Magnetic properties of $Sr_2Fe_{1-x}Ni_xMoO_6$ perovskites

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ABSTRACT

The magnetic properties of $Sr_2Fe_{1-x}Ni_xMoO_6$ perovskites, with $x \leq 0.2$, in a large temperature range, are reported. The saturation magnetizations decrease, while the Curie temperatures increase, as the nickel content is higher. These trends are correlated with the distribution of magnetic ions in B and B' sites. The reciprocal susceptibilities follow non linear temperature dependences. The magnetic properties are analysed assuming a two sublattices model, in the mean field approximation.

1 Introduction

The crystal structure and magnetic properties of Sr_2FeMoO_6 double perovskite were reported near 60 years ago [1]. Relatively recent studies, showed that this material is half-metallic, having large low field magnetoresistance [2]. Taking into account their Curie point, $T_c \approx 400$ °C, above room temperature, this perovskite was shown to be suitable for spin electronics applications and magnetoresistance based devices.

The ideal structure of Sr_2FeMoO_6 perovskite can be viewed as a regular arrangement of corner-sharing FeO_6 and MoO_6 octahedra, alternating along the three directions of the crystal. Although the structure falls within the cubic Fm3m space group, the crystal lattice of Sr_2FeMoO_6 is distorted. Since of large size of Sr^{2+} ions, occupying the voids in between the octahedra, these undergo cooperative tilting distortions, towards the most energetically favourable structure, which causes reduction of the cube cell to the tetragonal I4/m lattice.

The Fe and Mo atoms, in the ideal structure of Sr_2FeMoO_6 occupy the B and B' sites, respectively, favouring a NaCl type ordered structure. In this ideal atomic arrangement, the perovskite is ferrimagnetically ordered. The array of parallel Fe^{3+} magnetic moments are antiparallelly coupled with the Mo^{5+} spins; the resulting moment per formula unit is expected to be $4\mu_B$ [3]. The experimentally determined magnetic moments, smaller than the above-mentioned value, are due to: (1) antisite B cation disorder, when some Mo^{5+} cations occupy the position of the Fe^{3+} cations and vice versa; (2) a fraction of iron has Fe^{2+} valence state, with concomitant presence of Mo^{6+} ions; (3) the Mo^{5+} magnetic moment, at $T = 4$ K, is smaller than the expected value of 1 μ_B.

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