MAGNETIC AND MAGNETOCALORIC PROPERTIES OF $(Er_{1-x}Y_x)Co_2$ COMPOUNDS

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To obtain information of physical properties of $(Er_{1-x}Y_x)Co_2$ compounds, were studied by X-rays, magnetic measurements and band structure calculations.

INTRODUCTION

- The rare earth – transition metal intermetallic compounds R-TM (R – rare earth; TM – transition metal) exhibit a rich number of challenging physical phenomena [1]
- $ErCo_2$ is ferrimagnetically ordered compound with magnetic transition temperature $T_C \approx 35$ K [1]
- The ytrium will change the physical properties of the $ErCo_2$.

EXPERIMENTAL

- $(Er_{1-x}Y_x)Co_2$ with $x \leq 0.3$ ⇒ in an induction furnace, under high purity argon atmosphere.
- 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 $\mu_0 H \leq 12*10^4$ Oe and $4.2 \leq T \leq 500$ K (Oxford Instruments)

RESULTS AND DISCUSSION

- **XRD** ⇒ $(Er_{1-x}Y_x)Co_2$ compounds with $x \leq 0.3$ crystallize in a cubic $MgCu_2$-type structure [1]. The lattice parameters, determined at room temperature, show a Veguard-type dependence.

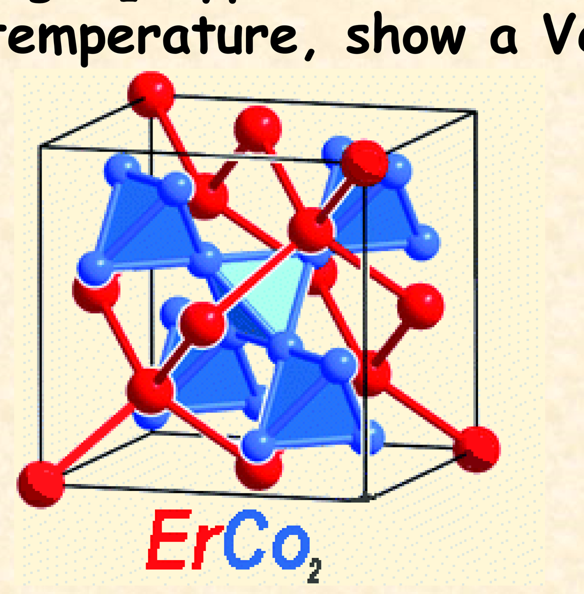

Fig. 1. Cubic $MgCu_2$-type structure of $ErCo_2$

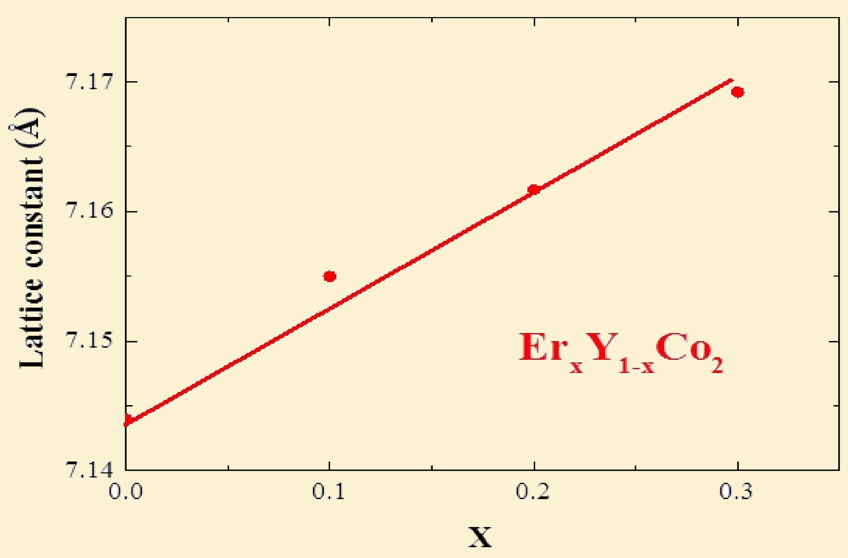

Fig. 2. Lattice parameters of $Er_{1-x}Y_xCo_2$

- **Magnetic measurements (1)** ⇒ The temperature dependences of magnetizations of zero field cooled (ZFC) and field cooled (FC) $Er_{0.7}Y_{0.3}Co_2$ compound is given in Fig.3. The compounds are ferrimagnetically order – Fig.4.

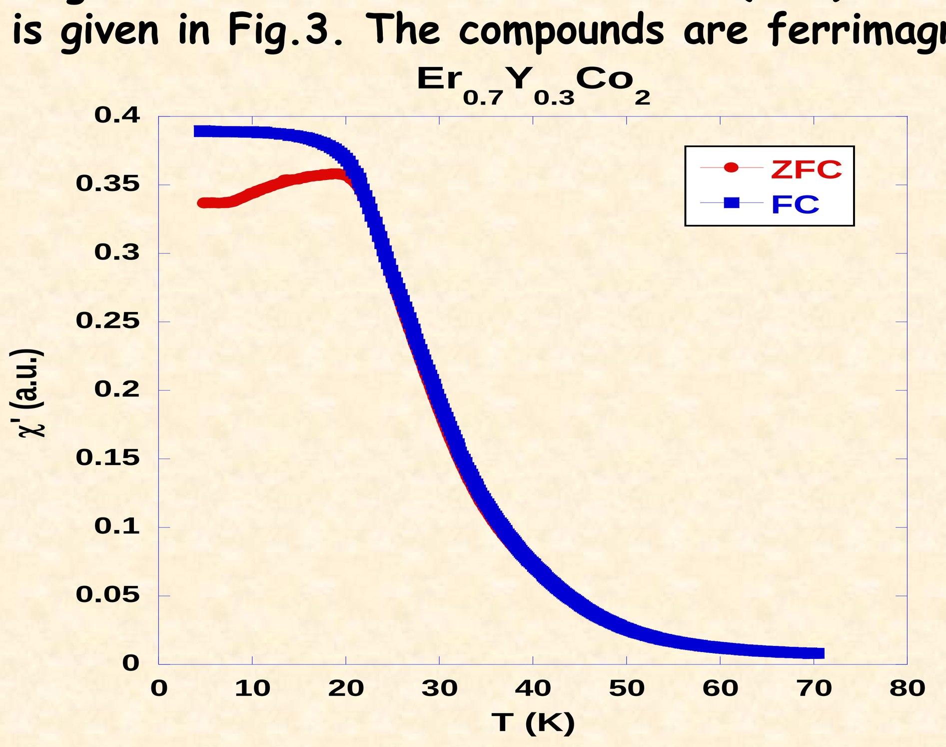

Fig. 3. Temperature dependences of magnetizations in a field of 0.5 T, for sample $Er_{0.9}Y_{0.1}Co_2$ field cooled (FC) and zero field cooled (ZFC).

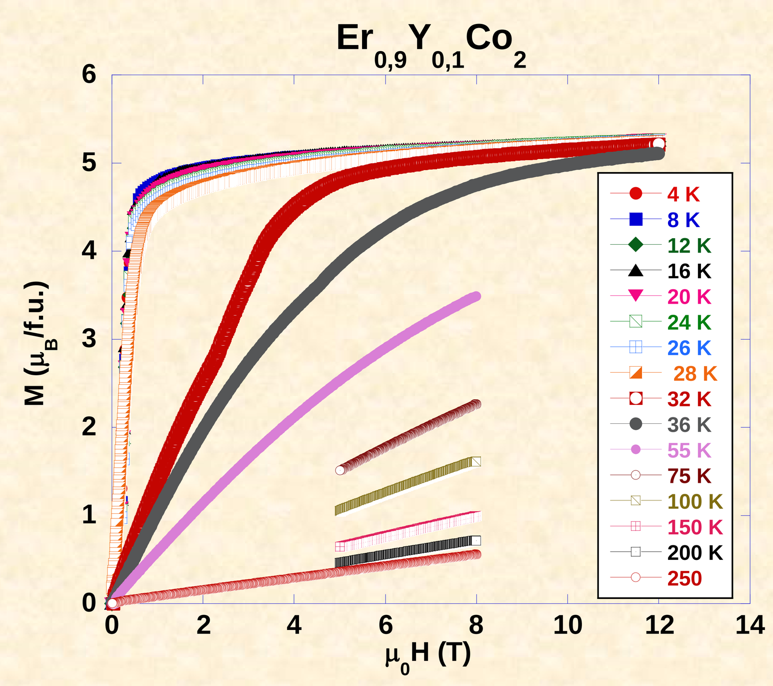

Fig. 4. Magnetization isotherms of $Er_{0.9}Y_{0.1}Co_2$

- **Magnetic measurements (2)** ⇒ The cobalt moments determined from saturation data (H ≤ 12 T, T = 4.2 K) decrease when Y content is higher- Fig. 5.

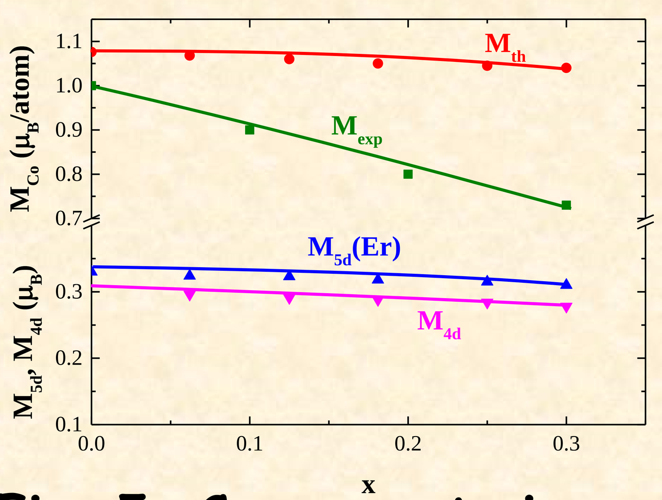

Fig. 5. Co moments in $Er_{1-x}Y_xCo_2$

The reciprocal susceptibilities follows non-linear characteristic for a ferrimagnetic system – Fig. 6.

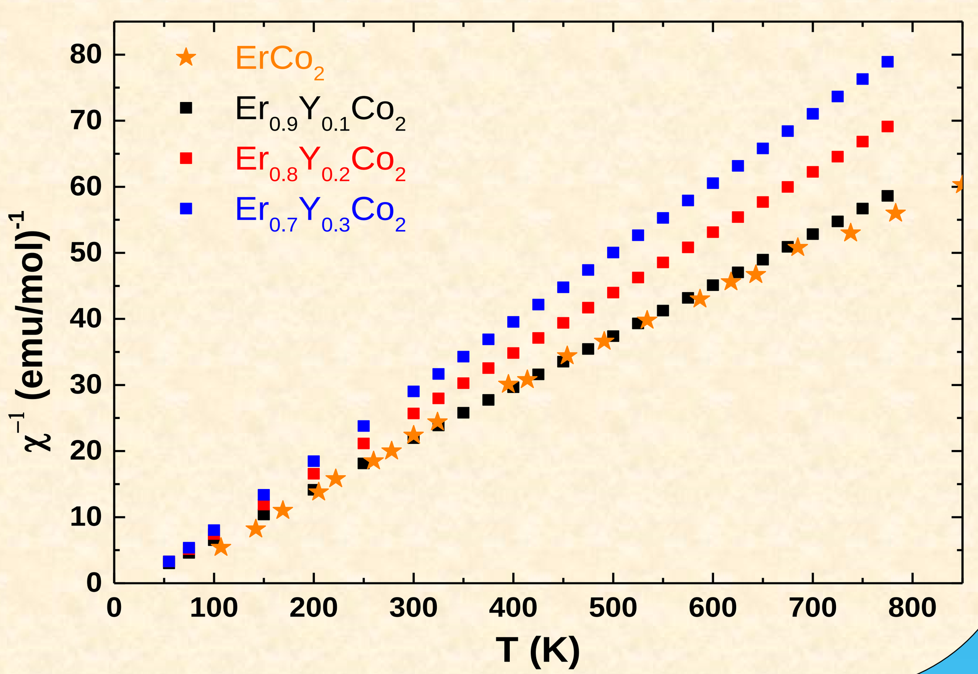

Fig.6. Reciprocal susceptibilities in $Er_{1-x}Y_xCo_2$

- **Magnetic measurements (3)** ⇒ Assuming that the effective erbium moment is given by its free ion value [2], the contributions of cobalt atoms to the Curie constants were determined. The effective cobalt moments, $M_{eff}(Co)$, decrease little in the investigated composition range – Fig.7.

The ratio $r = S_p/S_o$ between the number of spins determined from effective cobalt moment and saturation one can be founded in spin fluctuation ($r \propto T_C^{-2/3}$) model – Fig 8.

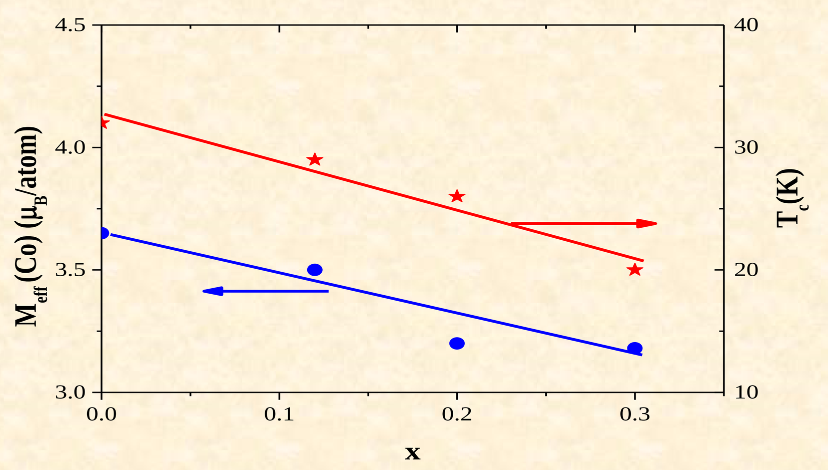

Fig. 7. Composition dependences of the effective cobalt moments and Curie temperatures

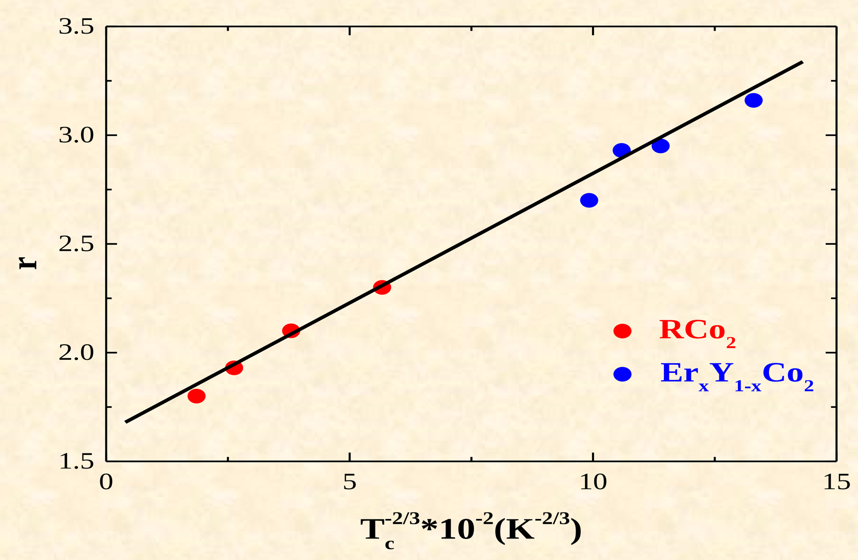

Fig. 8. The dependence of the ratios $r = S_p/S_0$ on the Curie temperatures

- **Magnetic measurements (4)** ⇒ The computed entropy changes, ΔS, for the $Er_{0.1}Y_{0.9}Co_2$ compound is plotted in – Fig. 9. The $-\Delta S_{max}$ values follow a $H^{2/3}$ type [3] dependence as expected in mean field model – Fig. 10. The specific renormalized power in a field H < 2.25 T an only constant for a given composition decrease from 60 J/kg*T (x=0) to 12 J/kg*T (x=0.2).

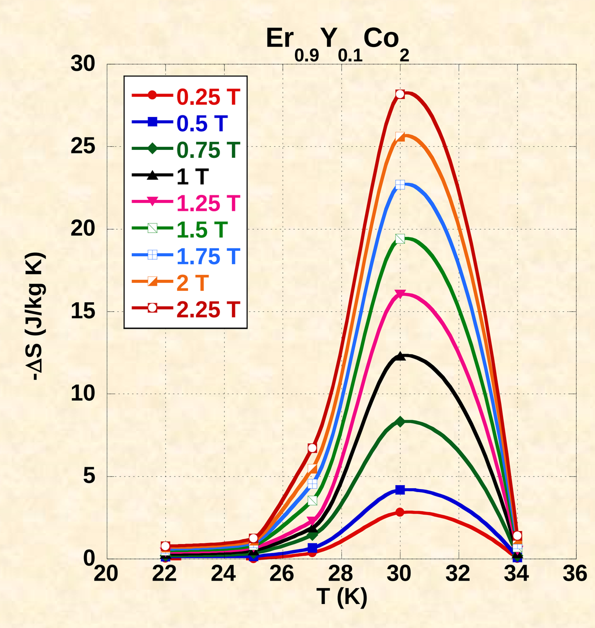

Fig. 9. Magnetocaloric effect for $Er_{0.9}Y_{0.1}Co_2$

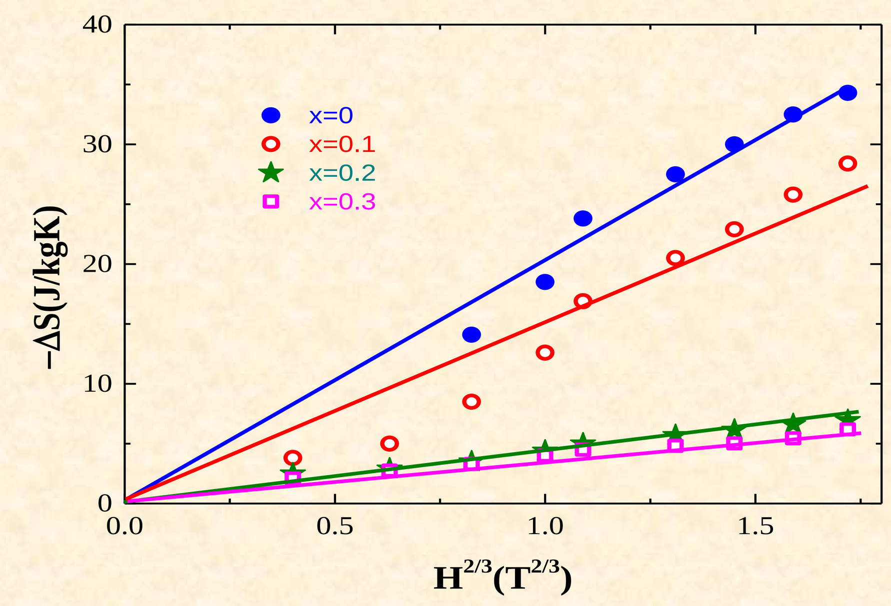

Fig. 10. $-\Delta S_{max}$ for $Er_{1-x}Y_xCo_2$

CONCLUSION

The substitution of erbium with ytrium in $ErCo_2$ decrease the magnetic interaction and also the magnetocaloric effect!!!

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Acknowledgements

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