Doping mechanisms and dielectric properties of Ca-doped bismuth magnesium niobate pyrochlores

ABSTRACT

Here we report the doping mechanisms and dielectric properties of Ca-doped bismuth magnesium niobate (BMCN) pyrochlores synthesised using solid-state reaction at 1025 °C over 24–48 h. The extensive solid solution of $(Bi_{3.36}Mg_{0.64-x}Ca_x)(Mg_{1.28}Nb_{2.72})O_{13.76}$ ($0 \leq x \leq 0.7$) pyrochlores formed with a fully indexed cubic structure, space group Fd3m and lattice constants, a = b = c in the range 10.5621 (17)−10.5332 (14) Å. The SEM analysis confirmed that the surface morphologies of BMCN pyrochlores were of irregular polyhedral grains and their crystallite sizes, as calculated by Scherrer and Williamson-Hall methods, were found to be in the range 46–70 nm and 38–75 nm, respectively. These thermally stable BMCN pyrochlores were highly insulating materials that showed a reproducible dielectric behaviour over heat-cool cycles and their activation energies were estimated to be in the range 1.17–1.47 eV. High bulk dielectric constants, ε', 69–171 and low dielectric losses, tan δ, in the order of ~10^{-3} were recorded at 30 °C and 1 MHz; negative temperature coefficient of capacitance (TCC) in the range, (−319)−(-933) ppm/°C was measured over ~30–300 °C at 1 MHz.