Magnetoresistive properties of $Ca_{1.5}La_{0.5}FeMo_{1-x}W_xO_6$ perovskites

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To obtain information of magnetoresistive properties of $Ca_{1.5}La_{0.5}FeMo_{1-x}W_xO_6$ perovskites, were studied by X-rays, magnetic measurements and resistivities.

INTRODUCTION

- $Ca_{2-x}La_xFeMoO_6$: 0.70 Fe^{2+} and 0.68 Mo^{5+} per formula unit
- When increasing the W content the number of Fe^{2+} ions increase by 10 % and Mo^{5+} decrease by 19 %

EXPERIMENTAL

- $Ca_{1.5}La_{0.5}FeMo_{1-x}W_xO_6$ with $x \le 0.3$ ⇒ prepared by solid state reaction. The samples were sintered at 900°C in a stream of 3% of H_2/Ar during 3 hours.
- X-ray diffraction analyses ⇒ all the samples shows one phase (Bruker D8 Advance AXS diffractometer with Cu Kα radiation) and for refinement was used ⇒ TOPAS code
- 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

- The $Ca_{1.5}La_{0.5}FeMo_{1-x}W_xO_6$ with $x \le 0.3$ crystallize in a monoclinic lattice of $P2_1/n$ type (Fig. 1.). The change of ordering increase from 58 % (x=0) to 77 % (x=0.1) and 91 % (x=0.3)

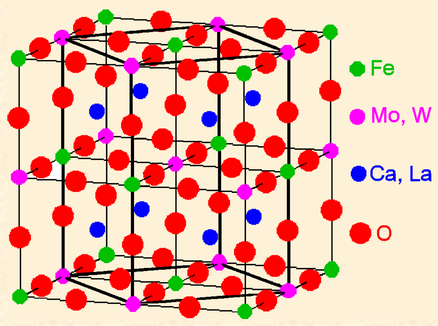

Fig. 1. Monoclinic lattice ($P2_1/n$) of $Ca_{1.5}La_{0.5}FeMo_{1-x}W_xO_6$

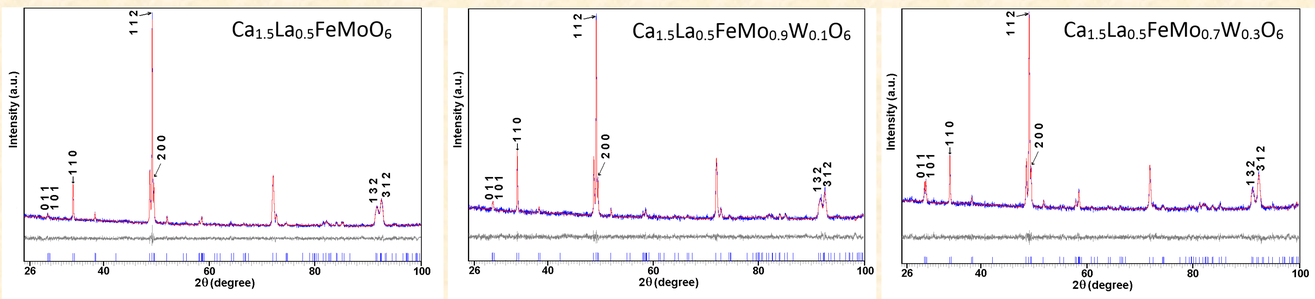

Fig. 2. Refinement with the TOPAS code

- Resistivities ⇒ Semiconducting-metal transitions (Fig. 5.) at T_t = 204 K (x=0), 221 K (x=0.1) and 249 K (x=0.3).
- For x=0.3

$$\log \rho \propto T^{-1/4}$$

as predicted by Mott's variable range hopping.

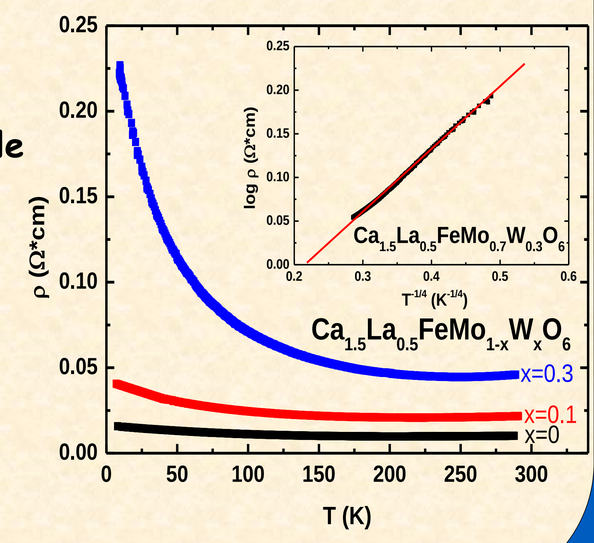

Fig. 5. Thermal variations of resistivities. In inset is plotted the dependence of ρ values as function of $T^{-1/4}$ for the sample with x = 0.3.

- Magnetic properties ⇒ cluster glass component superposed on essentially ferrimagnetic behavior (Fig. 3.).

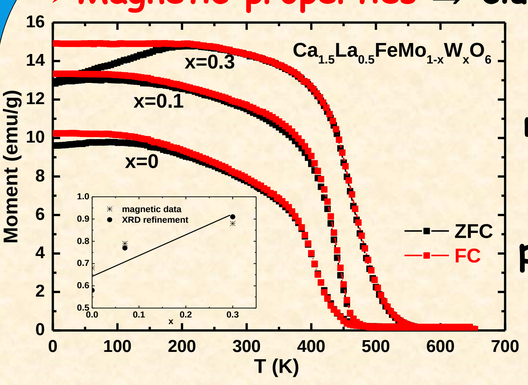

Fig. 3. Temperature dependences of magnetizations of ZFC and FC samples (H = 1 kOe). In inset are given the composition dependences of the order parameters determined from XRD and magnetic measurements..

Reciprocal susceptibility

$$\frac{1}{\chi} = \frac{1}{\chi_o} + \frac{T}{C} - \frac{\sigma}{T-\Theta}$$

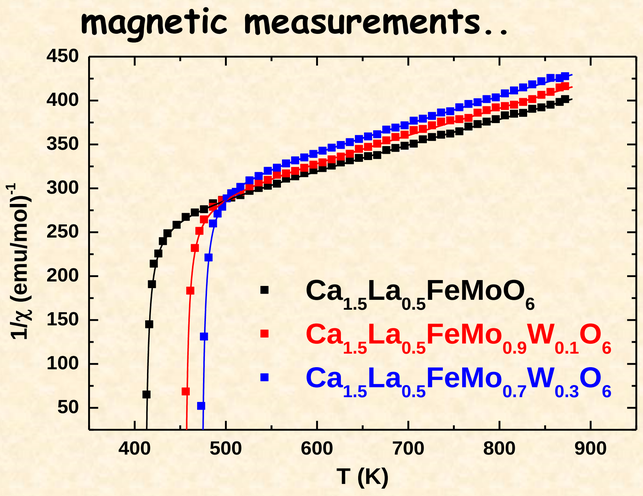

Fig. 4. Thermal variations of reciprocal susceptibilities.

- Curie constants decreases from 3.5 (x=0), 3.45 (x=0.1) and 3.22 (x=0.3)

- Magnetoresistivities ⇒

$$MR = -P^2 m(H)^2 [1 + P^2 m(H)^2]^{-1} - bH$$

- Intergrain tunneling magnetoresistence (low external field)
- Intergrain contribution (high external field)

$m(H) = (1 - aH^{-1/2})$ (spin-glass behavior)

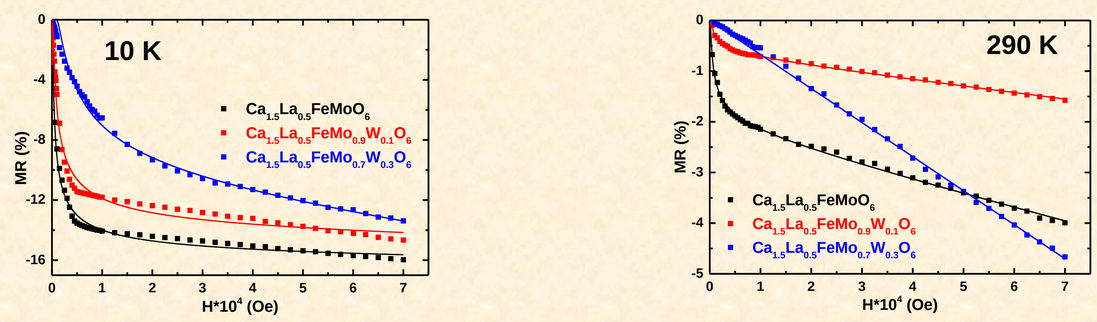

Fig. 6. The field dependences of the magnetoresistivities at 10 and 290 K. By solid lines are plotted the prediction of the above relation with parameter P, b and a given in Fig. 7.

- Spin polarization increases with ordering degree

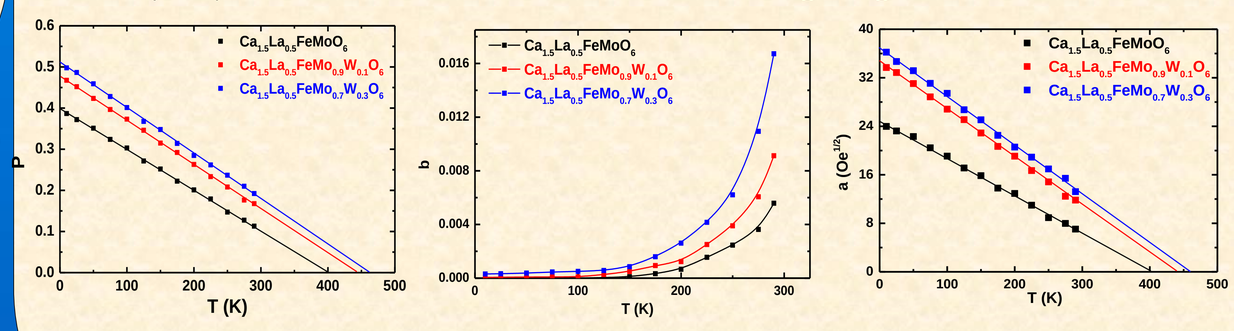

Fig. 7. Temperature dependences of the spin polarization P, spin disorder coefficient b and parameter a, proportional to exchange anisotropy and reciprocal exchange strength, respectively.

CONCLUSSION

- The degree of crystallographic ordering increases with W content
- Little increase of magnetoresistivities
- The spin polarization increases from P = 0.4 (x=0) to 0.5 (x=0.3)

Acknowledgements

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