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Microstructure of Piezoceramic Materials

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Lead containing oxides with perovskite structure are widely used as sensors and actuators. Among those materials lead titanate zirconate $PbZr_{1-x}Ti_xO_3$ (PZT) and lead magnesium niobate-lead titanate, PMN-PT are the most prominent ones. The possible environmental hazard connected with lead has driven research of novel materials with comparable electrical and mechanical properties as PZT.

Domains play an important role as part of the microstructure in ferroelectric materials. In morphotropic PZT ($PbZr_{1-x}Ti_xO_3$) a complicated system of micro-and nanodomains is present, which may induce interference effects. With field dependent measurements by synchrotron x-ray and transmission electron microscopy the influence of this microstructure on the materials properties is studied.

Lead-free piezoelectric ceramics $(1-x-y)Bi_{0.5}Na_{0.5}TiO_3$-$xBaTiO_3$-$K_{0.5}Na_{0.5}NbO_3$ ($0.05 \leq x \leq 0.07$and $0.01 \leq y \leq 0.03$) have been synthesized by the mixed oxide route and sintering. High resolution neutron powder diffraction and HRTEM revealed superstructure reflections. No prominent domain structure as commonly observed in PZT polycrystals was initially observed in TEM. Recent in-situ field dependent TEM experiments indicated, however, a formation of ferroelectric domains. The strength of synchrotron radiation, neutron scattering and TEM will be compared and discussed.