Novel pyrochlores in the Bi2O3-Fe2O3-Ta2O5 (BFT) ternary system: Synthesis, structural and electrical properties

ABSTRACT

The purpose of this work is to present a systematic study related to the doping mechanism, structural and electrical properties of the novel pyrochlores in the Bi2O3-Fe2O3-Ta2O5 (BFT) system. The pyrochlores with the general formula of Bi3.36Fe2.08+xTa2.56-xO14.56-x (-0.32 ≤ x ≤ 0.48) were prepared through solid-state reaction at 975 °C for 48 h. The subsolidus solution formation involved a mechanism of x Ta^{5+} + x O^{2-} ↔ x Fe^{3+}. These phase-pure BFT pyrochlores had a cubic structure with a space group of Fd3m (No. 227), Z = 4. Their lattice parameters were found to vary insignificantly within the range 10.4979 (8)-10.5033 (1) Å. The crystallite sizes determined by Scherrer and Williamson–Hall methods showed a good agreement with their values found to be in the range ∼57−78 nm. Meanwhile, the larger grain sizes in the range 0.2−4.7 μm were measured by the scanning electron microscopy (SEM) analysis. BFT pyrochlores were also found to be high refractory and thermally stable by the thermal analyses. These highly insulating pyrochlores exhibited high activation energies, ∼0.87−1.10 eV; moderate high dielectric constants, ∼78–92 and dielectric losses, ∼10-1 at 1 MHz and ∼30 °C. As such, these dielectric materials could be attractive candidates for potential application in low temperature co-fired ceramic (LTCC).

Keyword: Solid-state reaction; Electrical properties; Tantalates; Pyrochlore