Synthesis, structural and electrical properties of novel pyrochlores in the Bi2O3-CuO-Ta2O5 ternary system.

ABSTRACT

A series of non-stoichiometric cubic pyrochlores with general formula, Bi3−xCu1.8Ta3+xO13.8+x (BCT) was successfully prepared by solid state reaction at the firing temperature of 950 °C over 2 days. The solid solution mechanism is proposed as one-to-one replacement of Bi3+ for Ta5+, together with a variation in oxygen content in order to achieve electroneutrality. The solid solution limit is confirmed by X-ray diffraction technique (XRD) for which linear variation of lattice constants is observed at $0 \leq x \leq 0.6$. The refined lattice constants are found to be in the range of 10.4838 (8) Å–10.5184 (4) Å and the grain sizes of these samples determined by scanning electron microscopy (SEM) fall between 1 and 40 μm. Meanwhile, thermal analyses show no physical or chemical change for the prepared pyrochlores. The relative densities of the densified pellets for AC impedance measurements are above 85% and the measured relative permittivity, ε′ and dielectric loss, tan δ for composition, x = 0.2 at ambient temperature are ∼60 and 0.07 at 1 MHz, respectively. The calculated activation energies are 0.32–0.40 eV and the conductivity values, Y′ are in the order of 10−3 at 400 °C. The conduction mechanisms of BCT pyrochlores are probably attributed to the oxygen non-stoichiometry and mixed valency of copper within the structure.

Keyword: Solid state reaction; X-ray methods; Electrical properties; Tantalates.