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Giant Dielectric Permittivity and Low Dielectric Loss Tangent in Yb-doped $CaCu_3Ti_4O_{12}$ Ceramics

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In this research work, the giant dielectric response in $Ca_{1-3x/2}Yb_xCu_3Ti_4O_{12}$ (x = 0, 0.05, 0.15) ceramics prepared by a modified sol-gel method and sintered at 1100 °C for 6 and 12 h were investigated as functions of temperature and frequency. A single phase of $CaCu_3Ti_4O_{12}$ was obtained in all ceramic samples. Grain growth of $Ca_{1-3x/2}Yb_xCu_3Ti_4O_{12}$ ceramics was effectively inhibited by Yb^{3+} doping ions, which can be explained to the effect of solute drag of Yb^{3+} doping ions. High dielectric permittivity ($\sim 10^4$) and very low loss tangent ($\sim$0.01−0.02) at 1 kHz with good temperature stability of ε' ranging from -55 to 125 °C were achieved in a $Ca_{0.925}Yb_{0.05}Cu_3Ti_4O_{12}$ ceramic. Furthermore, the dielectric permittivity was found to be nearly independent of frequency (10^2-10^6 Hz) and dc bias voltage (0−40 V). Interestingly, the grain boundary resistances of $Ca_{1-3x/2}Yb_xCu_3Ti_4O_{12}$ ceramics at room temperature were calculated from the activation energies and found to be $\sim$0.7−12.5 GΩ.cm. The effect of annealing in O_2 atmosphere on the dielectric properties was also investigated. It was suggested that variations in dielectric properties of $Ca_{1-3x/2}Yb_xCu_3Ti_4O_{12}$ ceramics due to Yb^{3+} substitution and annealing were associated with the electrical response at grain boundaries.

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