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Magnetic Structure and Transitions in 45% Mn Substituted $HoFeO_3$: A Neutron Diffraction Study

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Abstract : Rare earth orthoferrites ($RFeO_3$) exhibit interesting and useful magnetic properties like multiferroicity, magnetodielectric coupling, spin reorientation (SR) and exchange bias. B site doped $RFeO_3$ are attracting attention due to the complex and tuneable magnetic transitions. In this work, 45% Mn-doped $HoFeO_3$ polycrystalline sample ($HoFe_{0.55}Mn_{0.45}O_3$) was synthesized by a solid-state reaction method. The magnetic structure and transitions were studied by magnetization measurements and neutron powder diffraction methods. The neutron diffraction patterns were taken at 13 different temperatures from 7°K to 300°K (7°K and 25°K to 300°K in 25°K intervals). The Rietveld refinement was carried out by using a FULLPROF suite. The magnetic space groups and the irreducible representations were obtained by SARAh module. The room temperature neutron diffraction refinement results indicate that the sample crystallizes in an orthorhombic perovskite structure with Pnma space group with lattice parameters a = 5.6626(3) Å, b = 7.5241(3) Å and c = 5.2704(2) Å. The temperature dependent magnetization (M-T) studies indicate the presence of two magnetic transitions in the system (TN Fe/Mn~330°K and TSR Fe/Mn ~290°K). The inverse susceptibility vs. temperature curve shows a linear behavior above 330°K. The Curie-Weiss fit in this region gives negative Curie constant (-34.9°K) indicating the antiferromagnetic nature of the transition. The neutron diffraction refinement results indicate the presence of mixed magnetic phases $\Gamma_4(A_xF_yG$

Keywords : neutron powder diffraction, rare earth orthoferrites, Rietveld analysis, spin reorientation
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