MS09.O02

Probing the Giant Piezoelectric response of ferroelectric perovskites

J. Rouquette[1], M. Hinterstein[2], J. Haines[1], M. Knapp[3], J. Glaum[4], J. Eckert[2], H. Fuess[5], H. Dammak[6]

[1]Université Montpellier II, Institut Charles Gerhardt UMR CNRS 5253 Equipe C2M, Montpellier, France., [2]Technische Universität Dresden, Institut für Werkstoffwissenschaft, Dresden, Germany, [3]Karlsruher Institut für Technologie, Institut für Angewandte Materialien – Energiespeichersysteme, Eggenstein-Leopoldshafen, Germany, [4]University of New South Wales, School of Materials Science and Engineering, NSW, Australia., [5]Darmstadt University of Technology, Materials Science, Darmstadt, Germany, [6]European Synchrotron Radiation Facility, Grenoble, France, [7]CNRS-École Centrale Paris, Laboratoire Structures, Propriétés et Modélisation des Solides, UMR 8580 Châtenay-Malabry, France

By analogy with ferromagnetism and the hysteresis of the magnetic moment with a magnetic field, materials that exhibit a macroscopic spontaneous polarization Ps, which can be reversed under electric field E were defined as ferroelectrics. Ps, the directional order parameter can give rise to different polar structural phase transitions and finally disappear as a function of temperature T and/or hydrostatic pressure P in a transformation from a non-centrosymmetric to a centrosymmetric space group. The physical properties of ferroelectric materials are the basis of many technological applications based on their hysteretic properties (Ps / E in ferroelectric random access memories) or based on their coupled properties (η (mechanical strain)/ E in piezoelectric applications). In order to understand the origin and the mechanisms associated with the ferroelectric properties, “in-situ” structural studies as a function of E, T and P have to be performed. In addition ferroelectric materials exhibit based on their directional properties (Ps) a particular domain configuration which makes the structural understanding of these compounds much more complex. Different scales should be taken into account: from the atomic scale (individual polar displacements) to the macroscopic scale (macroscopic piezoelectric effect) and finally the mesoscopic scale in between, which is governed by the domain wall motion. High piezoelectric/ferroelectric properties in lead perovskite materials (PZT, PMN, PZN) are structurally linked to strong disorder which can be characterized by the presence of diffuse scattering in diffraction experiments and by nanosized domains. Here we will present “in-situ” characterization in lead perovskite materials as a function of the applied electric field based on X-ray and neutron diffraction and EXAFS techniques. A brief overview of the challenges to solve in future studies as a function of pressure and temperature will also be discussed.

Keywords: In situ characterization, Ferroelectrics, Electric field