University of Liège
Belgium

www.ulg.ac.be

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FAME Master Partner presentation February 2015
City of Liège

- A cosmopolitan city of art and history, with a strong industrial and intellectual identity
- At the heart of the Meuse-Rhine Euroregion (with Maastricht, Aachen) and the Greater Region (Luxemburg, Saarbrücken, Metz, Nancy)
- Rapid train and road links with major European cities (Brussels, Paris, London, Amsterdam, Cologne)

http://earthobservatory.nasa.gov
City of Liège

- A major transport and logistics centre (2nd river port in Europe, Liege Airport)
- A city underdoing full renewal symbolised by the work of world renowned architects: Santiago Calatrava (high speed railway station) et Ron Arad (Médiacité)
University of Liège
4 sites

- Liège, the city centre:
The Rector's team, the Administration, the Faculty of Philosophy and Letters, HEC Management School, Faculty of Architecture
University of Liège
4 sites

- Liège, the Sart Tilman campus:
  A leafy campus of 760 hectares, the main teaching and research centre
University of Liège
4 sites

- Gembloux : Agro-Bio Tech
- Arlon : Environmental sciences and management
University of Liège

- 21,207 students in 2012, 21% from abroad
- 122 nationalities
- 667 academics active in research, 2,660 researchers
- 70,000 living graduates (10% abroad)
- 4,803 graduates in 2010-2011

- 9 Faculties, 1 School and 1 Institute
- 38 bachelor studies
- 193 master studies
- 65 advanced master studies
University of Liège

- Partnerships with over 700 institutions in Europe and the world
- 1537 conventions signed in 67 countries
- European quality labels
  - ECTS and Diploma Supplement
  - HRS4R ‘Human Resources Strategy for Researchers’
- European pioneer concerning Open Access
  (over 90,000 references, more than 55,000 of which with integral text)
- Over 3,600 research publications each year
- 2 million books available for consultation
Research at ULg

- A pioneer in Wallonia for research valorisation
  - 98 spin-offs created; 70 still active; > 100 million Euros
  - 225 patents; 168 licences

- Integrated research-valorisation structures in growth sectors
  - WSL space and engineering sciences
  - GIGA (interdisciplinary group for applied genoproteomics - life sciences)
  - Aquapôle water/environment sciences

- Overall budget: 434 million Euros
Faculty of Science

~ 1,700 students, including ~ 430 PhD students
90 professors + 700 researchers (including PhD students)

Erasmus Mundus FAME students are registered as 2nd year master students either
  in Chemistry
  in Physics
depending on their Bachelor degree
Erasmus Mundus Master Course
Functionalized Advanced Materials and Engineering

1. What is Erasmus Mundus program
Erasmus Mundus is a program launched by the European Commission to promote the cooperation and mobility in higher education. It is a unique opportunity to offer attractive scholarships to European and non-European students in a multicultural environment.

2. Objectives of the FAME Master
- Provide high-level academic education about the synthesis, characterisation and processing of all classes of materials with special emphasis on Nanomaterials, Hybrids and Ceramics,
- Offer mobility during the two-year master program to take advantage of the complementary skills of the universities in the network,
- Prepare students for entering a Ph.D. program in Europe or elsewhere for instance in one of the FAME network laboratories.

3. Who can apply?
Candidates should be graduated with BSc. in Materials Sciences, Physics, Chemistry, Metallurgy, Electrochemistry or related topics. Equivalences may be given for 180 ECTS successful studies in these topics.

4. Scholarship amount and contribution to EMMC

<table>
<thead>
<tr>
<th>Type</th>
<th>Total (max. scholarship)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT A = Non European students</td>
<td>48.000 EUR for 2 years</td>
</tr>
<tr>
<td>CAT B = European students</td>
<td>20.000 EUR for 2 years</td>
</tr>
<tr>
<td>Scholars = Researchers / Teachers</td>
<td>1.200 EUR per week (for min. 2 weeks and max. 3 months)</td>
</tr>
</tbody>
</table>

5. Tuition fees
- 1000 EUR / year for EU students with own finance
- 4000 EUR / year for EU students with Erasmus Mundus Scholarship
- 4000 EUR / year for non-EU students with own finance
- 8000 EUR / year for non-EU students with Erasmus Mundus Scholarship

6. Program details of the FAME Master
- A two-year program (120 ECTS) taught in Advanced Materials Science within 7 European universities (Belgium, France, Germany and Portugal)
- The 7 partner institutions host world-renowned leading research laboratories in the field of Advanced Materials Science,
- Associated partners from research and industry playing an active role in the definition of students' Master Thesis, and through seminars provide advice,
- Courses taught by distinguished professors and researchers of international reputation, as well as Erasmus Mundus scholars,
- EMMI (European Multifunctional Materials Institute) offering services such as jobs, training schools, e-learning website, online databases of know-how, is a unique structure in Europe integrating Education, Collaborative Research and sound contacts with Industry (www.emmi-materials.eu).

7. Mobility scheme
- Mobility between year 1 and 2 in at least two institutions from different countries,
- 3 semesters within the Consortium universities + 1 semester for the Master Thesis in an European research laboratory or among the associated partners.

http://www.emmi-materials.eu/
FAME Master courses at University of Liège
M2 program at ULg

- General Courses: 20 ECTS
- Master Thesis: 30 ECTS
- Elective Courses: 10 ECTS
### General courses at ULg

<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor</th>
<th>Credits (Total Hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantum Chemistry</td>
<td>F. Remacle</td>
<td>4 credits (30 h + 10 h)</td>
</tr>
<tr>
<td>Functional Materials : theory and modeling</td>
<td>Ph. Ghosez</td>
<td>4 credits (20 h + 10 h)</td>
</tr>
<tr>
<td>Macromolecular Chemistry</td>
<td>C. Jérôme</td>
<td>4 credits (20 h + 15 h)</td>
</tr>
<tr>
<td>Advanced Inorganic Chemistry (incl. Smart materials)</td>
<td>B. Vertruyen</td>
<td>4 credits (30 h)</td>
</tr>
<tr>
<td>Nanomaterials, electrosynthesis and applications</td>
<td>C. Detrembleur, C. Jérôme</td>
<td>4 credits (30 h)</td>
</tr>
</tbody>
</table>

**TOTAL : 20 credits ECTS**

- Courses start on September 14, 2015
- In principle, all courses take place during the first semester
- Exams take place in January and June
Specialised courses

10 credits to be chosen in the list:

<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor(s)</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanomaterials: theory and modeling</td>
<td>J.-Y. Raty</td>
<td>4</td>
<td>20h + 10h</td>
</tr>
<tr>
<td>Characterisation of Biomaterials</td>
<td>E. De Pauw, M.-C. Gillet</td>
<td>4</td>
<td>15h + 15h</td>
</tr>
<tr>
<td>Biohybrids: theory and modeling</td>
<td>F. Remacle</td>
<td>4</td>
<td>30h</td>
</tr>
<tr>
<td>Molecular logic</td>
<td>F. Remacle</td>
<td>2</td>
<td>15h</td>
</tr>
<tr>
<td>Physics of superconductors</td>
<td>A. Silhanek</td>
<td>4</td>
<td>30h</td>
</tr>
<tr>
<td>Polymers and environment</td>
<td>P. Lecomte</td>
<td>2</td>
<td>15h</td>
</tr>
<tr>
<td>Characterization of nanostructures by scanning</td>
<td>A.-S. Duwez</td>
<td>2</td>
<td>15h</td>
</tr>
<tr>
<td>probe techniques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic and vibrational spectroscopies</td>
<td>M. Verstraete</td>
<td>4</td>
<td>15h + 15h</td>
</tr>
<tr>
<td>Introduction to solid state NMR</td>
<td>C. Damblon, P. Lecomte, B. Vertruyen</td>
<td>2</td>
<td>15h</td>
</tr>
<tr>
<td>Physical characterization of materials and</td>
<td>N. D. Nguyen</td>
<td>4</td>
<td>10h + 15h + 1 day (visit)</td>
</tr>
<tr>
<td>interfaces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theory of magnetism</td>
<td>E. Bousquet</td>
<td>4</td>
<td>20h + 10h</td>
</tr>
</tbody>
</table>
Master thesis and PhD thesis

Local practices

Master thesis (30 credits):
- promotor from University of Liège (a co-promoter can be added)
- performed at the University of Liège or at a collaborating lab

For your information (concerning PhD theses):
- Each year, PhD positions are supported by regional government, industry, Europe (Erasmus Mundus) or Wallonie-Bruxelles International
- Minimum 3 years
- Each PhD student has to follow 60 credits of doctoral training (only part of the 60 credits are courses – publications, conferences,… are taken into account)
Examples of master thesis topics

Laser Triggered Drug Release from Smart Polymeric Nanospheres Containing Gold Nanorods

Development of Commingled Natural Fiber-Reinforced Composite Profiles Based on the Pultrusion Process

Development of a Local Structural Probe: Diffraction-Tomography for Extraction and Analysis of Pigments in Cultural Heritage Materials

Phase Change Material property of carbon-doped GeTe studied with ab-initio molecular dynamics

Materials characterization using advanced ion beam analysis

Electrical characterization of GeSn/oxide interfaces by admittance spectroscopy
Research groups of the Molecular and Nanosciences Platform
Research Platform
Molecular and Nanosciences

Materials Physics
Nanofabrication and Characterization

Synthesis and Characterization of Polymers

Theoretical Physics of Materials

Theoretical Physical Chemistry

Inorganic Materials
Synthesis and Characterization
FAME Master courses at University of Liège
Quantum Chemistry : Molecular Electronic structure

(Françoise Remacle - 4 credits – 30 h theory + 10 h exercices)

The course is devoted to the foundations of molecular electronic structure, from diatomic to polyatomic molecules.

Contents :
- Methods of approximations (perturbation theory and variation method),
- The Pauli Principle,
- Bonding in diatomic molecules,
- Symmetry of molecular orbitals,
- Hückel Theory,
- Optical selection rules,
- Hartree-Fock ab initio method.

Prerequisites : Principles of Quantum Mechanics

Exams practices : Oral exam on theory, Written exam on exercises
Introduction to macromolecular chemistry

(C. Jérôme – 4 credits - Theory : 20 h - Practicals : 15 h)

Content :
1- Introduction to polymers
2- Controlled/living polymerization techniques (radical, anionic, …)
3- Characterization of polymer materials
4- Properties of polymers in solution and in bulk

A copy of the slides will be available to the students

Prerequisites : General course in organic chemistry

Exam : Written exam (half a day)
Advanced inorganic chemistry (incl. smart materials)
(B. Vertruyen – 4 credits - 30 h incl. practicals)

Content: As a sequel to the introductory courses of Master 1, this course will discuss in more detail topics such as solid state reactivity, precursor syntheses, microstructure control, powder technology… Emphasis will be placed on critical analysis of papers from the literature. The course will be illustrated by a short lab project (3-4 half days).

Prerequisites: introductory courses in inorganic and solid state chemistry

Assessment: written report of lab project + oral exam with presentation of a paper from the literature
Nanomaterials, (electro)synthesis and applications
(C. Detrembleur, C. Jérôme – 4 credits - 30 h )

Content :
1- Introduction to the nanotechnology (C. Jérôme)
2- Electrosynthesis of functional nanoparticles and thin films (C. Jérôme)
3- Preparation of inorganic nanoparticles and polymer based nanoparticles (C. Jérôme)
4- Polymer/clay nanocomposites: introduction, properties and applications (M. Alexandre)
5- Carbon nanotubes (CNTs): structure, properties, preparations, applications and chemical functionalizations (C. Detrembleur)

The copy of the slides will be available to the students

Prerequisites : General course in macromolecular chemistry (synthesis and physical properties of macromolecules) and organic chemistry

Exam : Written exam (half a day)
Physics of Functional Materials
(Ph. Ghosez - 4 credits – 20 h theory + 10 h exercises)

**Aims**
Provide the basics to understand (i) the microscopic origin of the coupling properties in functional materials and (ii) their subsequent evolution in nanostructures.

**Content:**
- Basics of the first-principles (density functional theory), semi-empirical (effective Hamiltonians) and phenomenological technics allowing the theoretical description of functional materials.
- Microscopic origin of various coupling properties as well as their T-dependence.

The course will focus on the family of multifunctional oxides and will describe applications in the fields of electronics and sensing. It will also describe the influence of finite size effects in nanostructures and the computational design of artificial nanomaterials with optimized properties.

**Prerequisites**
Introductory course to Condensed Matter Physics

**Exam**
Oral exam after writing preparation
Nanomaterials : theory and modelling

(Jean-Yves Raty - 4 credits – 20 h theory + 10 h exercises)

Contents :

Nanoparticles and low dimensional systems

1. Fundamental properties
2. Simulation techniques : Molecular dynamics – Monte Carlo sampling
4. Application to : Carbon nanotubes, Graphene, Semiconductor and Metal nanoparticles, Alloy nanoparticles

Exam : Written exam
Characterisation of Biomaterials

(E. De Pauw, M.-C. Gillet - 4 credits – 15 h + 15 h)

Contents:
Mass Spectrometry of biomolecules
  - ion sources
  - mass spectrometers
  - biomolecules sequencing
Applications
  - mass spectrometry imaging
  - Structural analysis of biomolecular complexes (DNA, RNA, Proteins)
  - Molecular recognition

Prerequisites: Analytical chemistry

Exams: applications
Biohybrids: Theory and modeling
(Françoise Remacle - 4 credits – 30 h theory)

Contents:
The course is devoted to the different theoretical approaches of quantum chemistry that allow to compute the structural, electronic properties of hybrid complexes metallic cluster-organic molecules. The second part is devoted to the formalisms used to compute optical and transport properties.

Prerequisites:
Principles of Quantum Mechanics
Principles of Quantum Chemistry

Exams:
Oral exam
Molecular logic
(Françoise Remacle – 2 credits – 15 h theory)

Contents:
The course begins with an Introduction to classical Boolean logic and to quantum logic. Then, the different approaches aiming at implementing logic machines at the molecular level are reviewed:
(i) Molecular electronics,
(ii) Implementation of logic operation by software,
(iii) Implementation of concatenated logic gates at the hardware level,
(iv) quantum computing. Several concrete examples are discussed: molecular combinations circuits, finite state molecular machines, implementation of search algorithms.

Prerequisites: Basic principles of quantum mechanics and of molecular physical chemistry

Exams: Oral exam
**Polymers and environment**

(Philippe Lecomte – 2 credits – 15 h theory)

**Contents:**

The course is devoted to the synthesis of macromolecules and will cover various polymerization mechanisms such as the anionic, radical, coordination, metathesis and ring-opening mechanisms. The synthesis of various architectures and functionalized polymers in the frame of a macromolecular engineering will be shown. A special attention will be paid on recent developments in this field. The impact on environment of these different processes will be discussed.

**Prerequisites:** Principles of Organic Chemistry

**Exams:** Written exam
Characterization of nanostructures by scanning probe techniques

(Anne-Sophie Duwez - 2 credits – 15 h theory)

Aims: Provide a basic knowledge of scanning probe microscopies. Give an overview of the recent possibilities of SPMs beyond imaging.

Contents:
Introduction: how the doors to the nanoworld were opened
Scanning Tunneling Microscopy:
- Basic principle
- Some examples
- Manipulation and chemistry

Atomic Force Microscopy:
- Basic principle
- Imaging modes
- The force spectroscopy mode
- Dip Pen Nanolithography
- Molecular Manipulation

Prerequisites: Introductory course to physics and chemistry of surfaces
Exams: Oral exam + presentation of a paper from the literature

http://www.emmi-materials.eu
Introduction to solid state NMR

(B. Vertruyen, P. Lecomte, C. Damblon – 2 credits - 15 h)

Content:
- Introduction to solid state NMR concepts and methods (B. Vertruyen)
- Application to biological materials (C. Damblon)
- Application to polymers: cross polarisation and relaxometry (P. Lecomte)
- Lab visit and model experiment (P. Lecomte)

Prerequisites: basic knowledge of liquid state NMR

Assessment: oral exam
Electronic and vibrational spectroscopies

(Matthieu Verstraete - 4 credits – 15 h theory + 15 h Practicals)

Aims: Approach the theory and theoretical state-of-the-art tools to predict the spectroscopic properties of molecules, solids, and nanostructures.

Contents:
- Introduction to the perturbation theory underpinnings and different types of spectroscopies (on vibrational and electronic degrees of freedom)
- Overview of ground and excited state theories which allow one to calculate spectroscopic quantities
- Use of the ab-initio simulation codes OCTOPUS and ABINIT to carry out a mini-project of spectroscopic prediction and interpretation

Prerequisites: Introductory course to condensed matter physics

Exams: Project "mini-thesis" and oral presentation
Physical characterization of materials and interfaces

(Ngoc Duy Nguyen - 4 credits – 10 h Theory + 15 h Lab + 1 day visit)

Contents:
Junctions, interfaces and heterostructures for next generation optoelectronic and nanoelectronic devices
- Principles of electrical and optical characterization of semiconductor materials: ultra thin films and nanostructures
- Application to admittance spectroscopy, transient photoconductivity, photoluminescence, …
- Visit of imec (Leuven)

Prerequisites: Basics of condensed matter physics
Evaluation: Laboratory report + research assignment
The physics of superconductors

(A. Silhanek - 4 credits – 30 h)

Contents:
This course presents an introduction to superconductivity with particular attention on superconductors of low dimensionality and the manipulation of quantized units of flux (so called fluxonics)

-Some of the concepts that will be addressed include: London model and Basic concepts of the microscopic theory (BCS) and Thermodynamics of superconductors (Ginzburg-Landau). Fluxoid quantization, Vortex structures, vortex trapping and periodic pinning, Self Organized criticality in Superconductors (Bean Model), Vortex avalanches, Confinement effects in superconductors, Vortex ratchets, Superconductor-ferromagnet hybrid systems

Prerequisites: Basics of condensed matter physics
Evaluation: Written exam
Research groups of the Molecular and Nanosciences Platform
FP7 FET-proactive **MOLOC**
(Molecular Logic circuits)

Electrical addressing of a dopant molecular ion in a Fin-FET transistor.

properties of solvated and functionalized Au$_{55}$ nanocluster

Project **NANOFORCES**
Theoretical Physical Chemistry  
Dr Françoise Remacle

Possible master thesis topics
- electronic atto dynamics in molecules following excitation by attopulses
- design of molecular logic gates by optical addressing
- design of molecular logic gates by electrical addressing
- Design of intelligent sensors anchored on surfaces

Possible PhD topics
- Design of logic gates and finite state machines in molecular and nanosystems
- Responses of hybrid systems upon electrical, optical, electrochemical addressing.
- Ultrafast electron dynamics and the control of chemical reactivity

Fellowships
- EC projects
- ARC Nanoforces
- Belgian (Communauté française) National Fund
- Belgian (federal) attraction interuniversity poles
Research topics:
- development of new polymerization techniques
- synthesis of well-defined copolymers
- preparation of new nanohybrids for electronics and biomedical applications
- design of multifunctional (nano)coatings
- preparation of (co)polymers and nanocomposites in supercritical CO₂

Keywords: macromolecular engineering, nanotechnology, biomedical

Industrial partners: SOLVAY, Arcelor-Mittal, Physiol, Chitozyme…
Possible master thesis topics:

- Synthesis of functional copolymers and nanohybrids for cancer therapy

- Preparation of carbon based nanomaterials from macromolecular precursors

- Hybrid nanomaterials by electrospinning for novel bioactive implants
Examples of PhD topics:

1- Preparation of well-defined functional copolymers in supercritical CO2: a green alternative for the macromolecular engineering

2- Preparation of photoactive nanohybrids for the photodynamic cancer therapy

3- New smart nanohybrids for controlled drug release

4- Synthesis of thermo-responsive copolymers for the stabilization of colloids for optical and magnetic detection

5- Novel pH-responsive polymers for the elaboration of triggered drug delivery systems

6- New electrografted polymer films for sensing applications
**Research:** Design of AFM probes and development of AFM-based methods to manipulate matter and modify it at the single molecule level

**Molecule by molecule constructions**

Nature Nanotech. 2006, 1, 122
Nature Nanotech. 2008, 3, 188

**Molecular Elasticity**

Macromolecules 2006, 39, 8428

**Smart probes, ultra-miniaturized sensors and actuators**

Design of pH-, T-, and redox-responsive probes

Small 2008, 4, 1101
J. Am. Chem. Soc. 2007, 129, 8410

**Molecular Recognition**

Supramolecular interactions in host-guest systems

Small 2008, 4, 1101
Possible topics of Master thesis or PhD:

- Manipulation and transport of molecules, molecule by molecule assembly
- Molecular recognition by AFM
- Mechanochemistry on single macromolecules
- Development of smart molecular systems and organic functional surfaces able to perform specific tasks at the single molecule level (actuators, artificial muscles)
- Development of miniaturized probes with sensor capabilities and 'tunable' properties (thermo-, light-, pH-responsive, …)
Research topics:
- Mesoporous thin films by soft templating
- Oxides for energy and/or environment-related applications (photocatalysis, photovoltaïcs, …)
- Synthesis and microstructure control of functional oxides – characterization of magnetic and electrical properties (coll. Prof. Ph. Vanderbemden, Electrical engineering)

Grid-like mesoporous TiO$_2$ thin film

BaZrO$_3$ by coprecipitation of carbonates

Grafted mesolamellar silica
Possible topics of Master thesis or PhD:

- mesoporous TiO$_2$ materials for photovoltaics applications
- mesoporous thin films for Li-insertion
- plasma-spraying of oxides for thermal barrier coatings
- composites by spontaneous phase separation of oxides
Mass spectrometry of non covalent complexes (DNA metallation)
Biomarkers discovery
Development of functionalized nanoparticles for imaging and hyperthermia
Mass spectrometry imaging of biomaterials

Contact: Institute of chemistry, B6C
Telephone: +32 43 66 3415
Email: e.depauw@ulg.ac.be
www.mslab.ulg.ac.be
Master thesis topics
• Identification of biomarkers for specific diseases and elaboration of contrast agents
• Development of nanoparticles for hyperthermia
• Binding in supramolecular systems, applications to drug design
• Cell culture models and biosensors
• Biocompatibility of Ocular implants (Physiol)
• Biocompatibility of Textiles (Centexbel)
• Proteomics and molecular imaging

PhD thesis topics
• Mass spectrometry of non DNA covalent complexes
• DNA metallation and nanowires
• Biomolecules patterned surfaces
• Development of a lab system for early detection of prostate cancer
• Interactions of lens epithelial cells with artificial lens (coll. C. Jérôme –Physiol)
• Development tissue and biomaterials molecular imaging
**Methods:**
First-principles theory and modelling (DFT based methods)
Functional materials by design

**Materials:**
Engineering exotic phenomena in oxide nanostructures
Ferroelectrics, piezoelectrics, multiferroics, thermoelectrics, high-K
Including bulk and nanostructures (thin films, superlattices, nanowires,...)

**References:**
Master Thesis

- Tailoring the properties of ferroelectric oxide superlattices from first-principles
- Monitoring the magneto-electric coupling in multiferroic nanostructures from first-principles
- First-principles theory and modelling of thermoelectric oxides: the cases of cobaltites and doped SrTiO$_3$
- First-principles investigation of finite-size effects in ferroelectric polymers (like PVDF).
**Methods:**
First-principles theory and modelling (DFT based methods)
Perturbation theory for DFT (phonons, elastic constants…)
Many Body Perturbation Theory for high level electronic structure

**Materials:**
Investigating materials properties for metals, solids, nanostructures
Thermodynamics and thermal properties
Prediction of technological performance of thermoelectrics, phase change materials, catalytic efficiency…
Master thesis or PhD thesis topics

- Thermoelectric properties of nanostructured materials from first principles for renewable energy
- Finite temperature and anharmonic effects in vibrational modes of solids and molecules
- Theoretical spectroscopy of noble metals: relativistic and many-body effects
Research activities dedicated to the study of the electrical and optical properties of semiconducting materials and systems, with a particular interest in crystalline ultra thin films and engineered nanostructures

- Electrical activation of dopants in ultra shallow junctions
- Traps and interface states in heterostructures
- Conduction mechanisms in nanostructures
- Phase change materials for data storage
- Nanomaterials (nanodiamonds)
- Covalent materials under extreme conditions
- Crystal growth of carbon nanotubes

**Electrical spectroscopy**

**Optical and electrical transport measurements**

**Scattering of X-rays and neutrons**

**First-principles theory and modelling**

**Semi-empirical modelling**

**Device simulation tools**
Master Thesis topics

- Thin film photovoltaics
- Band-gap engineering for nanoelectronics with group-IV and III-V semiconductor compounds
- Degradation mechanisms in organic light-emitting diodes
- Mechanism of phase change materials
- Polymerisation of nanodiamonds
- Optical properties of doped Si/Ge nanowires

Ph. D. Thesis topics

- Nanostructures for next generation solar cells based on transparent conductive oxides and II-VI semiconductors (collaboration with LMGP Grenoble)
- Delta doping of planar and 3D devices by atomic layer epitaxy for sub-22 nm CMOS technology
- Optical properties of functionalised nanoparticles
Laboratory devoted to the investigation of confinement effects in mesoscopic systems including nanomagnets, structured superconductors, plasmonics, and hybrids heterostructures, with the aim of unveiling new phenomena, not present in large size systems.

- Supersonic
- Fluxons (kinematic vortices, thermomagnetic instabilities, phase slip lines)
- Manipulation of quantum units of flux via nanostructuring
- Visualization of magnetic flux in superconductors
- Electrical transport properties of materials at low temperatures
- Optical response of nanostructured materials
University of Liège
Belgium

www.ulg.ac.be

Contact:
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FAME Master Partner presentation February 2015