



Laboratoire de **Cristallographie et**
Sciences des Matériaux
CNRS – UMR 6508
Université de Caen Normandie & ENSICAEN
Caen (France)



Institut Laue-Langevin
Grenoble (France)

The CRISMAT Laboratory (CNRS – ENSICAEN - Université Caen Normandie) and the Institut Laue-Langevin (ILL, Grenoble, France), jointly invite applications for a three-year PhD program focusing on :

Ordered Spinel for Magnetolectric Properties

For the last 15 years, the studies of multiferroic materials are one of the most enthusiastic subjects in condensed matter field of research. A multiferroic compound presents two simultaneous ferroic orders (ferroelectric, ferromagnetic or ferroelastic). For the magnetolectric (ME) multiferroic materials the magnetization can be controlled by the electric fields. Such properties open the way of new spintronic devices with various applications.

The spinel structures AB_2O_4 are very well known for their numerous magnetic properties and recently $CoCr_2O_4$ has been investigated as ME-multiferroic (type II) compounds. In that case, the appearance of the incommensurate conical-spiral magnetic order directly involves the ferroelectricity. Moreover, the magnetic dilution on the B-sites for the series $Co^{II}(Cr^{III}_{1-x}Co^{III}_x)O_4$, significantly increases both saturated electric polarization and magnetization under magnetic field. On the other hand, the magnetic dilution on the A-sites for the series $Zn_{1-x}Co_xCr_2O_4$ causes the disappearance of the ferromagnetic ordering to benefit to frustrated antiferromagnetism. At the CRISMAT we recently start to study the spinel family $Co_{5-x}Zn_xTeO_8$. In those compounds the Te^{6+} cation plays the role of a B-site magneto-diluting agent and enables to get ordered spinel. On the other side the Zn^{2+} cation plays the role of A-site magneto-diluting agent. The $Co_{5-x}Zn_xTeO_8$ series appears as very versatile spinel family since we can perfectly decide on which sites the magnetic dilution will take place and easily modify the ME properties.

The aim of this project is to continue the investigation of this remarkable $Co_{5-x}Zn_xTeO_8$ spinel series. A special attention will be paid on ordered spinel compounds $Co_{5-x}Zn_xTeO_8$ with $0 < x < 1$ to establish the magnetic phase diagram and the evolution of ME coupling versus x . We will also investigate other chemical systems to find novel ordered spinel phases. All the compounds will be synthesized by solid state reactions and their structures (nuclear and magnetic) characterized by X-ray and neutron diffraction. An important part of the synthesis work will be consecrated to grow single-crystals of sufficient sizes to characterize the dielectric properties and the complex magnetic structures.

Location and Salary

The PhD project will be located in Grenoble (France), at the ILL, and at the CRISMAT in Caen (France). The successful candidate will be employed for a period of up to three years, with a gross salary of around 2350 €/month, together with other benefits depending on the student's social status (for more details see: <http://www.ill.eu/science-technology/phd-students/phd-recruitment/phd-work-at-the-ill/>).

A team of experts, including Nicolas Barrier, Emmanuelle Suard, Juan Rodriguez-Carvajal and Alain Pautrat, will supervise the work of the PhD student.

Profile

Applicants should have a Master degree in solid state chemistry or in physics. Academic knowledge of condensed matter physics and crystallography will be appreciated. Good English communication skills (oral and written) are also required.

Supervisors: Dr. Nicolas Barrier, Univ. of Caen Normandie, and Dr. Emmanuelle Suard, ILL (Grenoble).

Contact information: To apply, please send a letter of motivation and a CV (with 2 recommendation letters) to Dr. Nicolas Barrier, nicolas.barrier@ensicaen.fr.

For more information on the CRISMAT please visit our web site: www-crismat.ensicaen.fr