Characterization of $Ba(Ti,Sn)O_3$ ceramics

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$BaTi_xSn_{1-x}O_3$ (BTS) solid solutions display a diffuse ferroelectric phase transition due to macroscopic heterogeneity. In view of its interesting electromechanical behavior, BTS can be conjectured as potential lead-free electrostrictive material system for various applications. We investigated the influence of Sn-substitution onto the dielectric, electromechanical and elastic properties of BTS-ceramics sintered from conventional mixed-oxide powder. Thermal expansion, dielectric and electromechanical experiments have been carried out, both for the pure compounds (x=0 and x=1, respectively), and for various BTS compositions with $0.025 \leq x \leq 0.2$. It will be shown that this composition range covers both the diffuse phase transition state and the ferroelectric relaxor state of BTS. The thermal expansion of BTS at elevated temperatures is nonlinear, both due to thermally generated impurities and, below the Burns-temperature T_d, due to the strain contribution of polar nanoregions. The deviation from the Curie-Weiss law of the permittivity was studied as well as the non-Debye dispersion arising from the precursor polarization in the Burns-phase of BTS. Analyzing dielectric spectra in the vicinity of the mechanical resonance frequency of DC-biased bar-shaped samples, we obtain information about the complex coupling factor and the elastic anomaly accompanying the diffuse phase transition. The large field electromechanical and dielectric responses were investigated simultaneously using a capacitive dilatometer and a Sayer-Tower setup, respectively. We provide results illustrating the decisive role of the Sn-content on the shape and on characteristic parameters of the strain-field- (S(E)), polarization-field- (P(E)) and strain-polarization (S(P))-loops in BTS. The unhysteretic P(E)-dependence in the slim-loop region will be addressed as well as the coupling between polarization and electromechanical strain. This contribution was supported by Deutsche Forschungsgemeinschaft, Schwerpunktprogramm "Substitutionseffekte in ionischen Festkörpern"