Effect of Co Doping on $Sr_2F_2(Fe_{1-x}Co_x)_2OS_2$

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Transition metal oxychalcogenide compounds with layered checkerboard lattices, such as $La_2O_3T_2OX_2$ and $A_2F_2T_2OX_2$ (T = Mn, Fe, Co; X = S, Se; A = Sr, Ba), have recently attracted attention due to their unique crystal and magnetic structures, as well as correlation-induced Mott insulating behaviors. To examine the possibility of tuning this Mott insulating system into a metallic, or even superconducting regime, we studied the effects of Co doping on $Sr_2F_2Fe_2OS_2$ with using dopant content up to 40%. Annealing temperature at 1223K is not suitable than 1173K because X-Ray diffraction shows most 22122 phase decomposed. Measurement of resistivity shows linear figure at ρ-T curve. It means that this material has possible to characteristic of semiconductor. The results of magnetization and heat capacity measurements are presented.

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Introduction

What do we do?

- Examine the transition metal oxychalcogenide compounds with layered checkerboard lattice, such as $La_2O_3T_2OX_2$ and $A_2F_2T_2OX_2$ (T=Mn, Fe, Co; X=S, Se; A=Sr, Ba) by means of doping

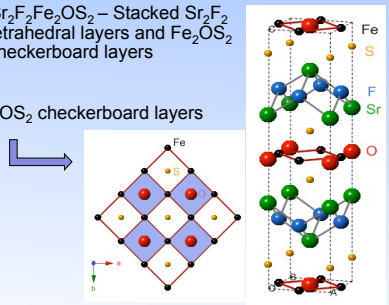
Motivation

- To examine the possibility of tuning this *Mott insulating system towards a metallic, or even superconducting regime and studied effect of Co doping on $Sr_2F_2(Fe_{1-x}Co_x)_2OS_2$ (x=0.1, 0.2 and 0.3)

*Mott insulators are a class of materials that should conduct electricity under conventional band theories, but are insulators when measured

Crystal Structure

- $Sr_2F_2Fe_2OS_2$ – Stacked Sr_2F_2 tetrahedral layers and Fe_2OS_2 checkerboard layers
- Fe_2OS_2 checkerboard layers

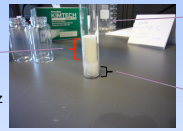


Experimental Procedure

1: Preparation

Mixed and grinding up the starting materials | Pellet pressing | Finished

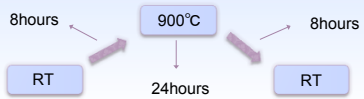
2: Sealed in evacuated quartz tube



- To prevent the reactants from attacking the quartz ampoule
- To prevent excessive heat transport

3: Annealing

- Annealing at 800, 900, and 950℃



4: Measurement

- Perform X-Ray Diffraction (XRD) measurements to check the purity of samples
- Measure physical and magnetic properties in
  - -Physical Property Measurement System (PPMS)
  - -Magnetic Property Measurement System (MPMS)

Results

Structural Properties

Powder XRD measurement

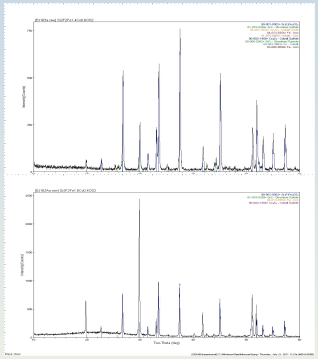


Fig.1-1 XRD result of x=0.1 annealing at 800℃

Fig.1-2 XRD result of x=0.1 annealing at 900℃

- Annealing at 900℃ results in less amount of impurity than annealing at 800℃
- Most part of the $Sr_2F_2(Fe_{1-x}Co_x)_2OS_2$ phase decomposed at 950℃
- Results for x=0.2 and 0.3 showed the same trends

Physical Properties

Resistivity

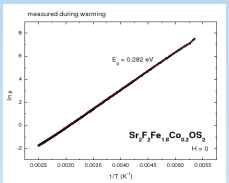


Fig.2-1 x=0.1

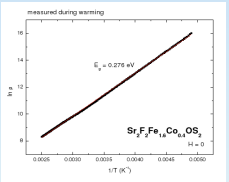


Fig.2-2 x=0.2

- Results for x=0.1 and 0.2 showed that changing E_g value
- x=0.3 are same trend

Magnetization

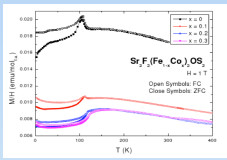


Fig.3

- The irreversibility between the ZFC and FC data becomes smaller as x increases

Specific heat

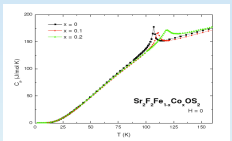


Fig.4

- The peak in heat capacity moves to higher temperatures as x increases, consistent with the magnetization data

M-H curve

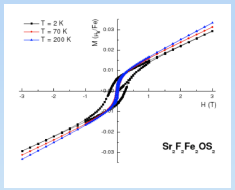


Fig.5-1 x=0

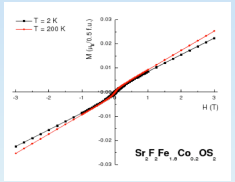


Fig.5-2 x=0.1

- Hysteresis loop area is decrease due to doping Co
- x=0.2 and 0.3 are same trend

Conclusions

- These samples have a semiconductor feature due to E_g value
- Magnetization and M-H curve shows that Co doping samples has a antiferromagnetic ordering

Future Work

- Increase the Co content and examine the evolution of T_N and E_g at higher x
- Optimize the synthesis and try to grow single crystals

Acknowledgments

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