MAGNETIC AND ELECTRICAL PROPERTIES OF $Ca_2Fe_{1-x}Ni_xMoO_6$ DOUBLE PEROVSKITES

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To obtain information of magnetic and electrical properties of $Ca_2Fe_{1-x}Ni_xMoO_6$ double perovskites, were studied by X-rays, magnetic measurements and resistivities.

INTRODUCTION

- $A_2B'B''O_6$, where A is an alkaline-earth, the transition-metal sites are occupied randomly by cations B' and B"
- Ca_2FeMoO_6 is ferromagnetic compound with magnetic transition temperature $T_C \approx 377$ K [1]
- The nickel will change the physical properties of the $Ca_2FeMoO6$

EXPERIMENTAL

- $Ca_2Fe_{1-x}Ni_xMoO6$ with $x \le 0.2$ ⇒ prepared by solid state reaction. The samples were sintered at 1250°C in a stream of 3% of H_2/Ar during 4 hours.
- X-ray diffraction analyses ⇒ all the samples shows only one phase (Bruker D8 Advance AXS diffractometer with Cu Kα radiation)
- Magnetic measurements ⇒ in magnetic fields $\mu_0 H \le 12*10^4$ Oe and $4.2 \le T \le 500$ K (Oxford Instruments)
- Resistivity measurements ⇒ with conventional four probe method, in $4\ K \le T \le 290$ K and magnetic fields $\mu_0 H \le 7*10^4$ Oe (Oxford Cryogenic Limited System)

RESULTS AND DISCUSSION

- XRD ⇒ the samples crystallize in a monoclinic lattice of $P2_1/n$ type [1,2]. All lattice parameters increase when the when Ni content is higher. The above behavior can be correlated with a greater radius of Ni^{2+}(0.83 Å) ion, as compared to those of Fe^{2+} (0.75 Å) or Fe^{3+} (0.69 Å) ones.

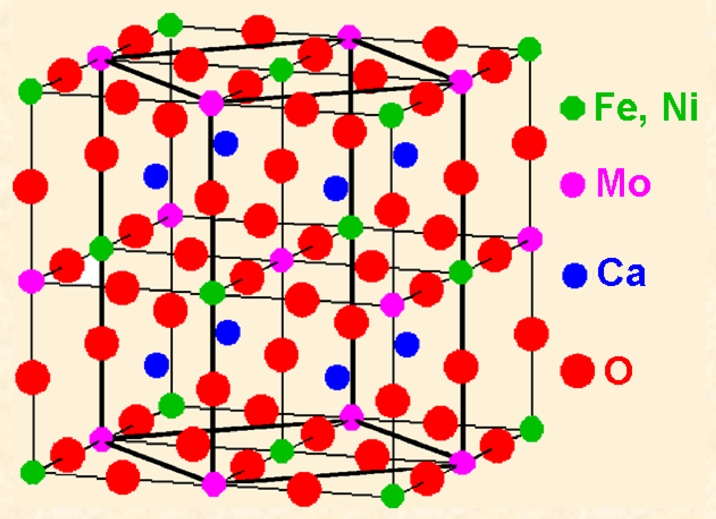

Fig. 1. Monoclinic lattice ($P2_1/n$) of $Ca_2Fe_{1-x}Ni_xMoO_6$

Table 1.	a (Å)	b (Å)	c (Å)	β (°)	Cry Size (nm)	V (Å³)
Ca_2FeMoO_6	5.4139	5.5223	7.7058	90.034	235.2	230.379
$Ca_2Fe_{0.9}Ni_{0.1}MoO_6$	5.4158	5.5298	7.7125	89.955	250.3	231.209
$Ca_2Fe_{0.8}Ni_{0.2}MoO_6$	5.4254	5.5486	7.7211	90.157	240.2	232.428

- Magnetic measurements ⇒ at 4.2 K the magnetizations decrease when the nickel content increases. The above behavior can be correlated with the change of the proportion of iron valence state, from Fe^{3+} to Fe^{2+}. Spin-glass behavior was observed at low temperatures (Fig. 3).

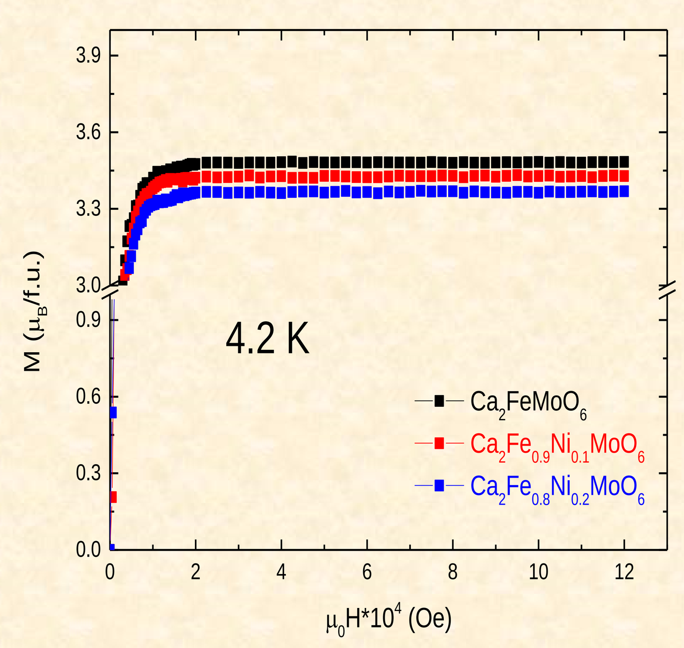

Fig. 2. Magnetization isotherms at 4.2 K.

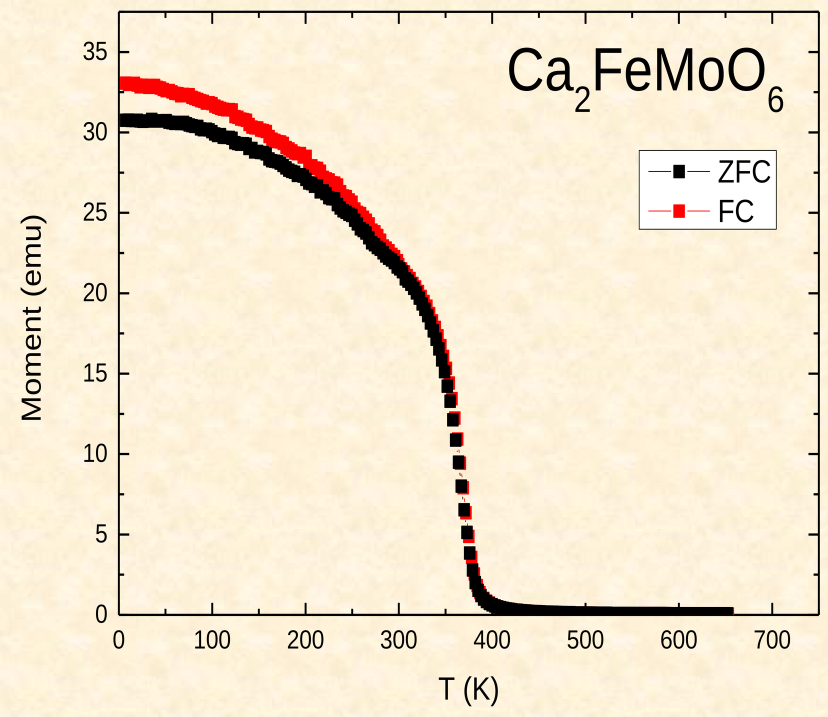

Fig. 3. The ZFC and FC magnetizations for Ca_2FeMoO_6 in field of 500 Oe.

- Resistivity measurements (1) ⇒ The magnetoresistivities of $Ca_2Fe_{1-x}Ni_xMoO_6$ (Fig. 4.). The experimental data were analyzed by considering the contributions of the intergrain tunneling magnetoresistence (ITMR) between grains and intra-grain magnetoresistence.

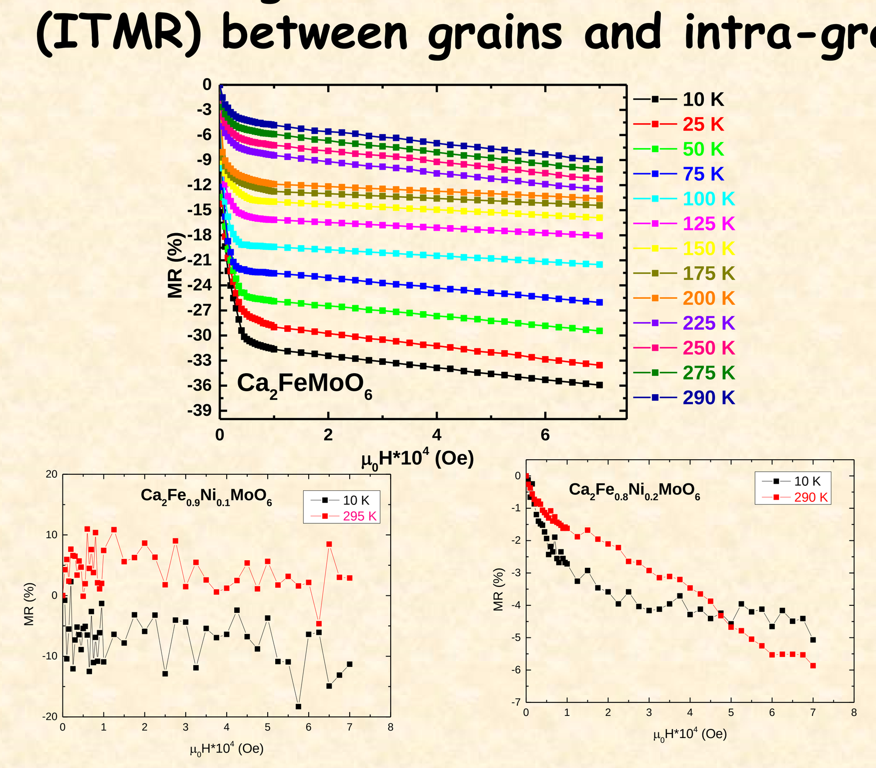

Fig. 4.Temperature and field dependences of magnetoresistence

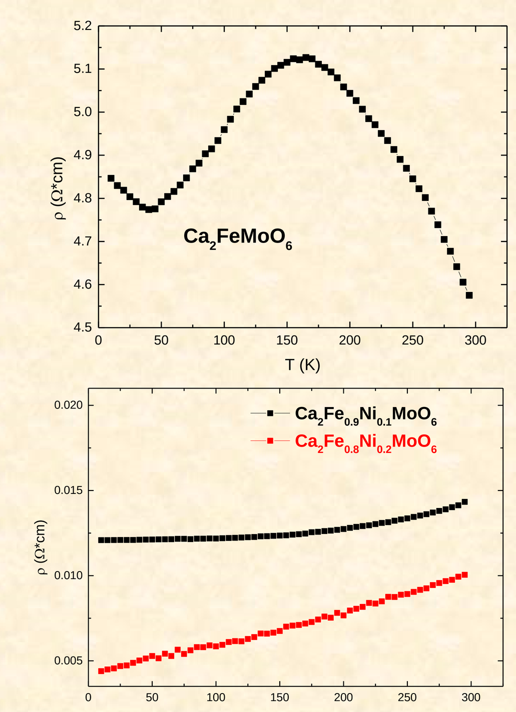

Fig. 5. the temperature dependences of resistivity in 0 T field

- Resistivity measurements (2) ⇒ Network of tunnel junctions,whose electrodes are ideal perovskite grains and an insulating oxid layer separating each one

$$\Delta\rho/\rho_0 = -P^2 m_g(H)^2[1+P^2 m_g(H)^2]^{-1} - bH$$

where $m_g(H)$ is the magnetization from the disordered region over the grain boundaries, P the polarization and respectivelly the –bH the intra-grain contribution to magnetorezistence [2]. Assuming a spin glass model, with weak anisotropy field, the $m_g(H)$ behaviour can been described by the relation: $m_g(H)=(1-aH^{-1/2})$[2].

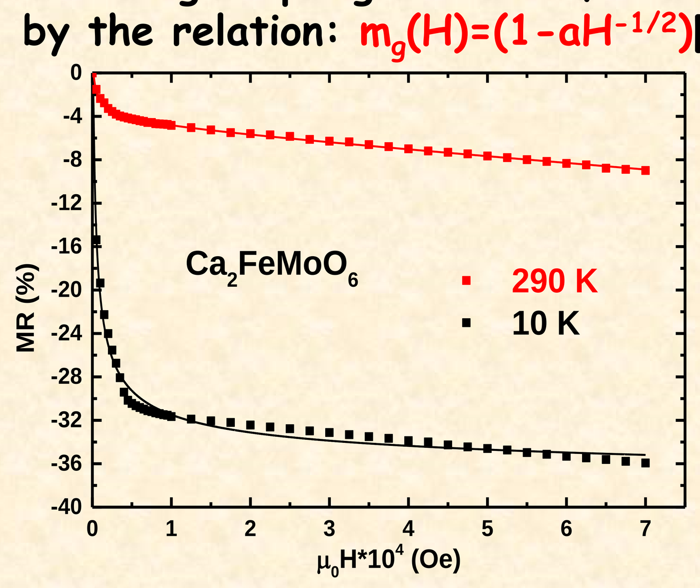

Fig. 6. The field dependences of the magnetoresistivities at 10 and 290 K. By solid lines are plotted the prediction of the above relation with parameter P, b and a given in Fig. 7.

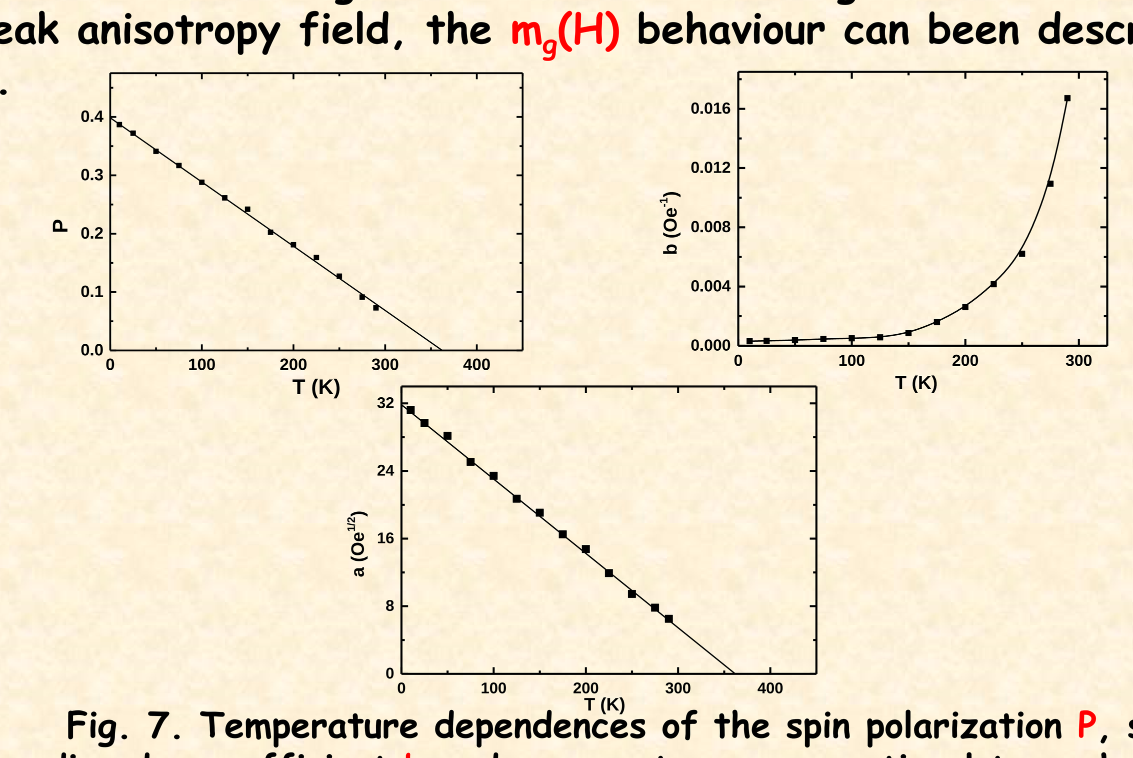

Fig. 7. Temperature dependences of the spin polarization P, spin disorder coefficient b and parameter a, proportional to exchange anisotropy and reciprocal exchange strength, respectively.

CONCLUSSION

The substitution of iron with nickel in Ca_2FeMoO_6 decrease the magnetic interaction and also the transport properties!!!

REFERENCES

[1] Asok Poddar, R. N. Bhowmik and I. Panneer Muthuselvam, JOURNAL OF APPLIED PHYSICS 108 (2010) 103908

[2] E. Burzo, I. Balasz, M. Valeanu and I.G. Pop, J. Alloy. Compd. 509 (2011) 105

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