Ordered Spinels for Magnetoelectric 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 magnetoelectric (ME) multiferroic materials the magnetization can be controlled by the electric fields. Such properties open the way of new spintronic devises 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 investigate 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 statured 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.