ELECTRICAL CONDUCTION IN γ-IRRADIATED AND UNIRRADIATED PURE AND Mn-DOPED MgAl$_2$O$_4$ SPINEL

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The electrical conductivity of pure and Mn-doped MgAl$_2$O$_4$ spinel has been studied in nitrogen atmosphere as a function of temperature. The conduction process is explained by the motion of cation vacancies in each of γ-irradiated and unirradiated samples. The effect of γ-irradiation on the conductivity and activation energy has been discussed.

INTRODUCTION

Recently, several mixed metal oxides having the general formula XY$_2$O$_4$ have been investigated and found to have interesting structural, electrical, magnetic and catalytic properties. In these types of oxidic spinels, the physical properties were found to be dependent on the nature of the ions involved, their charges and site distribution amongst 8 tetrahedral and 16
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octahedral sites. This cation distribution in the spinels is proved to be an equilibrium function of temperature and pressure as well as other factors concerning the ions such as the ionic charge, ionic radius, anion polarization, etc. Recently, iron-magnesium spinels have been considered for use as electrical conductors and as refractories in open-cycle magnetohydrodynamic electric generators.

The present work was designed to determine the electrical conductivity of pure and Mn-doped MgAl$_2$O$_4$ spinels and the effect of γ-irradiation on this property in order to investigate the type of charge carriers and the nature of lattice defects.

EXPERIMENTAL

Analar grade Al$_2$O$_3$, MgO and MnO were used as starting materials to prepare Mn$_x$Mg$_{1-x}$Al$_2$O$_4$ (0 < x < 0.1) by soaking the appropriate amounts of the previous oxides. The soaked mass was dried at 370 K and then heated under nitrogen at 1200 K for about 150 h. The manganese content in each sample was analyzed, using atomic absorption technique. X-ray analysis confirmed the spinel phase formation in both γ-irradiated and unirradiated samples.

The electrical conductivity of γ-irradiated and unirradiated samples was measured in a nitrogen atmosphere over the temperature range of 700-1100 K. The measurements were performed on pellets (7 mm diameter and thickness 2 mm) using the method already reported.

The spinels were irradiated with γ-radiation doses of 9.6 and 42.1 Mrad using a $^{60}$Co cell.