Grain Size Effect on the Dielectric Nonlinearity of $BaTiO_3$ Ceramics

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Abstract: The dielectric nonlinearity of $BaTiO_3$ ceramics with grain sizes from 1.2 to 76 μm was investigated using the ac electric field dependence of the dielectric properties and the first order reversal curves (FORC) distribution. Defect dipoles in samples with large grains led to pinching of minor polarization-electric field hysteresis loops as well as a threshold field in the ac field dependence of the dielectric constant and loss. For samples with small grains, a sublinear ac field dependence was observed. The irreversible FORC distributions characterizing the responses showed two strong and narrow peaks for large-grained samples and a weak, broad peak centered near the origin for samples with small grains. As the grain size decreased, the reversible FORC distribution at zero-bias field increased. No grain size dependence of the reversible FORC distributions was observed at high dc electric fields. These results indicate that the grain size dependence of the small field dielectric constant is attributable to a domain wall contribution. Furthermore, the potential profile through which the domain walls travel changes from a landscape with shallow widely-spaced wells with deep local wells to one with deep widely-spaced wells with shallow local wells, as the grain size decreases. (C) 2010 American Institute of Physics. [doi: 10.1063/1.3428423]