BICMM
MAGNETIC MATERIALS. NEW TECHNOLOGIES
RUSSIA, BAIKALSK
11-14 SEPTEMBER
2023

NEUTRON DIFFRACTION STUDIES OF $La_{1-X}Y_XMn_2Si_2$ COMPOUND: EVIDENCE OF DOMINANT ANTIFERROMAGNETIC COMPONENTS WITHIN THE Mn PLANES

Alsafi H.M.[1,2*], Gerasimov E. G.[1,2], Mushnikov N.V.[1,2], Terentev P. B.[2], and Pirogov[1,2]

[1] Institute of Natural Sciences and Mathematics, Ural Federal University, 620002 Ekaterinburg, Russia

[2] Institute of Metal Physics of UB RAS, S. Kovalevskaya str, 18 Ekaterinburg, Russia

INTRODUCTION

Intermetallic compounds with general formula RM_2X_2, where R is the rare earth metal; M is the transition 3d-, 4d-, or 5d-metal; X is Si or Ge, crystallize in the body-centered tetragonal $ThCr_2Si_2$-type structure. The structure consists of the single atomic layers of different elements, stacked along the crystallographic c-axis in the sequence -M-X-R-X-M-. The natural layered structure is considered to be responsible for very exciting variety of physical properties ranging from super conductivity to heavy-fermion behavior [1].

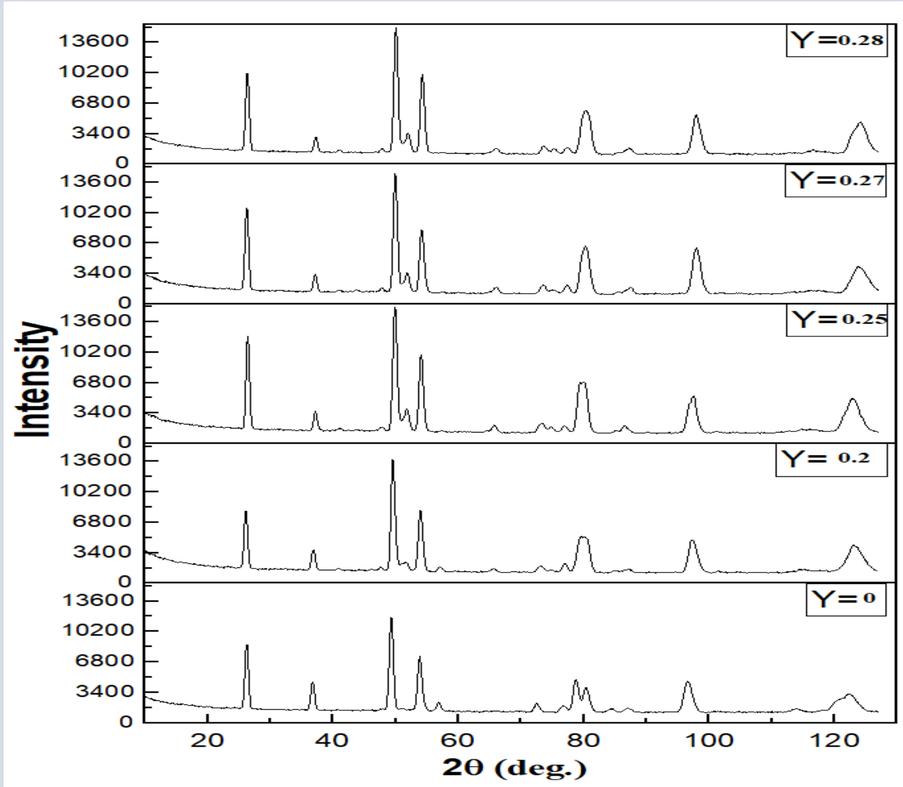
The compounds RM_2X_2 for M=Mn attract the greatest attention since they demonstrate a wide variety of magnetic structures and magnetic phase transitions. One of the reasons of the transitions is due to a strong dependence of the type of interlayer Mn-Mn ordering on the lattice parameters and on the in-plane Mn–Mn distance $d_{Mn–Mn}$. The effects of interatomic distances, an important role information of magnetic structures in RMn_2X_2 compounds belongs to a competition between the interlayer Mn–Mn, R-Mn, and R–R exchange interactions and magnetic anisotropy.

SAMPLES AND EXPERIMENTAL DETAILS

The alloys $La_{1-x}Y_xMn_2Si_2$ with the concentration $0 \leqslant x \leqslant 1$ were prepared by induction melting of the constituents in an argon atmosphere followed. According to the powder X-ray diffraction alloys are single-phase with the tetragonal ThCr2Si2-type structure. For the magnetization studies, the samples are quasi-single-crystal. The magnetization measurements of quasi-single-crystal samples were performed in the Center of Collective Use of IMP UB RAS with Quantum Design MPMS5-XL SQUID magnetometer in magnetic fields up to 50 kOe at 4.2K temperature. Neutron powder diffraction studies have been carried out the D-3 diffractometer with the neutron wavelength λ = 2.423200 A at a horizontal channel of the IVV-2M reactor (Zarechny, Russia). The data were analyzed with the Rietveld-type refinement FullProf program.

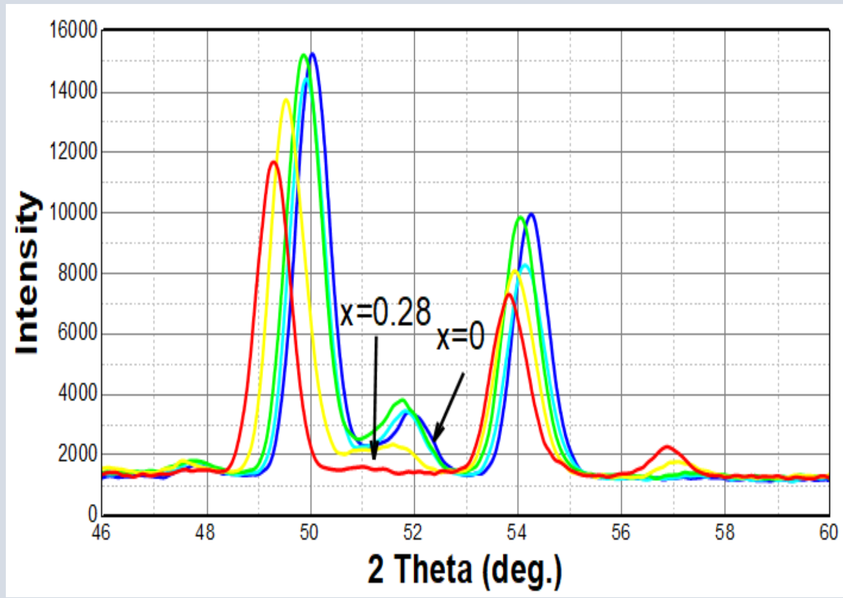
RESULTS AND DISCUSSION

Based on the magnetic phase diagram of the $La_{1-x}Y_xMn_2Si_2$ system obtained from magnetization measurements, we selected for neutron diffraction studies compositions with the Y content x = 0, 0.2, 0.25, 0.27, and 0.28.

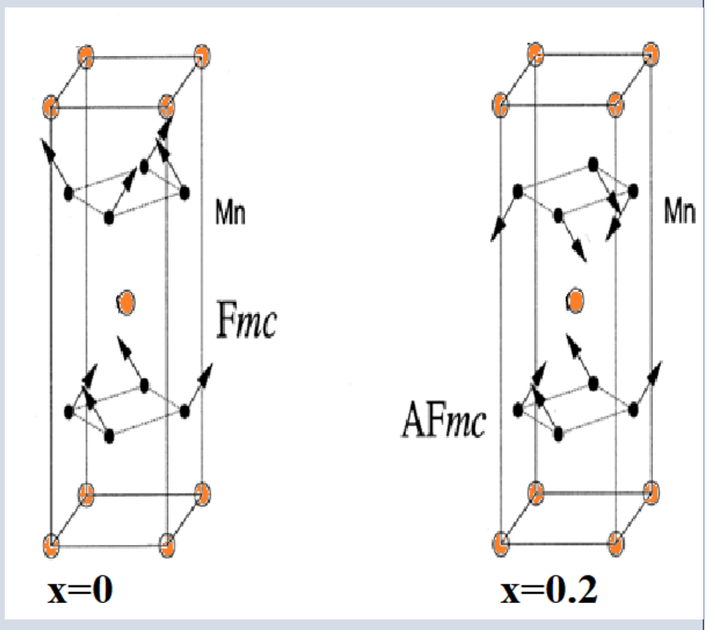


Neutron diffraction patterns of all the selected samples collected at 4.2K are given in Fig. 1. The diffraction patterns contain the magnetic reflections originated only the Mn moments contribute to the magnetic neutron scattering.

Fig. 2 illustrated, the temperature dependence of the magnetic contribution for typical peak. It is found the relative magnetic contribution to the intensity of (001) peak at different concentrations.



Magnetization studies suggest that ferromagnetic ordering occurs for $x < 0.2$ and antiferromagnetic ordering sets in for $x \geqslant 0.2$.



The in-plane ferromagnetic component couples FM with those of adjacent planes for x=0.2 and AFM for x=0.2. The $La_{1-x}Y_xMn_2Si_2$ compound displays a F–AF transition as a function of the temperature.

CONCLUSION

- The structural and magnetic properties of the system $La_{1-x}Y_xMn_2Si_2$ ($0 \leqslant x \leqslant 1$) were investigated.
- Magnetization studies suggest that F. ordering occurs for $x < 0.2$ and AF ordering sets in for $x \geqslant 0.2$. The nature of the magnetic ordering in these compounds depends on the Mn-Mn distance.

REFERENCES

1. Gerasimov, E. G., et al. "Magnetic structure of La1-xTbxMn2Si2 compounds." *Journal of Alloys and Compounds* 731 (2018): 397-402.

2. Gerasimov, E. G., et al. "Competing exchange interactions and magnetic anisotropy of La1− xTbxMn2Si2." *Journal of Magnetism and Magnetic Materials* 422 (2017): 237-242.

ACKNOWLEDGEMENTS

This work was supported by..