Influence of donor co-doping by niobium or fluorine on the conductivity of Mn doped and Mg doped PZT ceramics

B. Guiffard, E. Boucher, L. Eyraud, L. Lebrun and D. Guyomar

LGEF, INSA de Lyon, 8 rue de la Physique, 69621 Villeurbanne Cedex, France.

Electronic mail : benoit.guiffard@insa-lyon.fr

Abstract

In this study, AC and DC conductivity measurements were performed under ambient atmosphere on doped lead zirconate titanate (PZT) ceramics in order to investigate the defect chemistry by identifying the predominant charge carriers. The considered compositions were acceptor (1% mol. Mn or Mg) and donor (Nb or F) co-doped PZTs with [Donor] = 1 or 2 % mol.

The influence of donor concentration on the conductivity was determined. From the conduction activation energy values calculated in the temperature range 200°C – 700°C, the principal contributing charge carriers are doubly-ionized oxygen $V_{\ddot{O}}$ and lead vacancies $V_{Pb}^{''}$. For Mg doped PZTs, neither Nb nor F co-doping strongly reduce both conductivity levels and the dominant conducting species $V_{\ddot{O}}$. For Mn doped materials, both donor co-dopants niobium and fluorine reduce the conductivity but do not have the same effect on the conduction mechanism at low temperature. With 2% Nb doping, the dominant conducting species are $V_{\ddot{O}}$ whereas electrical conduction is controlled by electrons from the second-ionization of oxygen vacancies with 2% F doping. The difference of oxygen vacancies content in (Mn, F) and (Mn, Nb) co-doped PZTs may be at the origin of the two distinct conducting species and of the different conductivity levels.