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Colossal permittivity and dielectric behaviour of (Nb0.5Fe0.5)0.1Ti0.9O2 and (Ta0.5Fe0.5)0.1Ti0.9O2 ceramics

Abstract

The influence of pentavalent elements (Nb5+, Ta5+) with Fe3+ on TiO2 ceramic were investigated. The (Nb0.5Fe0.5)0.1Ti0.9O2 and (Ta0.5Fe0.5)0.1Ti0.9O2 ceramics have been synthesized and realized that the effect of Nb in the system has developed lattice expansion, although Nb and Ta exhibit similar ionic radii. The colossal permittivity value for (Nb0.5Fe0.5)0.1Ti0.9O2 ceramic is about εr ≥ 104 which is slightly higher than the (Ta0.5Fe0.5)0.1Ti0.9O2 ceramic. According to the dielectric analysis, both ceramics exhibit colossal permittivity below 103 Hz which contributed by the electron-pinned defect-dipole (EPDD) model. However, the low εr values in the high-frequency region are associated with the internal barrier layer capacitor (IBLC) model. In addition, the grain boundary resistance is far greater than the grain resistivity (Rgb≫ Rg) which confirmed the existence of the IBLC effect by equivalent circuit analysis.

Keywords

Equivalent circuits; Grain boundaries; High-k dielectric; Iron compounds; Niobium; Niobium compounds; Permittivity; Tantalum