# In-situ high-pressure and high-temperature Raman spectroscopy on advanced perovskite-type relaxor ferroelectrics

N Waeselmann[1], B Mihailova[1], M Gospodinov[2] and U Bismayer[1]
[1] Department Geowissenschaften, Universität Hamburg, Grindelallee 48, 20146 Hamburg, Germany
[2] Institute of Solid State Physics, Bulgarian Academy of Sciences, Blvd. Tzarigradsko Chausse 72, 1784 Sofia, Bulgaria

Relaxor ferroelectrics (relaxor) of the perovskite structure ($ABO_3$) have been extensively studied over last few decades due to their remarkably high dielectric permittivity, piezoelectric/electro-elastic and electro-optic coefficients. Relaxors are a special class of ferroelectrics which exhibit a broad temperature and frequency dependent maximum of the dielectric permittivity. Due to these properties relaxors have found numerous technical applications and are considered as one of the most promising materials for next generation electromechanical sensors and transducers.
It is still unclear which are the key structural features that cause the desired properties. It is known that the structure of relaxors contains polar nanoregions within a paraelectric matrix. Dynamical polar nanoclusters nucleate at $T_b$, then they merge into larger clusters at another characteristic temperature T* and below the temperature of the dielectric-premittivity maximum $T_m$ the polar nanoregions either freeze or develop into normal, long-range ordered ferroelectric domains. Our recent in-situ high-pressure structural studies on pure and doped $PbSc_{0.5}Ta_{0.5}O_3$ and $PbSc_{0.5}Nb_{0.5}O_3$ at room temperature [Mihailova et al. 2008, 2011] show the existence of a pressure-indcued phase transition from a pseudocubic relaxor state to a ferroic phase comprising antiphase $BO_6$ tilts, as the phase transition is preceded by dynamical decoupling of the off-centred Pb. Our results also indicate the co-existence of nanoscale polar and anti-ferrodistortive interemediate-range structural species at ambient conditions. The temperature decrease favours the polar order, whereas the pressure increase leads to the development of the nanoscale antiferrodistortive atomic arrangements into long-range ordered antiferrodistortive domains.
The aim of this study was to check if high temperatures renormalize the sequence of the pressure-induced structural chances. Raman spectra of $PbSc_{0.5}Ta_{0.5}O_3$ collected at different pressures and constant temperatures close to the characteristic temperatures clearly show that the critical pressure is reduced with increasing temperature.

References:
Mihailova B., Angel R. J.et al. (2008), Phys. Rev Lett, 101, 017602.
Mihailova B., Angel R. J.et al. (2011), The structural state of lead-based relaxor ferroelectrics under pressure, IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, in press.