Solid state sintering and microstructural evolution on wide frequency range dielectric responses of mechanically activated CaTiO3 ceramics

ABSTRACT

The $CaTiO_3$ samples were prepared by high-energy ball milling process followed by sintering process from 1040 to 1200°C. X-ray diffraction (XRD), microstructural analysis, and dielectric properties over a wide range of frequency varying from 0.01 Hz to 1 GHz at room temperature were investigated. The formation of a single phase $CaTiO_3$ with orthorhombic structure was achieved at 1120°C and above. From a morphological point of view, sintering temperature promoted grain growth. Dielectric properties in the frequency range 0.01 Hz - 1 MHz revealed a relaxation-type process. Interfacial phenomena were the possible physical mechanisms that gave rise to these relaxation-type plots. Extending the frequencies above ~1 MHz yielded a frequency-independent characteristic of dielectric constant (ε'). These turned out to the relatively small dielectric loss (tan δ) values. The origin of the dielectric responses in the frequency range 1 MHz - 1 GHz was attributed to the domination of dipolar polarization. The grain size effect in sintered $CaTiO_3$ samples was prominent, notably in dielectric responses above ~1 MHz. Increase in sintering temperature remarkably led to an enhancement in dielectric constant values and reduction in dielectric loss values. Therefore, a significant correlation existed between microstructural features and dielectric properties.

Keyword: Dielectric response; High-energy ball milling process; Calcium titanate