World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:12, No:01, 2018

# Mg Doped $CuCrO_2$ Thin Oxides Films for Thermoelectric Properties

**Authors :** I. Sinnarasa, Y. Thimont, L. Presmanes, A. Barnabé

**Abstract :** The thermoelectricity is a promising technique to overcome the issues in recovering waste heat to electricity without using moving parts. In fact, the thermoelectric (TE) effect defines as the conversion of a temperature gradient directly into electricity and vice versa. To optimize TE materials, the power factor ($PF = \sigma S^2$ where σ is electrical conductivity and S is Seebeck coefficient) must be increased by adjusting the carrier concentration, and/or the lattice thermal conductivity $K_{th}$ must be reduced by introducing scattering centers with point defects, interfaces, and nanostructuration. The PF does not show the advantages of the thin film because it does not take into account the thermal conductivity. In general, the thermal conductivity of the thin film is lower than the bulk material due to their microstructure and increasing scattering effects with decreasing thickness. Delafossite type oxides $Cu^{I}M^{III}O_2$ received main attention for their optoelectronic properties as a p-type semiconductor they exhibit also interesting thermoelectric (TE) properties due to their high electrical conductivity and their stability in room atmosphere. As there are few proper studies on the TE properties of Mg-doped $CuCrO_2$ thin films, we have investigated, the influence of the annealing temperature on the electrical conductivity and the Seebeck coefficient of Mg-doped $CuCrO_2$ thin films and calculated the PF in the temperature range from 40 °C to 220 °C. For it, we have deposited Mg-doped $CuCrO_2$ thin films on fused silica substrates by RF magnetron sputtering. This study was carried out on 300 nm thin films. The as-deposited Mg doped $CuCrO_2$ thin films have been annealed at different temperatures (from 450 to 650 °C) under primary vacuum. Electrical conductivity and Seebeck coefficient of the thin films have been measured from 40 to 220 °C. The highest electrical conductivity of 0.60 $S.cm^{-1}$ with a Seebeck coefficient of +329 $\mu V.K^{-1}$ at 40 °C have been obtained for the sample annealed at 550 °C. The calculated power factor of optimized $CuCrO_2$:Mg thin film was 6 $\mu W.m^{-1}K^{-2}$ at 40 °C. Due to the constant Seebeck coefficient and the increasing electrical conductivity with temperature it reached 38 $\mu W.m^{-1}K^{-2}$ at 220 °C that was a quite good result for an oxide thin film. Moreover, the degenerate behavior and the hopping mechanism of $CuCrO_2$:Mg thin film were elucidated. Their high and constant Seebeck coefficient in temperature and their stability in room atmosphere could be a great advantage for an application of this material in a high accuracy temperature measurement devices.

**Keywords :** thermoelectric, oxides, delafossite, thin film, power factor, degenerated semiconductor, hopping mode
**Conference Title :** ICNEMPT 2018 : International Conference on New Energy Materials and Processing Technologies
**Conference Location :** Paris, France
**Conference Dates :** January 25-26, 2018