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Giant Dielectric Response and Maxwell–Wagner Relaxation in Isovalent and Pentavalent Co–doped Rutile–TiO_2

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Due to their high potential for use in ceramic capacitors, high–performance giant dielectric properties (HP–GDPs), i.e., high dielectric constant (ε′), low loss tangent (tanδ), and the temperature stability of ε′ over a wide temperature range ($\Delta\varepsilon'/\varepsilon'_{25}(\%)$) < ±15, of acceptor/donor (***A***/***D***) codoped–TiO_2 ceramics have been widely studied since the discovery of a new In^{3+}/Nb^{5+} codoped rutile–TiO_2. In this presentation, HP–GDPs of the TiO_2–based oxides were achieved in Sn^{4+}/Nb^{5+} codoped rutile TiO_2 (SnNTO) ceramics. SnO_2 isovalent (I^{4+}) dopant was employed to replace the ***A*** dopants. The SnNTO samples with different Sn^{4+}/Nb^{5+} concentrations (x = 0.01–0.05) were prepared using a standard solid–state reaction (SSR) method . The X–ray diffraction patterns of all the SnNTO ceramics showed only a single–phase rutile–TiO_2 (JCPS 21–1276) without any impurity phases. A highly dense microstructure of all SnNTO samples consisted of grains and grain boundaries. The average grain size slightly enlarged from 1.6 to 2.6 μm, which was caused by the diffusion of oxygen vacancies ($V_o^{\bullet\bullet}$) due to the existence of multivalent Sn^{2+}/Sn^{4+} ions. The dielectric properties of the SnNTO ceramics showed a high ε′ (~10^4), very low tanδ (<~0.05), and a low $\Delta\varepsilon'/\varepsilon'_{25}(\%)$ < ±15 values in a wide temperature range. The origin of HP–GDPs was investigated using impedance spectroscopy (IS). The dielectric response was described by Maxwell–Wagner relaxation.

Keywords: TiO_2; Giant dielectric constant; Codopant; Grain boundary; Maxwell–Wagner relaxation

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