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Structural magnetic characterization of $Ca_{2-x}Sr_xRu_{0.99}Sn_{0.01}O_4$ compounds

Ada López[(1)*], J. L. Gonzalez[(2)], I. Souza Azevedo[(3)], A. M. Gomes[(4)], H. A. Borges[(2)] and E. Baggio-Saitovitch[(3)]

(1) UERJ, IF, Rua São Francisco Xavier 524, Rio de Janeiro, Brazil, adalopez@cbpf.br.
(2) PUC-Rio, IF, Rua Marquês de São Vicente, 225, Rio de Janeiro, Brazil.
(3) CBPF, Rua Xavier Sigaud, 150, Rio de Janeiro, Brazil.
(4) UFRJ, IF, Av. Athos da Silveira Ramos s/n, Rio de Janeiro, Brazil.
*Corresponding author.

Abstract – Polycrystalline samples of $Ca_{2-x}Sr_xRu_{0.99}Sn_{0.01}O_4$ (x = 0.0, 0.09, 0.2, 0.3, 0.5, 1.0 and 2.0) have been prepared by the solid-state reaction and characterized by x-ray diffraction. ^{119}Sn-Mössbauer spectra were done at 300K and 4.2K. We report on the magnetic structure of the Ru-ions sub-lattice as a canted one. ^{119}Sn-Mössbauer results show transferred hyperfine fields (B_{hf}) to Sn (fig. 1). B_{hf} is inclined to the *c*-axis of the structure; the angle increases for higher Sr-concentrations (fig. 2). The results agree with the magnetic measurements which show an anomalous peak in the magnetic susceptibility at low temperatures for the $Ca_{1.5}Sr_{0.5}RuO_4$ compound.

The phase diagram of $Ca_{2-x}Sr_xRuO_4$ exhibits a rich variety of physical phenomena, showing antiferromagnetic Mott-insulator (Ca_2RuO_4) behavior in the x = 0 extreme and unconventional superconductivity (Sr_2RuO_4) at x = 1.0 [1]. The modifications of the ionic radius on the Ca/Sr-site along the series produce several structural transitions. The coupling between structural and magnetic transitions has been claimed to be the factor responsible for the exotic phase diagram of this system. Previous studies performed in this compound allowed to reveal the magnetic structure for low strontium concentrations [2]. In this work we have extended those studies to include high strontium concentrations, in particular, the important concentrations of x = 0.3, 0.5 and 1.0.

Polycrystalline samples of $Ca_{2-x}Sr_xRu_{0.99}Sn_{0.01}O_4$ (x = 0.0, 0.09, 0.2, 0.3, 0.5, 1.0 and 2.0), doped with ^{119}Sn for Ru (1 %) were prepared by the solid-state reaction method. The samples were characterized by x-ray diffraction (XRD) in a X'Pert PRO (PANalytical) powder diffractometer in order to probe the modification of the lattice parameters for the different strontium concentrations. The ^{119}Sn-Mössbauer spectra were done at 300 K and 4.2 K in transmission geometry, using a conventional spectrometer in constant acceleration mode and with a $BaSnO_3$ source.

Our studies identified that the magnetic structure of the Ru-ions sub-lattice corresponds to a canted one; it was observed an angular evolution of transferred hyperfine fields (B_{hf}) to Sn-sites, which are related to the x-values. In figure 1 we can follow that, particularly for x = 0.5 concentration. B_{hf} is inclined with respect to the *c*-axis of the structure, and the inclination angle (theta) increases up to almost a constant value for high Sr-concentrations (fig. 2). Our results are in accord with magnetic measurements, which have shown an anomalous peak in the magnetic susceptibility at low temperatures for the $Ca_{1.5}Sr_{0.5}RuO_4$ compound [3]. Finally, our results were compared to the structural transitions occurring along the $Ca_{2-x}Sr_xRuO_4$ series.

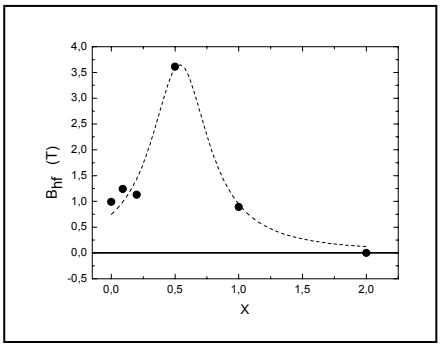

Figure 1: B_{hf} for different Sr-concentrations. Note the peak at x = 0.5. The dash line is a guide.

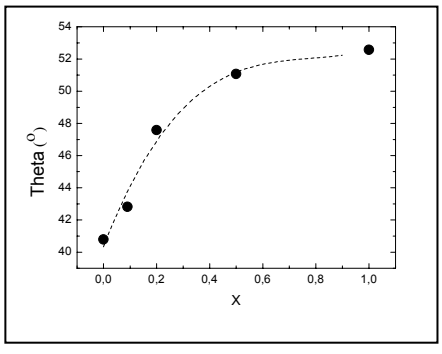

Figure 2: Theta as a function of the Sr-concentrations. The dash line is a guide.

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