RESEARCH GROUP

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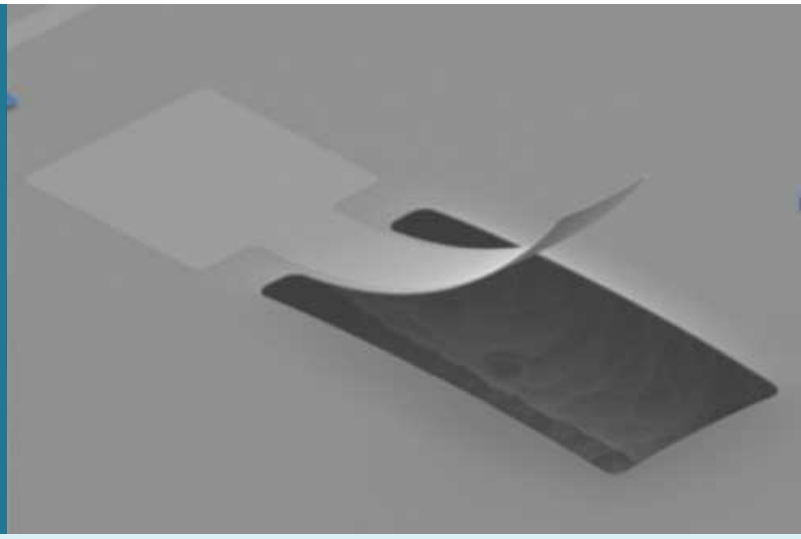
Ferroic Materials for Transducers



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

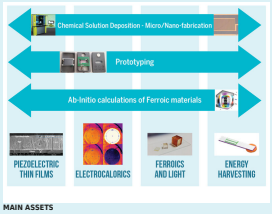
As depicted in the figure, our group has four areas of interest and two transversal activities.

Application areas of interest

- Design of ferroic materials (ab initio, phase transitions)
- Advanced characterization of oxides (Raman, XRD, piezoRens)
- 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

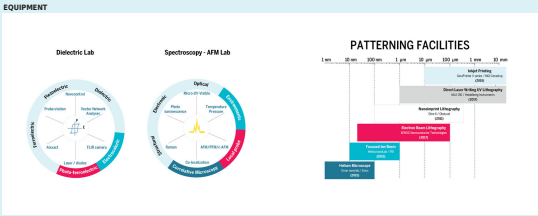
Technology

- 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



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 Antiferrodistortive Transition in Perovskite Oxyfluorides, 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 domain walking on the stability of ferroelectric ladius, Sangida Dutta, Hugo Aramberri, Tony Schenk and Jorge Íñiguez. (2020). Physica Status Solidi (Rapid Research Letters) 2000047/1-6
- Lead-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 perovskite thin oxides with rich polymorphism, Hugo Aramberri and Jorge Íñiguez. (2020). Communications Materials 1, 521-6
- Tracking antiferroelectric-ferroelectric phase transitions in PbZrO3 capacitors by interpreting force microscopy, Haidong Lu, Sebastjan Glinšek, Pratyush Buragohain, Emmanuel Defay, Jorge Íñiguez and Alexei Gruverman. (2020). Advanced Functional Materials 2003822/1-6
- A new stone of the ferroelectric hafnia oxides, 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. Hagemeister, D. Meyers, V. Ravi, B. Prasad, H. Zhou, Z. Zhang, H. Wen, F. Gómez-Ortiz, P. García-Fernández, 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 Flexible Perovskite-Based Piezoelectric Nanogenerators, Sebastjan Glinšek, 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 (38), 2003539
- Highly conductive low-temperature combustion-derived transparent indium tin oxide thin films, S Glinšek, T Schenk, E Defay, S Glinsek. (2020). Mater. Adv.
- Role of the ferroelastic strain in the optical properties of BiVO4, Hill, NC Weber, J Lehmann, T Leinen, M Fiebig, J Kreisel, M Guennou. (2020). APL Materials 8, 081108

2019

- Ferrielectric switching in thin films of lead-free relaxor ferroelectrics for electrostatic energy storage and harvesting: Preisach modelling and experimental verification, Sebastjan Glinšek, Brahim Ahmed Ould Mohamed Moussa, Emmanuel Defay. (2019). Acta Materialia 175, 384-391
- Ferroelectric negative capacitance, Jorge Íñiguez, Pavlo Zubko, Igor Luk'yanchuk and Andrés Cano. (2019). Nature Reviews Materials 4, 243-56
- Fluorite-structured antiferroelectrics, Xiao, Y. Liu, T. Qiao, J. Li, M.A.P. Gonçalves, E. Glogowski, D. Chen, T. Shimizu, M. Nishida, T. Usui, S. Yasui, Y. Kondo, H. Funakubo, J.L. Jones, V. Stoica, S. Saremi, L.W. Martin, J. Íñiguez, E. Defay, S. Trolier-McKinstry and J.-P. Maria. (2019). Journal of Applied Physics 125, 114103
- Ferroelectric switching in sub-20 nm aluminum scandium nitride thin films, S. Fichtner, N. Wolff, F. Lofink, L. Kienle and B. Wagner. (2019). IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control 67, 1233-1241
- Ferroelectricity in yttrium-doped hafnium oxide, S. Fichtner, N. Wolff, G. Krishnamurthy, A. Petraru, S. Bohse, F. Lofink, S. Chemnitz, H. Kohlstedt, L. Kienle and B. Wagner. (2019). Journal of Applied Physics 125, 114103
- Identifying Ferroelectricity in Boracite Single Crystals via Calorimetry and Second Harmonic Generation, Craig J. Fennie, Matthew Dawber, Jorge Íñiguez, Eric Bousquet, Xianghan Xu, Sang-Wook Cheong, Fei-Ting Huang, Yazhong Wang, Daniel Puggioni, Vikram Anil Rondinelli, Eric Ye Tsymbal, Evgeny Y. Vedmedenko, Arthur Kosmowska Petrov, Alexei Bokov, Hena Das, Lane W. Martin, Antonio Cano, Emmanuel Defay, Darrell G. Schlom, Ramamoorthy Ramesh, Nicola A. Spaldin, Oswaldo Diéguez, Valentina Garcia, Manuel Bibes, Agnès Barthélémy, Sergey Artyukhin, Matthew P. Ljungberg, Sergey Prosandeev, Massimiliano Stengel, Darrell G. Schlom, Craig J. Fennie, Turan Birol, Chris J. Pickard, Karin M. Rabe, David Vanderbilt and Ronald M. Wentzcovitch. (2019). Physical Review Letters 123, 105901/1-5
- Harnessing bulk photovoltaic current by phase tuning, Shankari Nadupalli, Jens Kreisel, Torsten Granzow. (2019) Science advances 5 (3), eaau9339

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)

Partners

Canadian Institute of Nanoscience and Nanotechnology - ICN2 (ES)
Centre national de la recherche scientifique -CNRS (FR)
Ecole Polytechnique (FR)
Fundamental Science Polymers - IFSA (FR)
Inac3D (FR)
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