urban cohesion) dimensions.

Research Axes :

- Strategies, governance and decision-making in urban development
- Modelling and management of urban landscapes
- Sustainable local development

www.lema.ulg.ac.be/



LAB FOR USER COGNITION & INNOVATIVE DESIGN - LUCID

Created in 2001, the LUCID-ULg's team brings together researchers and academics pooling their complementary skills: architects and building engineers, computer scientists, work psychologists, electronic and mechanical engineers, assisted by a staff of computer graphic designer, administrative manager and business manager.

Its research works aim at bringing support to designers and concern:

- analysis of cognitive activity during design tasks
- knowledge models formalization: design process, design product and implicit data management
- innovative technologies for human machine interaction: fuzzy logic & computer graphics, signal processing, AI & computer vision
- development of intelligent and natural interfaces software, especially based on smart sketch modelling

www.lucid.ulg.ac.be/www/welcome/



REINFORCED AND PRESTRESSED CONCRETE

The laboratory focuses its research on the following main topics:

- Rational kinematics-based models for concrete structures
- Retrofit of existing structures with new materials
- Monitoring and assessment of existing concrete structures
- Resilience of concrete structures under extreme loading

www.uee.uliege.be/reinforcedandprestressedconcrete

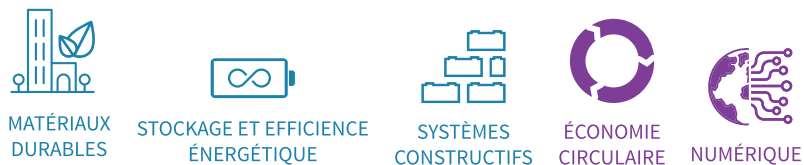


SUSTAINABLE BUILDINGS DESIGN LAB – SBD

The Sustainable Buildings Design Lab works in different fields of research:

- Regenerative Design and Construction
- Building Performance and Evidence Based Design
- Regenerative Design : Comfort and Climate
- Design Decision Support

www.sbd.ulg.ac.be/



GEMME GEORESOURCES, MINERALS ENGINEERING AND EXTRACTIVE METALLURGY LAB

The laboratory focuses its research on the following topics:

- Characterization of mineral and metallic raw materials (Quantitative microscopy, on-line and at-line characterization)
- Geological imaging and image analysis
- Sensor Based Sorting (3D, Hyperspectral (VNIR, XRT, LIBS))
- Mineral processing
- Extractive metallurgy (hydrometallurgy)

www.gemme.ulg.ac.be/



GEMME BUILDING MATERIALS GROUP

UEE GeMMe Building Materials group (Laboratoire des Matériaux de Construction) is active in the characterization of materials, specifically recycled products from construction industry but also wastes to be introduced in the manufacture of building materials.

UEE GeMMe Building Materials group has been involved in several research projects oriented to the increase of the thermal performances of buildings (aPROpaille, DREAM), as well as the development of recycled materials concrete based (VALDEM, ECOLISER, ConRePaD, SeRaMCo): these projects clearly show the need for biosourced or secondary resources for the development of insulating but also structural materials.

A group of geologists, chemists and construction engineers has developed expertise which enabled them

to obtain a series of equipment and research grants from FEDER, INTERREG, Belspo, FNRS, the French Community and the Walloon Region. In addition, based on these researches and expertises in the field of concrete, a series of international collaborations have been set up, particularly with Université Laval (Quebec), Warsaw University of Technology (Poland) and IMT Douai (France). Building Materials Laboratory (LMC) is well equipped for the characterization of materials: physical, chemical, thermal and mechanical properties are classically determined.

www.gemme.ulg.ac.be/index.php/lmc/



APPLIED GEOPHYSICS

Applied geophysics deals with the applications of physics to study the subsurface. Techniques range from the propagation of electric current in the Earth to the study of the ambient magnetic field. The group focuses on the development and use of geophysical methods and inversion algorithms for imaging, monitoring, and characterizing subsurface properties and processes, mainly in environmental applications such as groundwater resources, contaminated sites, landfills, or shallow geothermal systems.

The team has developed these methods and gained further interests in assimilating geophysical data together with other types of data in generic framework for different types of applications: groundwater, geothermal systems, imaging.

appliedgeophysiculg.wordpress.com/about-2/



HYDROGEOLOGY AND ENVIRONMENTAL GEOLOGY

The activities developed within the group «Hydrogeology and Geology of the Environment» are mainly dedicated to the identification, characterization and quantitative and qualitative assessment of water resources. The hydrogeological properties of aquifers but also of low permeability environments are studied, at different scales, for calculating and modeling groundwater flow and contaminant transport. Applications in the field of Environmental Geology, impact studies and predictive studies are multiple.

Research Themes

- Energy and groundwater
- Characterization and modeling of groundwater
- Interactions 'Nappe-Rivers'
- Vulnerability and protection of aquifers
- Contamination of soil and groundwater
- North-South cooperation
- Hydrogeological data management

www.uee.uliege.be/cms/c_2682694/fr/hydrogeologie-et-geologie-de-l-environnement



GEOMECHANICS AND ENGINEERING GEOLOGY

The numerical tools developed within the team make it possible to approach problems of Civil Engineering where soil-structures interactions exist (aqueduct foundations, heating piles, Val Benoit bridge foundation) or problems of soils and rocks mechanics.

The team focuses on three areas of research.

Civil Engineering - Geology of the Engineer

- Study of the behavior of heat exchangers piles
- Finite element study of stresses, deformations and displacements under the foundation of a pile, Houdeng aqueduct
- Finite element study of stresses and deformations under the foundation of Liège Bridge pile
- Slope stability and partial saturation. Experimental study and numerical modeling

Underground waste storage

- 3D digital study of the thermohydro-mechanical behavior of argillites around radioactive waste disposal cells
- Modeling of chemical effects in partially saturated clays
- Small scale heating and hydration test performed on highly compacted bentonite inside a thermohydraulic cell
- 2D modeling of a long-lived medium-level waste disposal cell - Benchmark Couplex-Gaz

Tank engineering

- Numerical modeling of Hydro-Mechanical fracture behavior
- Hydromechanical coupling and bassin tectonic compression

www.uee.uliege.be/cms/c_2716166/fr/geomecanique-et-geologie-de-l-ingenieur



STEEL AND COMPOSITE CONSTRUCTIONS (CMM)

The CMM group (Construction Métallique et mixte) specializes in the characterization of the behavior of steel and composite construction and is involved in various activities such as teaching (including continuing education), research, technical support to industries, standardization, participation in international committees, etc.

Research Themes

- Stability of structures and structural elements: overall stability of structures, robustness and classification of cross-sections, stability of structural elements (plates, beams and columns of steel and steel-concrete, etc.)
- Behavior of structural assemblies: development of innovative assemblies or fasteners, characterization of the behavior of assemblies or new components, assemblies under accidental / exceptional loadings (fire, earthquake, impact, etc.)
- Robustness of structures: response of structures subjected to exceptional loading

www.uee.uliege.be/cms/c_2641541/en/cmm-constructions-metalliques-et-mixtes



HYDRAULICS IN ENVIRONMENTAL AND CIVIL ENGINEERING - HECE

HECE is active in all areas of hydraulics and hydrodynamics:

- Free surface flows
- Pressurized flows
- Underflow

www.hece.ulg.ac.be/cms/en



STOCKAGE ET EFFICIENCE
ÉNERGÉTIQUE



SYSTÈMES
CONSTRUCTIFS



NUMÉRIQUE

MATERIALS AND SOLID MECHANICS - MSM

The main research topics addressed by the MSM team are the following:

- Modeling industrial processes of shaping
- Modeling of unilateral contact with friction
- Prediction of ductile fracture of metals
- Dynamic analysis in large deformation with impact
- Metallurgical thermomechanical coupling
- Error estimators and remeshing in large deformations
- Micro-macro approach of metal plasticity (texture, recrystallization, rupture)
- Experimental determination of the laws of behavior of metals at high temperature

www.uee.uliege.be/cms/c_2672632/fr/mecanique-des-solides-et-des-materiaux-msm



MATÉRIAUX
DURABLES



SYSTÈMES
CONSTRUCTIFS



NUMÉRIQUE

SHIP & OFFSHORE ENGINEERING - TRANSPORT SYSTEM (ANAST)

Activities are carried out in the following areas:

- Shipbuilding
- Inland waterway traffic, sea transport and modelization of river-maritime and intermodal transport
- Telematics applied to the management of river infrastructures and navigation material
- Development of an integrated application software (CAD-CAE) in shipbuilding
- Optimization of naval and floating structures
- Technical-economical comparative analysis about transport's modes (+ intermodality)
- Development of a transport plan
- Mathematical modelization of traffic flows' forecast and allocation
- Urban movements modelization
- Testing techniques after optimisation in towing tank and naval hydrodynamics
- Production simulation (Space, Flow)



STOCKAGE ET EFFICIENCE
ÉNERGÉTIQUE



SYSTÈMES
CONSTRUCTIFS



NUMÉRIQUE

STRUCTURAL AND STOCHASTIC DYNAMICS

The researches in «**Structural & Stochastic Dynamics**» not only cover these aspects of Dynamics of Structures, but also several additional topics like those of mechanics of drillstrings in petroleum applications and the behavioural response of humans on vibrating structures and their interaction.

An overview of our research projects with keywords:

- *Wind Engineering*: equivalent and principal static wind loads, tower crane dynamics in stormy winds, numerical admittance, nonlinear buffeting analysis
- *Random dynamics*: nonlinear random wind models, earthquake engineering – implementation in a research-oriented finite element software, reduction of analysis methods, multiple timescale spectral analysis, random dynamics of transient and/or slightly nonlinear civil structures, passive damping of structures
- *Deterministic Structural Dynamics*: effects of human- and machine-induced vibrations on civil engineering structures, nonsmooth dynamics of systems with few interfaces
- *Impact and Blasting Dynamics*: modelling of the post-blast structural behaviour, wave propagation in soil and solids under impact/blast loading
- *Nonlinear Structural Mechanics*: nonlinear behaviour of drillstrings in curved wells, variations of the classical constrained elastica problem to elastic vibration and softly constrained elastica
- *Human-induced vibrations and Biomechanics*: experimental and numerical assessment of human motion in sportive activities, and interaction with civil structures.
- *Seismic Engineering*: seismic design of structures (formerly developed by H. Degée & A. Plumier)

www.ssd.ulg.ac.be/Research.htm



7. HEC Management School Research Unit

SMART CITY INSTITUTE

The Smart City Institute is an academic institute dedicated to the thematic of Smart Cities. It is founded on an original partnership between six private companies (Belfius, Proximus, Schréder, Strategy&, Vinci Energies and Total), a University and its Management School (HEC Liège) and Wallonia.

This new academic institute aims at stimulating research, teaching, innovation and entrepreneurship in the field of the “Smart City”, among which energy efficiency. The SCI proposes to approach this thematic from a managerial angle (not a technical one) while collaborating with other disciplines (necessary multidisciplinary approach).

labos.ulg.ac.be/smart-city/en/the-institute/presentation/



8. Gembloux Agro-Bio Tech Research Unit

BIODIVERSITY AND LANDSCAPE

The team was created in 2010. It has since then developed fundamental and applied research, as well as awareness-raising activities, in the fields of biodiversity, management of biological invasions, functional and evolving ecology, landscape ecology and integrated assessment of ecosystem services.

The six main research activities are the following:

- Functional and evolving ecology
- Innovative methods in agricultural production
- Ecosystem services, green infrastructure and landscapes of the future
- Ecological engineering through and/or for biodiversity
- Ecological networks and population dynamics
- Populations Dynamics of invasive species

www.gembloux.ulg.ac.be/biodiversite-et-paysage/



AIR-WATER-PLANTS EXCHANGES

Our research focuses on the soil plants interactions and soil system, from soil-forming processes to soil evolution, both at a chemical and physical point of view.

Among others the team studies the interactions between organic and mineral constituents and the link between soil biogeochemical processes and ecological patterns.

Regarding **soil chemistry**, the topics studied include soil remediation and assessment of contaminations, soil fertility, soil mapping, soil genesis and soil organo-mineral interactions.

In the field of **soil physics**, the main study areas are: soil conservation and soil structure, hydrological modelling, soil-plan interactions, hydrogeophysics and interdisciplinary research for terrestrial systems.

www.gembloux.ulg.ac.be/echanges-eau-sol-plante/recherche/



BIOSYSTEMS DYNAMICS AND EXCHANGES - BIODYNE

The main research topics of BIODYNE are the following:

1. Coordination of the ICOS network in Wallonia
2. Management of three terrestrial observatories (greenhouse gas flux measurements, micrometeorology) in mixed forests (Vielsalm TO); in crops (Lonzée TO); in grasslands (Dorinne TO)
3. Methodology of eddy covariance: heat, water vapor, CO₂, CH₄ (in progress) and N₂O (in progress) fluxes
4. Multilayer analysis of soil respiration and its isotopic signature in forest ecosystems
5. Impacts of crop management on soil respiration and soil organic content
6. Impact of phenology and environmental conditions on BVOC emission by forest and crop ecosystems
7. Evaluation of carbon storage by a farm with cattle: effects of climate and management
8. Evaluation of the climatic impact of agri-environmental schemes in Wallonia

www.gembloux.ulg.ac.be/biodyne/



FOREST RESSOURCES MANAGEMENT

In 1897, in Gembloux, at the Agricultural State Institute, the section of Water and Forests was created. Driven by the necessity of adapting to changes, this section has constantly been under development, changing names several times.

This Axis develops basic and applied research activities in the fields of forest management, economics and technology, in both temperate and tropical countries.

The research activities of the 'Forest Resources Management' group focus on five themes:

- Characterization and quantification of natural resources
- Dynamics of landscapes and ecosystems facing global changes
- Functional and evolving ecology
- Management and development of natural and semi-natural environments
- Valorization of wooden and non-wooden natural resources

www.gembloux.ulg.ac.be/gestion-des-ressources-forestieres/



GEMBOUX ENVIRONNEMENT AND ANALYSIS OFFICE (BEAGX)

The Gembloux Environment and Analysis Office (BEAGx, Bureau Environnement et Analyses) is an accredited laboratory (approval for the analysis of toxic waste and waste in the Walloon Region (A.E.R.W. 09/07/1987)).

The fields of activity are:

- determination of micro-nutrients in fertilizers and soil amendments
- analyzes of crop protection products and determination of residues of crop protection products in foodstuffs
- control of product quality criteria (foodstuffs, water, plants, contaminated soils and soils, waste, organic materials that can be recycled in agriculture, sewage treatment plant sludge, amendments, fertilizers, incineration ashes, composts, etc.)
- the navigable waterways sediment quality monitoring network (SPW-DGO2) and non-navigable waterways (SPW-DGO3)
- participation in international inter-laboratory tests (AGLAE, BIPEA ...)

This lab can help you solve the following problems:

- environmental: management of air pollution control networks (plant bio-indicators, atmospheric deposition)
- analysis of organic and mineral micro-pollutants in waste, soil, sludge, sediments of waterways: landfill (elution tests DIN 38414-S4 - EN 12457-S2), incineration (slag, fly ash ...), agronomic valorization (sludge, composts ...)
- quality control of products (water, plants, animal feed, foodstuffs): organic micro-pollutants, PCBs, PAHs, pesticide residues, heavy metals, nitrates, etc

www.gembloux.uliege.be/cms/c_4393017/fr/beagx/



MICROBIAL PROCESSES AND INTERACTIONS LAB (MIPI)

The laboratory focuses its research on the following topics:

- Microbial Physiology and Ecology
- Bioreactors scale-up/down / single cell technologies and PAT/Metabolic engineering of microbial cell factories



BIOTECHNOLOGIES

BIOMASS AND GREEN TECHNOLOGIES LABORATORY

The Unit of Biomass & Green Technologies at Gembloux Agro-Bio Tech is engaged in research and education in the fields of biological chemistry, biorefining and industrial technologies.

Our aim is to be at the forefront of the revolution of the biorefinery concept. Our academics and researchers are involved in several projects and in industrial collaborations, they are specialized in the following areas:

- Optimized use of biomass for food, chemicals and fuels
- Pretreatments and cracking of lignocellulosic biomass, cellulose hydrolysis, hemicellulose and lignin extraction and characterization
- Green chemistry and development of new methodologies with low environmental footprints.
- Study of structure-function relationships of biomolecules : oligo- and polysaccharides, sugars derivatives, lipopeptides, surfactants...
- Functional analyses of industrial processes

www.gembloux.ulg.ac.be/chimie-biologique-industrielle/



CHIMIE VERTE



BIOTECHNOLOGIES

9. Faculté d'Architecture Research Unit

LABORATORY OF DIGITAL CULTURE IN ARCHITECTURE (LNA)

The Laboratory of Digital Culture in Architecture (LNA – Laboratoire de culture Numérique en Architecture) is a research laboratory attached to the Faculty of Architecture of the University of Liège.

Recently created (2014), it is managed by a team of teachers and researchers who are particularly interested in the development of digital culture in architecture.

Three fields of study characterize its research:

- digital culture and project practice
- digital culture and formal and architectural research
- digital culture and data capture of the existing building

www.lna.uliege.be/cms/c_3889781/fr/lna-portail



ÉCONOMIE
CIRCULAIRE



NUMÉRIQUE

10. TERRA Research Unit

ENVIRONMENT IS LIFE

Studies conducted within Environment is life focus on the evolution of the interactions between water, soil, plant, ecosystems and atmosphere in relation to environmental factors, under the effect of biotic and abiotic stresses (climate change).

The effects of climate change are studied on soil physico-chemical properties, agricultural production and biological diversity, taking into account the complexity of the interactions involved and, in particular, allelopathy mechanisms. Particular attention is paid to the soil, where the organic and mineral phases evolve interdependently with living organisms. Soil plays an essential role as a biological, physical and chemical reactor, at the interface of the different environmental spheres (atmos-, bio-, hydro- and geo-spheres).

Atmospheric plant interactions are also studied at cell, leaf, plant or ecosystem scales. At the first three scales, the studies aim to characterize the impact of biotic and abiotic stresses on plants. In the fourth, the objective is to quantify and understand the role of terrestrial ecosystems in the dynamics of climate change.

The CARE Environment is life has developed two tools to achieve these results: the Ecotron and the ICOS Terrestrial Observatory Network (LTO ICOS).

Ecotron

The Ecotron is a model for studying ecosystems, including soils, plants, animals and micro-organisms, designed to reproduce the real world in a simplified way. Such equipment makes it possible to combine different environmental variables according to a defined time cycle, while avoiding undesired variability.

On a technical and operational level, the Ecotron consists of large chambers, offering the possibility of studying the behaviour of agro-ecosystems (lysimeter 1.63 m in diameter and 1.5 m deep, or 3 m³). The regulated variables are light (spectrum, intensity, photoperiod), air (temperature, humidity), rainfall, wind, carbon dioxide and ozone concentrations and boundary conditions at the base of the lysimeter.

An original feature of TERRA's Ecotron is its ability to continuously measure a set of ecosystem variables to characterize energy and nutrient flows. This will be done using either commercial sensors (soil water sensors, gas analysers, etc.) or experimental devices developed in various departments (continuous measurement of plant growth, etc.).

www.terra.uliege.be/cms/c_4082744/en/terra-environment-is-life



SOLS
ET SÉDIMENTS



EAUX ET BOUES,
AIR ET ÉMISSIONS

11. GIGA Research Unit

MOLECULAR BIOMIMETIC AND PROTEIN ENGINEERING LABORATORY - MBPEL

The major goal of the Molecular Biomimetic and Protein Engineering Laboratory (MBPEL) is to imitate nature at the molecular level for the design of materials with remarkable properties, through a multidisciplinary approach.

In this context the team is mainly involved in applied research at national and international level. The research focuses on the selection of biomolecules; natural proteins or engineered peptides; exposing either a high recognition property (assembly, addressing, signaling, ...), either a particular property (anti-microbial, anti-adhesion, adhesion, anti-odour, ...); either an enzymatic activity (degradation of pollutants, killing of bacteria...).

The fields of application are broad, from mineralogy to medical implants or environment (water and air depollution) through construction (wall coating and glass coating) or food industry.

MPBEL approach integrates the final application. In a first step, thanks to the phage display technology, specific peptides (GEPI) or natural proteins are identified and selected. In a second step those biomolecules are designed and applied to a surface to respond to a specific problematic. The function added is characterised in the lab and in pre-pilot study.

MPBEL counts with different laboratories:

- A first laboratory dedicated to the phage amplification, with all necessary equipment (Bacteriological hood, incubators, centrifuges, shakers...) to avoid cross-contamination with bacteria
- A second laboratory producing selected GEPIs/proteins (Bacteriological hood, incubators, centrifuges, protein disruptor...)
- A third laboratory with an Akta Purifier, an Akta Prime, a DLS, and several spectrophotometers to purify and characterize the produced GEPIs/proteins
- Finally, a dark space containing olympus fluorescence microscopes which helps visualising the interaction GEPI/target thanks to a fluorescent probe

As MBPEL is part of the GIGA Research, it also benefits from the different facilities of the Center.



BIOTECHNOLOGIES



EAUX ET BOUES,
AIR ET ÉMISSIONS



LA LISTE DES UNITÉS DE RECHERCHE

INTERFACE ENTREPRISES

WWW.ENTREPRISES.ULIEGE.BE

Laurence DRUET, MScEng, PMP, Technology Transfer Officer

T +32 4 349 85 22 | M +32 475 63 25 58 | @ l.druet@uliege.be

FACULTY OF SCIENCES

WWW.FACSC.ULIEGE.BE

COMPLEX AND ENTANGLED SYSTEMS FROM ATOMS TO MATERIALS (CESAM) RESEARCH UNIT

CERM

Prof. Christine JÉRÔME

T +32 4 366 3491

@ C.Jerome@uliege.be

GRASP

Nicolas VANDEWALLE

T +32 4 366 3703

@ nvandewalle@uliege.be

GREENMAT

Prof. Rudi CLOOTS

T +32 4 366 3436

@ rcloots@uliege.be

Q-MAT

Philippe GHOSEZ

T +32 4 366 3611

@ Philippe.Ghosez@uliege.be

SPHERES RESEARCH UNIT

BUILDING ENERGY MONITORING AND SIMULATION – BEMS

Prof Philippe ANDRE

T +32 63 23 0858

@ P.Andre@uliege.be

EAU - ENVIRONNEMENT - DÉVELOPPEMENT – EED

Prof. Bernard TYCHON

T +32 63 230 829

@ Bernard.Tychon@uliege.be

ENERGY AND SUSTAINABLE DEVELOPMENT – ENERGYSUD

Prof. Jean-Marie HAUGLUSTAINE

T +32 63 230 900 | T +32 4 366 94 83

@ jmhauglustaine@uliege.be

SENSING OF ATMOSPHERES AND MONITORING – SAM

Prof. Anne-Claude ROMAIN

T +32 63 230 859

@ acromain@uliege.be

SOCIO-ECONOMIE ENVIRONNEMENT ET DÉVELOPPEMENT - SEED

Prof. François MELARD

T +32 63 230 901

@ F.Melard@uliege.be

AÉROSPATIALE ET MÉCANIQUE (A&M) RESEARCH UNIT

**MECHANICS OF BIOLOGICAL AND
BIOINSPIRED MATERIALS LABORATORY MBBM**

Prof. Davide RUFFONI
T +32 4 366 9359
@ druffoni@uliege.be

WIND TUNNEL LABORATORY

Prof. Thomas ANDRIANNE
T +32 4 366 9336
@ T.Andrianne@uliege.be

THERMODYNAMICS LABORATORY

Prof. Vincent LEMORT
T +32 4 366 4801
@ Vincent.Lemort@uliege.be

Prof. Pierre DEWALLEF
T +32 4 366 9995
@ P.Dewallef@uliege.be

CHEMICAL ENGINEERING RESEARCH UNIT

**NANOMATERIALS, CATALYSIS,
ELECTROCHEMISTRY - NCE**

Prof. Nathalie JOB
T +32 4 366 3537
Nathalie.Job@uliege.be

**PRODUCTS, ENVIRONMENT, AND
PROCESSES - PEPS**

Prof. Angélique LÉONARD
T +32 4 366 4436
@ A.Leonard@uliege.be

MONTEFIORE INSTITUTE OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
RESEARCH UNIT**SYSTEMS AND MODELING – SYSTMOD**

Prof. Damien ERNST
T +32 4 366 9518
@ dernst@uliege.be

URBAN AND ENVIRONMENTAL ENGINEERING (UEE) RESEARCH UNIT

FIRE AND TIMBER ENGINEERING

Jean-Marc FRANSSSEN
T +32 4 366 9265
@ JM.Franssen@uliege.be

Eric WELLENS - Gestionnaire
T +32 4 366 9138
@ E.Welles@uliege.be

**LOCAL ENVIRONMENT MANAGEMENT &
ANALYSIS - LEMA**

Prof. Jacques TELLER

T +32 4 366 9499

@ Jacques.Teller@uliege.be

Sigrid REITER

T +32 4 366 9482

@ Sigrid.Reiter@uliege.be

Mario COOLS

T +32 4 366 4813

@ Mario.Cools@uliege.be

**LAB FOR USER COGNITION & INNOVATIVE
DESIGN - LUCID**

Prof. Pierre LECLERCQ

T +32 4 366 9416

@ Pierre.Leclercq@uliege.be

Catherine ELSÉN

T +32 4 366 9416

@ Catherine.Elsen@uliege.be

**REINFORCED AND PRESTRESSED
CONCRETE**

Boyan MIHAYLOV

T +32 4 366 9497

@ Boyan.Mihaylov@uliege.be

**SUSTAINABLE BUILDINGS DESIGN LAB –
SBD**

Shady ATTIA

@ Shady.Attia@uliege.be

**GEMME GEORESOURCES, MINERALS
ENGINEERING AND EXTRACTIVE METALLURGY**

Prof. Eric PIRARD

T +32 4 366 9528

@ Eric.Pirard@uliege.be

Ir David BASTIN - Gestionnaire

T +32 4 366 9122

@ David.Bastin@uliege.be

Prof. Stoyan GAYDARDZHIEV

T +32 4 366 9120

@ S.Gaydardzhiev@uliege.be

GEMME CONSTRUCTION MATERIALS

Prof. Luc COURARD

T +32 4 366 9350

@ Luc.Courard@uliege.be

Frédéric MICHEL - Gestionnaire

T +32 4 366 9237

@ Frederic.Michel@uliege.be

APPLIED GEOPHYSICS

Prof. Frédéric NGUYEN

T +32 4 366 3797

@ F.Nguyen@uliege.be

HYDROGEOLOGY AND ENVIRONMENTAL GEOLOGY

Prof. Serge BROUYÈRE

T +32 4 366 2377

@ Serge.Brouyere@uliege.be

Alain DASSARGUES

T +32 4 366 2376

@ Alain.Dassargues@uliege.be

Joel OTTEN - Gestionnaire

T +32 4 366 2041

@ J.Otten@uliege.be

GEOMECHANICS AND ENGINEERING GEOLOGY

Frédéric COLLIN

T +32 4 36 69142

@ F.Collin@uliege.be

Robert CHARLIER

T +32 4 366 9334

@ Robert.Charlier@uliege.be

Pierre ILLING - Gestionnaire

T +32 4 366 2038

@ Pierre.Illing@uliege.be

STEEL AND COMPOSITE CONSTRUCTIONS - CMM

Prof. Jean-Pierre JASPART

T +32 4 366 9247

@ Jean-Pierre.Jaspart@uliege.be

Jean-François DEMONCEAU

T +32 4 366 9358

@ jfdemonceau@uliege.be

Carl VROOMEN - Gestionnaire

T +32 4 366 9233

@ C.Vroomen@uliege.be

HYDRAULICS IN ENVIRONMENTAL AND CIVIL ENGINEERING - HECE

Prof. Michel PIROTTON

T +32 4 366 9536

@ Michel.Pirotton@uliege.be

Benjamin DEWALS

T +32 4 366 9283

@ B.Dewals@uliege.be

Sébastien ERPICUM - Gestionnaire

T +32 4 366 9596

@ S.Epicum@uliege.be

MATERIALS AND SOLID MECHANICS - MSM

Prof. Anne-Marie HABRAKEN
T +32 4 3669430
@ Anne.Habraken@uliege.be

Laurent DUCHENE
T +32 4 366 9328
@ L.Duchene@uliege.be

SHIP & OFFSHORE ENGINEERING - TRANSPORT SYSTEM (ANAST)

Prof. Philippe RIGO
T +32 4 366 9366
@ Ph.Rigo@uliege.be

André HAGE - Gestionnaire
T +32 4 366 9225
@ ahage@uliege.be

STRUCTURAL AND STOCHASTIC DYNAMICS

Prof. Vincent DENOËL
T +32 4 366 2930
@ V.Denoel@uliege.be

HEC LIÈGE-MANAGEMENT SCHOOL

WWW.HEC.ULIEGE.BE

SMART CITY INSTITUTE

Carina BASILE
T +32 4 232 7255
@ Carina.Basile@uliege.be

FACULTY OF GEMBLOUX AGRO-BIO TECH

WWW.GEMBLOUX.ULIEGE.BE

AGROBIO TECH RESEARCH UNIT

BIODIVERSITY AND LANDSCAPE

Prof. Grégory MAHY
T +32 81 622 245
@ G.Mahy@uliege.be

AIR-WATER-PLANTS EXCHANGES

Prof. Gilles COLINET
T +32 81 622 539
@ Gilles.Colinet@uliege.be

BIOSYSTEMS DYNAMICS AND EXCHANGES - BIODYNE

Prof. Benoit MERCATORIS
T +32 81 622 198
@ Benoit.Mercatoris@uliege.be

FOREST RESSOURCES MANAGEMENT

Prof. Philippe LEJEUNE
T +32 81 622 296
@ P.Lejeune@uliege.be

**BUREAU ENVIRONNEMENT ET ANALYSES
(BEAGX)**

Philippe MAESEN

T +32 81 622205

@ Philippe.Maesen@uliege.be

**LABORATOIRE DE MICROBIAL PROCESSES
AND INTERACTIONS (MIPI)**

Prof. Philippe JACQUES

T +32 81 622 479

@ Philippe.Jacques@uliege.be

**BIOMASS AND GREEN TECHNOLOGIES
LABORATORY**

Prof. Aurore RICHEL

T +32 81 622 633

@ A.Richel@uliege.be

FACULTY OF ARCHITECTURE

WWW.ARCHI.ULIEGE.BE

**LABORATOIRE DE CULTURE NUMÉRIQUE
EN ARCHITECTURE (LNA)**

Prof. Sylvie JANCART

T +32 4 242 7960

@ Sylvie.Jancart@uliege.be

INTERFACULTY RESEARCH UNITS

TERRA RESEARCH UNIT

ENVIRONMENT IS LIFE

Prof. Bernard LONGDOZ

T +32 81 622 488

@ Bernard.Longdoz@uliege.be

GIGA RESEARCH UNIT

**LABORATORY OF MOLECULAR BIOMIMETIC
- MPEB**

Dr. Patricia LASSAUX

T +32 4 366 3309

@ plassaux@uliege.be



LIÈGE université
Interface Entreprises
Recherche & Innovation

Université de Liège
Interface Entreprises
LIEGE science park
Avenue Pré-Aily, 4
B-4031 Liège
Belgique

+32(0) 4 349 85 11
interface@uliege.be

www.uliege.be
www.recherche.uliege.be
www.entreprises.uliege.be



LE FONDS SOCIAL EUROPÉEN ET LA WALLONIE
INVESTISSENT DANS VOTRE AVENIR