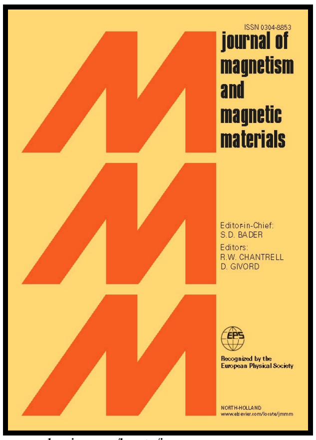

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THERMAL EVOLUTION OF EXCHANGE INTERACTIONS IN LIGHTLY DOPED BARIUM HEXAFERRITES

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The lightly doped $BaFe_{12-x}D_xO_{19}$ (D = Al^{3+}, In^{3+}; x = 0.1 and 0.3) polycrystalline hexaferrite samples have been investigated by powder neutron diffractometry as well as by vibration sample magnetometry in a wide temperature range from 4 K up to 740 K and in magnetic field up to 14 T to establish the nature of Fe^{3+}(Al^{3+}, In^{3+}) – O^{2-} - Fe^{3+}(Al^{3+}, In^{3+}) indirect exchange interactions. The crystal structure features such as the ionic coordinates and lattice parameters have been defined and Rietveld refined. The Invar effect has been observed in low temperature range below 150 K. It was explained by the thermal oscillation anharmonicity of ions. It is established that the ferrimagnet-paramagnet phase transition is a standard second-order one. From the macroscopic magnetization measurement the Curie temperature and ordered magnetic moment per nominal iron ion are obtained. From the microscopic diffraction measurement the magnetic moments at all the nonequivalent ionic positions and total magnetic moment per iron ion have been obtained at different temperatures down to 4 K. The light diamagnetic doping mechanism and magnetic structure model are proposed. The effect of light diamagnetic doping on nature of Fe^{3+}(Al^{3+}, In^{3+}) – O^{2-} - Fe^{3+}(Al^{3+}, In^{3+}) indirect exchange interactions with temperature increase is discussed.

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Keywords: barium hexaferrites, neutron diffraction, vibration magnetometry, crystal and magnetic structures.

1. Introduction

There is a great interest to the M-type hexagonal ferrites and their functional properties [1-4]. Interest in the study of hexaferrites is basically focused on the solid solutions with different substituting cations (Co, Sc, Ti, Nb, Cr etc.) [5-7]. However, when some of the Fe^{3+} ions are replaced by diamagnetic ions, a selective distribution of the latter may produce nonmagnetic layers and the non-collinear magnetic structure may be obtained [8] that significantly influences their properties. Recently the hexaferrites received in addition to all the remarkable properties a new birth as multiferroics [9] - the materials that exhibit a significant correlation of magnetic and