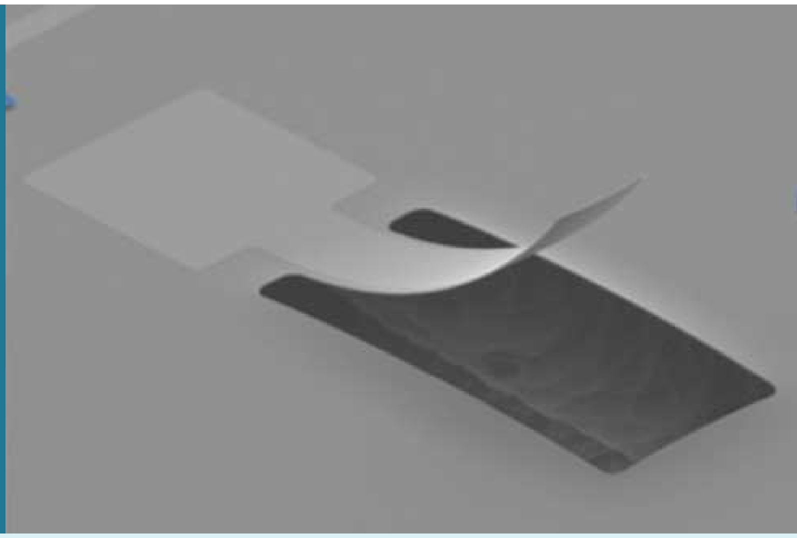
RESEARCH GROUP

www.list.lu/fr/research-groups/group/groupe-ferroic-materials-for-transducers/

Ferroic Materials for Transducers



The Ferroic Materials for Transducers (FMT) group studies and develops functional oxides, with a special interest on ABO_3 perovskite structures, which exhibit outstanding coupling properties. New intriguing physical effects are periodically discovered on this material family. Understanding these effects and using them in functional devices remains an internationally highly-competitive area and a great source of innovation. The main interest of ABO_3 perovskite structures is that their properties can be tuned and thus optimized to generate various devices with great performance and diverse functionalities, such as sensors and actuators.
The overall objective of our group is to acquire a broad knowledge of coupling phenomena in ferroic materials, with an aim of discovering new general concepts, clearing the way for both understanding and applications.

KEY FIGURES

180 publications since 2015 (average)

10 patents

22 members

30 publications per year (average)

MAIN EXPERTISE FIELDS

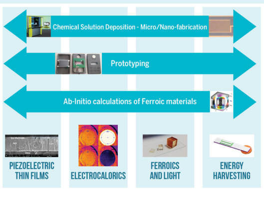
As depicted in the figure, our group has four areas of interest and two transversal activities.

Applicative areas of interest

- Design of ferroic materials (ab initio, phase transitions)
- Advanced characterization of oxides (Raman, XRD, piezo/ferro)
- Sol gel deposition, inkjet printing and Atomic Layer Deposition
- Fatigue of piezoelectrics

Transversal activities

- Modelling of functional oxides (first and second principles)
- Chemical Solution Deposition and micro-fabrication



MAIN ASSETS

Chemical platform to prepare sol gel functional oxides

- Inkjet printing
- Laser lithography
- Two labs dedicated to optical and dielectric characterizations

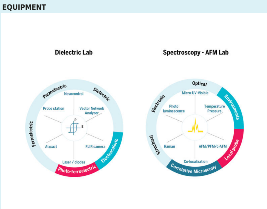
Technology

- Inkjet printing of piezoelectric films
- Printed sensors
- Chemical Solution Deposition of piezoelectric films

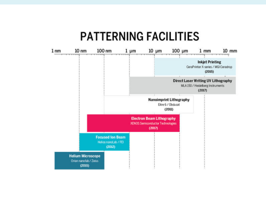
Applications

- Printed sensor on satellites
- Electrocaloric coolers
- Haptic function on glass

EQUIPMENT



Dielectric Lab
Piezoelectric
Dielectric
Novocontrol
Probe station
Vector Network Analyser
Ferroelectric
Aixxact
FLIR camera
Laser / diodes
Photo-ferroelectric
Electrocaloric
Spectroscopy - AFM Lab
Optical
Micro-UV-Visible
Environments
Electronic
Photo luminescence
Temperature Pressure
Structural
Raman
AFM/PFM/c-AFM
Co-localization
Correlative Microscopy
Local probe



PATTERNING FACILITIES
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
10 mm
Inkjet Printing
CeraPrinter X-series / MGI Ceradrop
(2015)
Direct Laser Writing UV Lithography
MLA 150 / Heidelberg Instruments
(2017)
Nanoimprint Lithography
Eitre 6 / Obducat
(2011)
Electron Beam Lithography
XENOS Semiconductor Technologies
(2017)
Focused Ion Beam
Helios nanoLab / FEI
(2012)
Helium Microscope
Orion nanofab / Zeiss
(2015)

SELECTED PUBLICATIONS

2020

- On the importance of pyrolysis for inkjet-printed oxide piezoelectric thin films, N Godard, MA Mahjoub, S Girod, T Schenk, S Glinšek, E Defay. (2020). Journal of Materials Chemistry C, 8, 3740-3747
- Archetypal Soft-Mode-Driven Antipolar Transition in Francisite Cu3Bi(SeO3)2O2Cl, Cosme Milesi-Brault, Constance Toulouse, Evan Constable, Hugo Aramberri, Virginie Simonet, Sophie de Brion, Helmuth Berger, Luigi Paolasini, Alexei Bosak, Jorge Íñiguez and Mael Guennou. (2020). Physical Review Letters 124, 097603/1-6
- Effect of dopant ordering on the stability of ferroelectric hafnia, Sangita Dutta, Hugo Aramberri, Tony Schenk and Jorge Íñiguez. (2020). Physica Status Solidi (Rapid Research Letters) 2000047/1-6
- 1-mW Vibration Energy Harvester Based on a Cantilever with Printed Polymer Multilayers, N Godard, L Allirol, A Latour, S Glinsek, M Gérard, J Polesel, Fabrice Domingues Dos Santos, Emmanuel Defay. (2020). Cell Reports Physical Science, 100068
- Antiferroelectricity in a family of pyroxene-like oxides with rich polymorphism, Hugo Aramberri and Jorge Íñiguez. (2020). Communications Materials 1, 52/1-6
- Probing antiferroelectric-ferroelectric phase transitions in PbZrO3 capacitors by piezoresponse force microscopy, Haidong Lu, Sebastjan Glinšek, Pratyush Buragohain, Emmanuel Defay, Jorge Íñiguez and Alexei Gruverman. (2020). Advanced Functional Materials 2003622/1-6
- A key piece of the ferroelectric hafnia puzzle, Beatriz Noheda and Jorge Íñiguez. (2020). Science 369, 1300
- Local negative permittivity and topological phase transition in polar skyrmions, S. Das, Z. Hong, V. Stoica, M.A.P. Gonçalves, Y.T. Shao, E. Parsonnet, E.J. Marksz, S. Saremi, M.R. McCarter, A. Reynoso, C.J. Long, A.M. Hagerstrom, D. Meyers, V. Ravi, B. Prasad, H. Zhou, Z. Zhang, H. Wen, F. Gómez-Ortiz, P. Garcia-Fernandez, J. Bokor, J. Íñiguez, J.W. Freeland, N.D. Orloff, J. Junquera, L.-Q. Chen, S. Salahuddin, D.A. Muller, L. Martin and R. Ramesh. (2020). Nature Materials.
- Giant temperature span in electrocaloric regenerator, A Torelló, P Lheritier, T Usui, Y Nouchokgwe, M Gérard, O Bouton, S Hirose, E Defay. (2020). Science 370 (6512), 125-129
- Fully Transparent Friction-Modulation Haptic Device Based on Piezoelectric Thin Film, Sebastjan Glinsek, Mohamed Aymen Mahjoub, Matthieu Rupin, Tony Schenk, Nicolas Godard, Stéphanie Girod, Jean-Baptiste Chemin, Renaud Leturcq, Nathalie Valle, Sébastien Klein, Cédrick Chappaz, Emmanuel Defay. (2020). Advanced Functional Materials 30 (36), 2003539
- Highly conductive low-temperature combustion-derived transparent indium tin oxide thin film, L Song, T Schenk, E Defay, S Glinsek. (2020). Mater. Adv.
- Role of the ferroelastic strain in the optical absorption of BiVO4C, Hill, MC Weber, J Lehmann, T Leinen, M Fiebig, J Kreisel, M Guennou. (2020). APL Materials 8, 081108

2019

- Spatially resolved steady-state negative capacitance, Ajay K. Yadav, Kayla X. Nguyen, Zijian Hong, Pablo García-Fernández, Pablo Aguado-Puente, Christopher T. Nelson, Sujit Das, Bhagawati Prasad, Daewoong Kwon, Suraj Cheema, Asif I. Khan, Chenming Hu, Jorge Íñiguez, Javier Junquera, Long-Qing Chen, David A. Muller, Ramamoorthy Ramesh & Sayeef Salahuddin. (2019). Nature 565, 468–471
- Theoretical guidelines to create and tune electric skyrmion bubbles, M.A.P. Gonçalves, Carlos Escorihuela-Sayalero, Pablo García-Fernández, Javier Junquera and Jorge Íñiguez. (2019). Science Advances 5, eaau7023/1-5
- Ferroelectric negative capacitance, Jorge Íñiguez, Pavlo Zubko, Igor Luk'yanchuk and Andrés Cano. (2019). Nature Reviews Materials 4, 243-56
- Observation of room-temperature polar skyrmions, S. Das, Y. L. Tang, Z. Hong, M.A.P. Gonçalves, M.R. McCarter, C. Klewe, K.X. Nguyen, F. Gómez-Ortiz, P. Shafer, E. Arenholz, V.A. Stoica, S.-L. Hsu, B. Wang, C. Ophus, J.F. Liu, C.T. Nelson, S. Saremi, B. Prasad, A.B. Mei, D.G. Schlom, J. Íñiguez, P. García-Fernández, D.A. Muller, L.Q. Chen, J. Junquera, L.W. Martin and R. Ramesh. (2019). Nature 568, 368-72
- Giant electrophononic response in PbTiO3 by strain engineering, Pol Torres, Jorge Íñiguez and Riccardo Rurali. (2019). Physical Review Letters 123, 185901/1-5
- Increasing bulk photovoltaic current by strain tuning, Shankari Nadupalli, Jens Kreisel, Torsten Granzow. (2019).Science advances 5 (3), eaau9199

2018

- Direct Patterning of Piezoelectric Thin Films by Inkjet Printing, N Godard, S Glinšek, A Matavž, V Bobnar, E Defay. (2018), Advanced Materials Technologies, 1800168 (2018)

Partenaires

- Catalan Institute of Nanoscience and Nanotechnology - ICN2 (ES)
- Centre national de la recherche scientifique -CNRS (FR)
- Ecole Polytechnique (FR)
- European Space Agency - ESA (FR)
- hap2U (FR)
- ICube (FR)
- Jožef Stefan Institute, Ljubljana (SI)
- muRata (JP)
- OHB Luxspace (LU)
- Thales (FR)
- University of Arkansas (USA)
- University of Cambridge (GB)
- Universidad de Cantabria (ES)
- Université de Liège (BE)
- University of Luxembourg (LU)
- University of Nebraska - Lincoln (USA)
- Universität Osnabrück (DE)
- Université Paris-Saclay (FR)

Contact

5, avenue des Hauts-Fourneaux
L-4362 Esch-sur-Alzette
tél : +352 275 888 - 1 | LIST.lu

Emmanuel DEFAY (emmanuel.defay@list.lu)

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY