The structure and magnetism of single crystal $DyFe_{1-x}Mn_xO_3$

B. Strange[a], J. Whalen[b], T. Siegrist[b], H. D, Zhou[b]

(a) Department of Physics, Florida State University (b) National High Magnetic Field Lab, Florida State University

Introduction

Perovskites $DyFeO_3$ and $DyMnO_3$ are both multiferroics. In $DyFeO_3$ the spin reorientation transition of Fe^{3+} spins is at 56 K. In $DyMnO_3$ the magnetic transition of Mn^{3+} spins is 39 K. Whether there is solid solution of $DyFe_{1-x}Mn_xO_3$, and how the structural and magnetic properties behave with Mn doping should be interesting to study.

Experimental

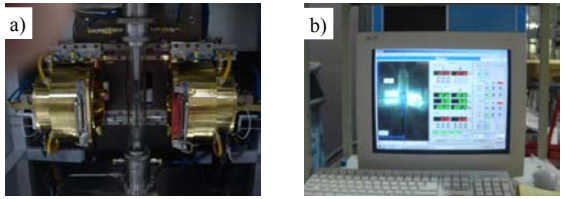

Fig. 1 a) The chamber with two mirrors for an image furnace. (b) The floating zone during a crystal growth.

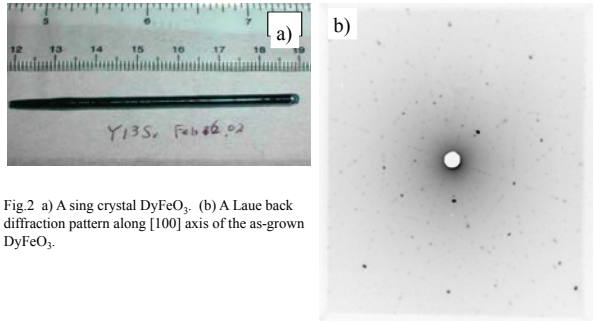

Fig.2 a) A sing crystal $DyFeO_3$. (b) A Laue back diffraction pattern along [100] axis of the as-grown $DyFeO_3$.

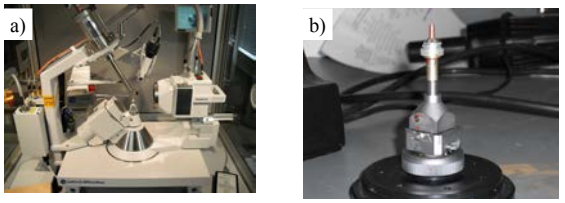

Fig.3 a) A single crystal XRD machine. (b) The sample holder for XRD measurement

- Single crystals of $DyFe_{1-x}Mn_xO_3$ were grown by the traveling-solvent floating-zone (TSFZ) technique.
- Single crystal X-ray diffraction data were collected on an Oxford Diffraction Xcalibur2 single crystal X-ray diffractometer with Mo Kα source.
- Susceptibility was measured using a DC superconducting interference device magnetometer (SUID) with applied magnetic field (H = 1000 Gs) along the *a*-axis.

Results and Discussions

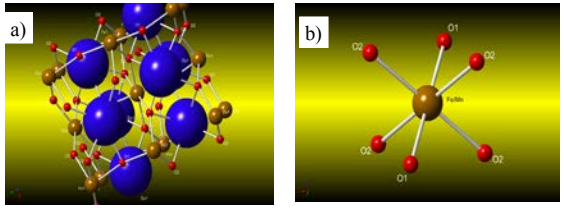

Fig.4 a) The crystal structure of $DyFeO_3$. (b) An octahedral site of $Fe(Mn)O_6$.

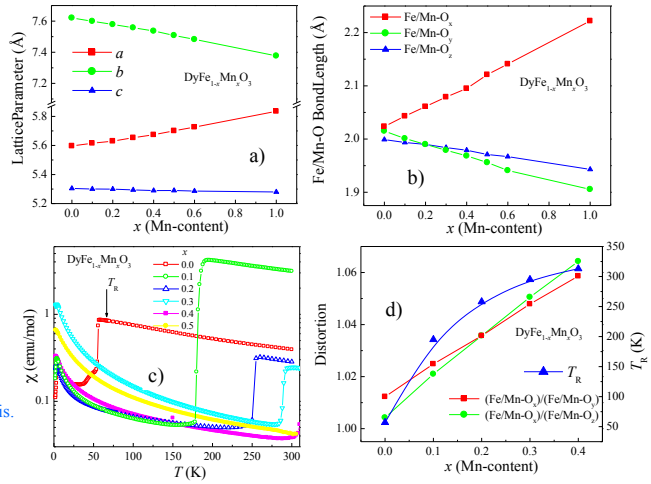

Fig. 5 The lattice parameters (a) Fe/Mn-O bond length (b) magnetic susceptibility (c), and distortion and T_R (d) for $DyFe_{1-x}Mn_xO_3$.

- Single crystal $DyFe_{1-x}Mn_xO_3$ are successfully grown. The single crystal XRD shows pure Pnma phase for all the samples.
- With increasing *x*, (i) *a* increases while *b* and *c* decrease; (ii) on the octahedral site, $Fe/Mn\text{-}O_X$ increases, and $Fe/Mn\text{-}O_Y$, $Fe/Mn\text{-}O_Z$ decrease. (iii) T_R increases but it disappears with $x \geq 0.5$.
- The dopng of Mn increases the distortion of the octahedron along the *a* direction, which enhances the Fe-O-Fe superexchange which leads to high T_R with $x \leq 0.4$.
- With high doping Mn ($x \geq 0.5$), the Fe-O-Fe interaction is destroyed, so T_R disappears and the Mn-O-Mn interaction begins to dominate the magnetic properties.

Acknowledgement

This work was supported by NSF Division of Materials Research through DMR-0654118 and the State of Florida.