Bulk and Electrode-Limited Conduction Mechanisms in Different Phases of Mn2+-doped Potassium Tetrachlorozincate Crystal

M. A. Gaffar, A. M. Abousehly, A. Abu El-Fadl and M. M. Mostafa

Abstract:

The current density-electric field intensity relationship of pre-heated potassium tetrachlorozincate (KZC) crystals (undoped and doped with Mn2+ in different concentrations) has been measured along the polar a-axis. The dependence was studied at selected temperatures covering the three high-temperature phases of KZC in order to investigate the type of conduction mechanism dominating in each phase. The original Richardson-Schottky (R-S) equation shows disagreement between calculated and experimental values of the Richardson and optical dielectric constants. The modified R-S equation fits the data well and facilitated the calculation of the barrier height, electronic mobility and high-frequency dielectric constant of KZC. The calculated parameters are in good agreement with the corresponding experimental values. The results indicated that the bulk- and electrode-limited mechanisms contribute to conduction in different phases of KZC. The temperature dependence of the dc conductivity along the polar axis of undoped and Mn2+-doped KZC shows anomalous behaviour in the region of the phase transitions. The dc conductivity and the activation energy of conduction (w) changed significantly due to doping. As indicated by the extremely high w values, superionic conduction is the dominating mechanism in the high-temperature part of the incommensurate (IC) and normal phases of KZC. Suppression of the superionic conduction by Mn2+-doping is observed. The effect of discommensurate pinning by Mn2+ ions and the possibility of dislocation formation on the dc conduction in the IC phase is also discussed.

Keywords:

Transition element compounds ; Ternary compounds ; Zinc chlorides ; Potassium chlorides ; Superionic conductivity ; Activation energy ; Phase transformations ; Temperature effects ; Electrical conductivity ; Barrier height ; Permittivity ; Impurities ; Manganese additions ; Electric field effects ; Ionic conduction ; Doping

Published In: