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Comparative studies of pure, Sr-doped, Ni-doped and co-doped $CaCu_3Ti_4O_{12}$ ceramics: Enhancement of dielectric properties

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Abstract

The $CaCu_3Ti_4O_{12}$ ceramic, CCTO, remains as the best material due to its high dielectric constant. In this context, Sr-doped CCTO, Ni-doped CCTO and Sr,Ni co-doped CCTO ceramics were prepared by the solid-state reaction method and were sintered at 1100°C for 24 h in order to enhance the geometric microstructure and dielectric properties. X-ray diffraction data refined via rietveld method for $CaCu_3Ti_4O_{12}$ confirms the formation of single phase. SEM micrographs revealed that the substitution of Sr^{2+} and/or Ni^{2+} on Ca and Cu sites respectively increase the grain size of $CaCu_3Ti_4O_{12}$ ceramics. Raman scattering measurements shows the presence of TiO_2 phase at grain boundaries, which is an important parameter to reduce the dielectric loss of samples. It is found that Sr,Ni co-substitution in CCTO leads to the best dielectric measurements at low frequency. The highest grain boundary resistance value is also obtained for co-doped CCTO sample in the order of $1.84\ 10^6\ \Omega$. This value is 10 times higher than pure CCTO. Meanwhile, the nonlinear coefficient values were improved, whereas, the breakdown electric field and leakage current decreased for all ceramic samples and co-doped CCTO is considered as the best conductive grain and insulating grain boundary.