High-pressure synchrotron X-ray scattering of oxides with a nano-scaled local structure

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Many of the remarkable physical properties observed in ABO_3-type oxides are related to materials with an *intrinsic* nano-scaled local structure, where the different regions are characterized by competing chemical, structural and/or physical properties. One of the major challenges in the analysis of the nano-scaled oxides is the experimental access to the local properties, which is often at best a difficult task. The presence of a nano-scaled structure is characteristic of so-called relaxor ferroelectrics (relaxors), materials that have attracted considerable attention since the recent discovery of ultrahigh strain and giant piezoelectric properties in relaxor-based single crystals [1].
New approaches to the detailed characterization of nano-structured materials are clearly of interest since they will provide improved understanding which in turn should lead to the possibility of tuning of local properties to create new functional materials with superior properties. Furthermore, a fundamental understanding of nano-scale features of materials including a good knowledge of the local structural properties is also an important prerequisite for promising *ab initio* calculations.

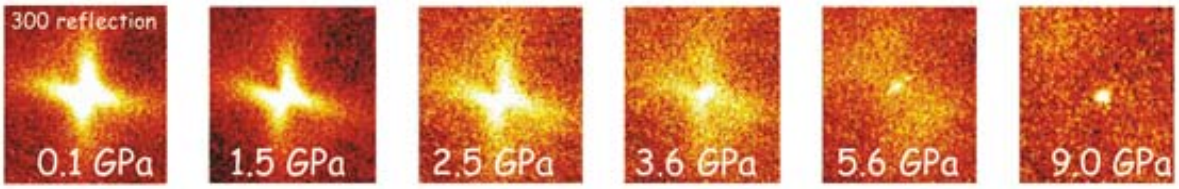

Figure 1: Pressure-dependent evolution of the diffuse scattering around the (300) reflection in $PbMg_{1/3}Nb_{2/3}O_3$

Motivated to understand in detail the local structure of relaxors we have extended our laboratory Raman scattering investigations [2-3] by high-pressure X-ray scattering studies at the ESRF synchrotron source [4-6]. Here we present results obtained for the model relaxors $PbMg_{1/3}Nb_{2/3}O_3$ (PMN) and $Na_{1/2}Bi_{1/2}TiO_3$ (NBT) which will be discussed within the framework of relaxors in a more general manner.
Our results show namely that an external pressure of several GPa (as can be met in thin films) alters fundamentally the structural and polar properties in relaxor ferroelectrics on the short- *and* long-range. A particular interesting observation is the suppression of the relaxor-characteristic X-ray diffuse scattering with pressure (see Figure [5]) which points to a pressure-induced crossover from short-to-long-range order.

References

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