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Magnetic, structural and morphological characterization of Sr_2GdRuO_6 perovskite

L. T. Corredor [(1)*], D.A. Landínez Téllez [(1)], J.L. Pimentel Jr.[(2)], P. Pureur [(2)] and J. Roa-Rojas [(1)]

(1) Grupo de Física de Nuevos Materiales, Departamento de Física, Universidad Nacional de Colombia, AA 14490, Bogotá D.C., Colombia, e-mail: ltcorredorb@bt.unal.edu.co
(2) Instituto de Física, Universidade Federal do Rio Grande do Sul, P.O. Box 15051, 91501-970 Porto Alegre, RS, Brasil
* Corresponding author.

Abstract – In this paper, we analyze the structural and morphologic properties for Sr_2GdRuO_6 compound, by using X-ray diffraction, X ray energy dispersive analysis (EDX) and scanning electron microscopy. The structure is a double perovskite in the monoclinic system with spatial group $P2_1/n$. The lattice parameters were found as a=5.8019(2) Å, b=5.8296(2) Å, c=8.2223(3) Å, $\alpha=\gamma=90.000°$ and $\beta=90.258°$. The sample presents a homogeneous morphology and mean grain size of 4μm.

The ruthenocuprate compound $RuSr_2GdCu_2O_8$, was synthesized for the first time in 1995 [1]. It belongs to the $RuSr_2RCu_2O_8$ (Ru-1212R) family, with R = rare earth. The main characteristic of these compounds is the presence of magnetic and superconductor properties in a simultaneous way, with magnetic transition temperature higher than the superconductor one, which make them unique respect to the other magnetic superconductors. Initially, ruthenocuprates were obtained by the solid state reaction with CuO and Sr_2RRuO_6 as precursor oxides. The superconductor properties are determined by the Cu-O bond in the conduction planes (CuO_2) [2], with T_c values between 15-50 K [2]. Magnetic properties are associated with Ru-O bonds (RuO_2), even when at present there is no consensus about the magnetic ordering between Ru atoms. Muon Spin Rotation measurements (μSR) point a ferromagnetic ordering normal to c axis [4], while neutron diffraction indicates an antiferromagnetic one [5]. The main obstacle to define the nature of the superconductor-magnetic mechanisms in this kind of materials is the lack of high purity samples. In order to enhance the synthesis method of $RuSr_2GdCu_2O_8$, the aim of this work is to provide a faster and high quality production process of Sr_2GdRuO_6 as precursor.

The synthesis was carried out by the solid state reaction method, with stoichiometric quantities of $SrCO_3$ (99 %), RuO_2 (99.9 %) and Gd_2O_3 (99.9 %). Calcination and sinterization steps at temperatures between 930°C – 1230°C improved the single-phase character of the sample, when compared with other production methods. Morphological characterization by scanning electron microscopy revealed a mean grain size of 4μm. This value enhances the diffusion process in the ruthenocuprates, because in a sample with low grain size, the number of grains per volume increments, and as a consequence the intergranular contact area. Magnetization measurements allowed to establish the antiferromagnetic character of the material, with Néel temperature $T_N \approx 8K$ and magnetic moment $\mu_{eff} = 7\mu_B$. The experimental results indicate that Sr_2GdRuO_6 is not an ideal antiferromagnet, which together with the other results are discussed and analyzed.

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