Synthesis and characterization of nanoscaled $\text{Ba}(\text{Ti}_{1-x-y}\text{Sn}_x\text{Ge}_y)\text{O}_3$ powders and corresponding ceramics

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Abstract

Nanoscaled $\text{Ba}(\text{Ti}_{1-x-y}\text{Sn}_x\text{Ge}_y)\text{O}_3$ (BTSG – $x - y$, $x = 0-0.1$, $y = 0-0.05$) powders were synthesized by a sol–gel method (SG) and, as a reference, coarse powders by a mixed-oxide method (MO). The particle sizes were determined by XRD, BET, photon correlation spectroscopy (PCS) and scanning electron microscopy (SEM). The sol–gel method supplied globular particles with narrow fractions in the range between 53 nm and 125 nm. However, from the mixed-oxide method irregularly grown particles were generated with diameters between 300 nm and 700 nm. The SG powders showed a higher sintering activity and, additionally, Sn^{4+} ions were incorporated at lower temperatures into the BaTiO_3 structure. The addition of at least 2 mol% BaGeO_3 (BG) resulted in ceramics of densities as high as 96% even at 1050 °C. Furthermore, the cubic $\rightleftharpoons$ tetragonal phase transition temperatures were measured by dilatometry, differential thermal analysis (DTA) and dielectric measurements. The temperature and sharpness of the transition are dependent on tin and germanium content. Increasing tin and germanium concentration causes the phase transition temperature to decrease and more diffuse transition.