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An investigation of magnetic structure and spin reorientation in Cr and Mn doped rare earth ferrites using neutron powder diffraction

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Rare earth orthoferrite RFeO_3 is a family of perovskite with fantastic property, such as ultra-fast spin switching[1], photomagnetic excitation[2] and multiferrocity[3]. These properties usually determined by their magnetic structure and unique spin reorientation (SR) effect. The antisymmetric interaction (DM interaction)[4] induce a weak ferromagnetism at room temperature, while the large anisotropic interaction of R^{3+} ion induce a rotation of Fe^{3+} spin in the ac or ab plane, viz. spin reorientation. Usually there are 3 types magnetic structure for orthoferrite, in terms of Bertaut's notation[5], $\Gamma_4(G_x A_y F_z)$, $\Gamma_2(F_x C_y G_z)$ and $\Gamma_1(A_x G_y C_z)$. For most of magnetic R^{3+} , there is $\Gamma_4(G_x A_y F_z) \rightarrow \Gamma_2(F_x C_y G_z)$ transition except $\text{R}^{3+} = \text{Dy}^{3+}$ upon cooling[6], which show a $\Gamma_4 \rightarrow \Gamma_1$. We investigated the magnetic structure and SR transition of Cr doped HoFeO_3 and Mn-doped TbFeO_3 using neutron powder diffraction. We found Cr substitution for Fe leads to an increasing SR transition temperature of $\Gamma_4 \rightarrow \Gamma_2$ dramatically. On the other side, the Mn substitution of Fe in TbFeO_3 vanishes the $\Gamma_4 \rightarrow \Gamma_2$ transition while induces a novel $\Gamma_4 \rightarrow \Gamma_1 \rightarrow \Gamma_4$ transition. This is unusual because it is usually think it is the the anisotropic rare earth ion determines the SR property. Our observation demonstrate a delicate balance of magnetic interaction in system. This will provide us new interesting physics and potential functional materials.

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