

Giant Dielectric Permittivity and Low Dielectric Loss Tangent in Yb-doped $\text{CaCu}_3\text{Ti}_4\text{O}_{12}$ Ceramics

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In this research work, the giant dielectric response in $\text{Ca}_{1-3x/2}\text{Yb}_x\text{Cu}_3\text{Ti}_4\text{O}_{12}$ ($x = 0, 0.05, 0.15$) 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 $\text{CaCu}_3\text{Ti}_4\text{O}_{12}$ was obtained in all ceramic samples. Grain growth of $\text{Ca}_{1-3x/2}\text{Yb}_x\text{Cu}_3\text{Ti}_4\text{O}_{12}$ 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 $\text{Ca}_{0.925}\text{Yb}_{0.05}\text{Cu}_3\text{Ti}_4\text{O}_{12}$ 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 $\text{Ca}_{1-3x/2}\text{Yb}_x\text{Cu}_3\text{Ti}_4\text{O}_{12}$ ceramics at room temperature were calculated from the activation energies and found to be $\sim 0.7-12.5$ G Ω .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 $\text{Ca}_{1-3x/2}\text{Yb}_x\text{Cu}_3\text{Ti}_4\text{O}_{12}$ ceramics due to Yb^{3+} substitution and annealing were associated with the electrical response at grain boundaries.

Summary

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