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Dynamics of Nanoscale Polarization Fluctuations in a Uniaxial Relaxor

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One of the most remarkable properties of relaxor materials is their extraordinarily large dielectric permittivity appearing over a broad temperature interval and attaining its maximum at a temperature Tmax, which varies linearly with the logarithm of the probing frequency. This frequency-dependent Tmax is described by the Vogel-Fulcher (VF) law and originates from a temperature-dependent dielectric relaxation. Such a behaviour has also been observed in tetragonal tungsten bronze crystals such as Sr0.61Ba0.39Nb2O6 (SBN61) [1], an almost ideal uniaxial relaxor with polar fluctuations appearing only along the tetragonal axis.

Recently, we have performed a neutron backscattering study on a SBN61 single crystal in the MHz-GHz frequency region [2]. Investigation of diffuse scattering coming from atomic displacements along the tetragonal axis allowed us to resolve the dynamic part of nano-scale polar fluctuations. Typical data are displayed in Fig.1a, showing a clear inelastic component which can be well described by a simple model based on an analysis of dielectric spectra [1,2]. The agreement between the experiment and model data can be better appreciated when the scattering intensity at a fixed energy transfer is plotted as a function of temperature (cf. Fig.1b,c). This comparison demonstrates that the peak positions shift towards higher temperatures with increasing energy transfers, closely following the VF law. Our results provide direct evidence that the 'critical'relaxation with its VF-type frequency dependence is associated with dynamic nano-scale polarization fluctuations.

Fig.1: Neutron-scattering intensity at Q ~ (0.15,0,1) as a function of (a) energy transfer and (b) temperature compared with (c) a model based on an analysis of dielectric spectra [1,2].

References
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