Contribution ID: **111** Contribution code: **S2 Condensed Matter Physics** Type: **Oral Presentation**

High–Performance Giant Dielectric Properties of (Tb+Nb) Co–Doped TiO2 Ceramics

Friday 24 June 2022 16:00 (15 minutes)

Giant dielectric (GD) ceramics have been extensively reported in recent years due to their potential for use in high–performance capacitors. However, the strong temperature stability of high dielectric permittivity ($> 10^3$) and low dielectric loss tangent (tanδ < 0.05) have been difficult to accomplish. In this work, a novel GD oxide was discovered in (Tb+Nb) co–doped TiO_2 (TNTO) ceramics. Their colossal ε´ (˜$4.7—5.3\times10^4$) and ultra–low tanδ (˜0.006 – 0.007) were achieved at 30℃ and 1 kHz. Moreover, their temperature coefficient of ε´ (Δε´ /ε´) values at 1 kHz were less than |±15%| over the temperature range from –60℃ to 210℃, which encounter the primary desire in X9R–type capacitor. Interestingly, their low tanδ (˜ 0.033–0.045) still appears at 200℃. These outstanding dielectric behaviors of TNTO ceramics were investigated via characterization of their phase structures, microstructures, and impedance spectroscopy (IS) analysis. The observation of electrical heterogeneity of semiconducting grains and high insulating layers indicates that interfacial polarization exists in the TNTO ceramics leading to the GD behaviors. Besides, the dispersed second phase particles in their microstructures could reduce their ε´ and tanδ values. Therefore, the appropriate second phase particles fraction could tune the TNTO's dielectric properties as required.

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Session Classification: S2 Condensed Matter Physics

Track Classification: Condensed Matter Physics