Conductivity analysis of Bi4Ti3O12 ferroelectric ceramic: a comprehensive study from the dynamic aspects of hopping conduction

Abstract

Objectives: We focus solely on a comprehensive conductivity analysis of $Bi_4Ti_3O_{12}$ ceramic, in a bid to bring seminal ideas for dielectric components, in particular frequency and temperature ranges. Methods/Statistical Analysis: The synthesis of $Bi_4Ti_3O_{12}$ ceramic is based on a mechanical activation method. The following sintering at 1273 K ascertains the $Bi_4Ti_3O_{12}$ appears to be of single phase crystallizes in orthorhombic form, whose conductivity is determined from the dielectric function in the context of Kramers-Kronig relation on which of this is measured in the frequency domain at varying temperatures. The evaluation of conductivity data is mainly in terms of activation energy. Findings: We find that the separately discussed dc and ac conductivities in similar manner are best isolated into two distinct temperature regions. Charge transport by hopping to the target localized states is the relevant conduction mechanism in bringing insights into the dynamic responses. Variable range and small polaron hopping models associated with the adiabatic small polaron are the decent choices, each of which explaining the dc conductions in these temperature regions. The former involves distant hops, whereas the latter denotes as nearest-neighbour hopping. The percolation treatments applied in the dc conductivity yield promising results if different percolation expressions are used. The correlation between dc and ac conductions for each temperature is irrefutably made through the Barton-Nakajima-Namikawa fitting. In frequency dependence ac regions, the thermally activated hopping carriers are transported in a correlated to a random manner between preferred sites. Performing a Summerfield ac scaling in these temperature regions leads to different scenarios in view of time-temperature superposition principle. Applications/Improvements: Further experiments are encouraged to support the hopping conduction mechanisms from another aspect in order to prompt the use as energy storage function in the electromagnetic application.

Keyword: Charge carriers; Conductivity; $Bi_4Ti_3O_{12}$; Ferroelectric ceramic; Hopping conduction