Laboratoire d’Analyse, Caractérisation et Mise en œuvre.
LACaMi

Platform of chemical analysis, characterisation and processing

09 October 2020

Marc Sinnaeve
Institute of Mechanics Materials & Civil Engineering

Members: 27 professors (out of ~70 in EPL)
140 researchers
43 technical & administrative staff

Key numbers: 10 M€ funding in 2017
~15 PhD theses every year
Patents & successful spin off companies
4 ERC grants since 2016

« Integrated environment for the advancement of engineering, with an emphasis on creativity and problem solving, and on bridging the gap between fundamental and applied research through a collective approach »
iMMC’s main research directions

- Biomedical engineering
- Computational science
- Civil and environmental engineering
- Dynamical and electromechanical systems
- Energy
- Fluid mechanics
- Processing and characterisation of materials
- Chemical engineering
- Solid mechanics
iMMC organization

Three technology platforms (LEMSC, LACAMI, CREDEM)
hosting all experimental facilities

Five research divisions

• GCE : Civil and environmental engineering
• MEMA : Applied mechanics and mathematics
• IMAP : Materials and process engineering
• TFL : Thermodynamics and fluid mechanics
• MEED : Mechatronic, electrical energy, and dynamic systems
Creation of the technical platforms

The institute IMMC has grouped every technician and technics in 3 technical platforms:

- **CREDEM**, pour **C**onception, **R**éalisation et **E**ssais de **D**ispositifs **E**lectro**M**écaniques (Design, fabrication and testing of electromechanical devices)
- **LEMSC**, pour **L**aboratoire **E**ssais mécaniques, **S**tructures et **G**énie civil (Mechanical testing, structures and Civil engineering)
- **LACaMi**, pour **L**aboratoire d’**A**nalysè, de **C**aractérisation et de **M**ise en oeuvre (Analyse, characterization, process of material)

The goal of this reorganisation was to facilitate the access of the technics facilities to any members of the university.

These platform are located in the different division of the IMMC institute:

CREDEM in MEED/TFL, LEMSC in GCE, LACaMi in IMAP.
CREDEM: Design, prototyping & testing of electromechanical devices

- Combustion
- Heat Engine
- Fluid mechanic
- Aerodynamic
- Energy
Certified laboratory

Catherine Doneux catherine.doneux@uclouvain.be
Tel: 010/472270
Vinci (SC02) Etage 01, Local A 164

LEMSC Platform: Structures, Mechanical testing and civil engineering

Test floor 200 m²
Main activity domains of the LACaMi platform:

- the processing of material (material and shape)
- their microstructural characterisation
- their chemical analysis
Missions of the platform

The main missions of the platform are to insure:

- the security of the users
- the daily management of equipment and technical rooms
- the user’s training
- the machining of samples and assemblies
- the aid in the design of new tests
- the technological watch
- buying new systems procedures
- installing new systems
- maintenance of systems.....
Supports from other members of the IMAP division and from other platforms: CREDEM, LEMSC
Chemical Analysis

Carbon/Sulphur Analyzer Sylab 1600F (2015)
Inductively Coupled Plasma ICP/OES Agilent 5100 (2015)
Liquid and gas chromatography

Specimen dissolution in HNO₃
Elements not measured C, S, N
ICP Radial/Axial

Contact: Nadine Deprez
Ronny Santoro
Tel: 72486
Microstructural Characterisation

Scanning electron microscopes (Zeiss Supra55 et Ultra 55)
Transmission electron microscopes Philips CM30 (ongoing refurbishment)
Optical microscopes Olympus provis AX70, BX60, 3D (Acquisition in 2021)

Contact: Laurence Ryelandt
Tel: 72427
Scanning electron microscope FEG SEM

Conductive samples and/or conductive coating (C or Au/Pd)

Raw or polished samples

Mounted or unmounted specimen

Contact: Laurence Ryelandt
Tel: 72427
**Scanning electron microscope FEG SEM**

- **HKL EBSD camera**
  - Crystalline samples
  - Grain size
  - Orientation/Texture/stress
  - Phase identification/distribution
  - Contact: Pascal Jacques Tel: 72432
  - Matthieu Marteleur Tel: 72439
  - New Oxford system in December 2020

- **Bruker EDS detector**
  - Chemical analysis
  - Elements mapping
  - Contact: Laurence Ryelandt
  - Tel: 72427

- **in situ mechanical test**
  - Rupture mechanism
  - Mechanical properties
  - Contact: Laurence Ryelandt Tel: 72427
  - Michaël Coulombier Tel: 73059

Contact: Laurence Ryelandt Tel: 72427
Transmission electron microscope TEM

Philips CM30 – 300kV (ongoing refurbishment)
Collaboration with the university of Antwerp
Thin samples (<0.1 µm in thickness, Ø3 mm)

Nanometric Scale

Internal Structure
(grains, precipitates…)

Crystalline defects
(dislocations, twins…)

Electron Diffraction

Contact:
Hosny Idrissi (72418)
Laurence Ryelandt (72427)
Preparation of Microscopy Samples

Cutting of the samples: milling, cutting, micro-cutting

Polishing: mechanical (SiC, diamond, silica)
ion beam (Ar)

Thinning (TEM): electrolytic
ion beam (Ar)

Cold and hot specimen mounting (conductive or not conductive resin)

Coating conducteur: C, Au/Pd

Nadine Deprez Tel: 72486
Jonathan Lorfière Tel: 72326
Laurence Ryelandt Tel: 72427

Main equipment
Characterization: Crystallography

X ray Diffraction Bruker D8 Advance
X ray Diffraction Bruker D8 Discover

**Bulk crystalline** specimen or powder
Phase Determination and quantification
Texture measurements
Internal stress measurements

Scientific expertise:
- Pascal Jacques 72432
- Matthieu Marteleur 79250

Measurements:
- Frédéric Van Wonterghem 72457
Micromechanical tests

In-situ mechanical test
Low load mechanical testing machine Instron 5500
Automated Micro-indenter EMCO DuraScan
Nano-scratch, Nano-indentor Agilent G200

Bulk specimen / multilayer
Load: few nN to 500mN
T° < 350°C

Main equipment

Contact: Audrey Favache Tel: 72473
Sophie Ryelandt Tel: 72427

Hardness HV
Young Modulus
Abradability tests / Tribology

Abradability bench

Tribometer bruker UMT-3

Load cells 0.1N et 500N

$T^\circ \text{ max } 350^\circ \text{C}$

5000 RPM

Contact : Michaël Coulombier
Tel : 73059
Thermal properties

Netzsch SBA458
Seebeck Coefficient $S$ (µV/K)
Electrical Conductivity $\sigma$ (S/cm)

Temperature range: -125°C...800 °C
Thermocouple type K

DSC/ATG Netzsch STA449F3
Phase transformations
Weight modification

Temperature RT to 1600°C Precision of 0,5°C.
Heating rate: 0,1 to 50°C/min
Sample mass: from 1 mg to more than 10 gram for DSC
Sample volume in TGA mode: up to 5cm³
Balance resolution: 0,1µg

Laser flash Netzsch LFA467
Thermal Conductivity/Thermal Diffusivity
How much heat is being transferred, and how fast?

Thermal conductivity 0.1 to 4000 W/(m*K)
Xenon flash lamp spectrum wavelength 150 to 2000nm
Pulse length 20 to 1500 µs
Temperature range: -100°C ... 500°C
**Main equipment**

**Quenching and Plasto-dilatometer**

**Phase transformations**
**Deformation process**

To study the heat treatment of steel and metal alloys

To identify the heating rate, the quenching rate and the isothermal dwell times necessary to yield the crystalline structure to meet the required physical properties.

To optimize steel processes like hot or cold rolling

Cooling with Ar or He
Specimen Ø5mm L=10mm
T° 20 °C to 1500 °C
Mechanical tests (LEMSC)

2 Zwick Z250 (250kN)
Zwick 1474 (50kN)
Instron 1126 (250kN)
Instron (100N to 2kN)
Impactor Instron 9200HV
Tensile/Torsion MTS 250kN/2kNm

• Test Certification
• Air-conditioned room

Contact : Catherine Doneux  Tel : 72270
Marc Sinnaeve    Tel : 72406
Processing of material

- Hot and cold rolling
- Swaging
- Several press
- Infiltration press
- Several heat treatment furnaces
- Casting and arc melting furnaces (Acast 50, 200)
- Thermochemical reactors

Contact: Marc Sinnaeve
Tel: 72406
Processing of material: 3D Printing

SLM: Selective Laser Melting

3D System Prox 200 Building volume 140*140*100mm³ Laser 300W
3D System Prox 100 Building volume 100*100*80mm³ Laser 100W

Camille Van Der Rest (72470)
Matthieu Martelleur (72470)
Atomizing of powders

Arcastr Atomizer

Main equipment

IMG_3848.MOV
Processing of material
Friction Stir Welding (FSW) and Friction Stir Processing (FSW)

Contact:
Jonathan Lorfèvre (72326)
Aude Simar (73565)
Machining

Access to CREDEM’s et CYCLOTRON’s machine’s shop

New in 2020

Contact: Marc Sinnaeve (72406)
Alban Maton (72326)

Main equipment

Electrical Discharge Machining (EDM) 2015
Futures big equipment 2020-2021

X-rays Tomography

- X-ray source
- Sample
- Array detector

- Step-by-step rotation
- X-ray cone beam

- Tube control
- CNC object stage
- Data acquisition

Computed tomography / volume reconstruction
The opening hours of the LACaMi are from 08:00AM to 04:30PM

The access is permitted:
- For students from 08:00AM to 04:30PM (Accompanied from 12:00AM to 01:30PM).
- For researchers from 08:00AM to 04:30PM.
  
  Working after 04:30PM until 06:00PM is permitted but must remain exceptional.

A good planning of your work should permit to everyone to work during these hours.

The technical halls are under card access control from
- 12:00 AM to 01:30 PM
- 04:30 PM to 08:00 AM
LACaMi Access rules

• To have access to the platform you must read and adhere to LACaMi access charter by signing it.

• Before using any equipment, users must apply to be trained to its use and received the authorisation of use alone. (Visa of use)

• The trainings are given by the equipment manager or a person mandated by the equipment manager.

• Safety must be everyone's concern. Any instruction given by a member of the staff must be scrupulously respected.

• Wear suitable personal protection equipment (PPE) (Refer to the pictogram on the door)

• Some equipment have to be reserved before using : Microscopes, furnaces, mechanical tests, etc…. On the web site : http://sites-final.uclouvain.be/bookingIMMC/login.php
• A physical distance of at least 1.5 m must be respected anytime.

• The mask is compulsory everywhere and at any time.

• You must regularly wash your hands with water and soap, and, if not possible, with hydroalcoholic gel.

• The cleaning of all the equipment is not possible, so you must wash your hands before and after use.

• If you have any question about these rules, ask explanation to Frederic van Wonterghem or any LACaMi ‘s members.
## Responsabilités techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Person in charge</th>
<th>Tel : 010/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Microscope, SEM, EDS</td>
<td>Laurence Ryelandt</td>
<td>72427</td>
</tr>
<tr>
<td>TEM Microscopy</td>
<td>Laurence Ryelandt</td>
<td>72427</td>
</tr>
<tr>
<td>Sample preparation</td>
<td>Matthieu Marteleur</td>
<td>72439</td>
</tr>
<tr>
<td>Sample cutting</td>
<td>Jonathan Lorfèvre</td>
<td>72326</td>
</tr>
<tr>
<td>Sample mounting and polishing</td>
<td>Nadine Deprez</td>
<td>72486</td>
</tr>
<tr>
<td>Sample mounting and polishing</td>
<td>Jonathan Lorfèvre</td>
<td>72326</td>
</tr>
<tr>
<td>Furnaces</td>
<td>Marc Sinnaeve</td>
<td>72406</td>
</tr>
<tr>
<td>Mechanical testing (LEMSC)</td>
<td>Catherine Doneux (Head of LEMSC)</td>
<td>72270</td>
</tr>
<tr>
<td>Configuration of the mechanical testing machine</td>
<td>Vincent Destoo</td>
<td>72338</td>
</tr>
<tr>
<td>Machining planning</td>
<td>Marc Sinnaeve</td>
<td>72406</td>
</tr>
<tr>
<td>Machining planning</td>
<td>Alban Maton</td>
<td>72326</td>
</tr>
<tr>
<td>Chemical analysis</td>
<td>Nadine Deprez</td>
<td>72486</td>
</tr>
<tr>
<td>Chemical analysis</td>
<td>Ronny Santoro</td>
<td>72486</td>
</tr>
<tr>
<td>XRD Scientific expertise</td>
<td>Pascal Jacques</td>
<td>72326</td>
</tr>
<tr>
<td>XRD Measurements</td>
<td>Matthieu Marteleur</td>
<td>72439</td>
</tr>
<tr>
<td>XRD Measurements</td>
<td>Frédéric Van Wonterghem</td>
<td>72457</td>
</tr>
<tr>
<td>Nano scratch</td>
<td>Audrey Favache</td>
<td>72328</td>
</tr>
<tr>
<td>Nano hardness</td>
<td>Sophie Ryelandt</td>
<td>72427</td>
</tr>
<tr>
<td>Friction measurements</td>
<td>Michael Coulombier</td>
<td>73059</td>
</tr>
<tr>
<td>3D printing</td>
<td>Matthieu Marteleur</td>
<td>72439</td>
</tr>
<tr>
<td>3D printing</td>
<td>Camille van der Rest</td>
<td>72457</td>
</tr>
<tr>
<td>Chemical solution</td>
<td>Frédéric Van Wonterghem</td>
<td>72457</td>
</tr>
<tr>
<td>Chemical solution</td>
<td>Nadine Deprez</td>
<td>72486</td>
</tr>
<tr>
<td>Chemical solution</td>
<td>Ronny Santoro</td>
<td>72486</td>
</tr>
<tr>
<td>Gas management</td>
<td>Nadine deprez</td>
<td>72486</td>
</tr>
<tr>
<td>Gas management</td>
<td>Jonathan Lorfèvre</td>
<td>72326</td>
</tr>
<tr>
<td>Chemical Labs</td>
<td>Frédéric Van Wonterghem</td>
<td>72326</td>
</tr>
<tr>
<td>Chemical Labs</td>
<td>Ronny Santoro</td>
<td>72326</td>
</tr>
<tr>
<td>Technical halls</td>
<td>Alban Maton</td>
<td>72326</td>
</tr>
<tr>
<td>Technical halls</td>
<td>Jonathan Lorfèvre</td>
<td>72326</td>
</tr>
<tr>
<td>Technical halls</td>
<td>Luc Wautier</td>
<td>72335</td>
</tr>
<tr>
<td>Technical halls</td>
<td>Marc Sinnaeve</td>
<td>72406</td>
</tr>
</tbody>
</table>
Marc Sinnaeve  
Building Réaumur (Sc05)  
Office N° b182  
2, Place Ste barbe  
1348 Louvain-la-Neuve

Tel : +32 10 472406 (Redirected to mobile)  
Fax : +32 10 474028  
marc.sinnaeve@uclouvain.be

IMAP division secretariat : +32 10 472487 (Catherine Bauwens)
Thanks a lot for your attention

Any questions?