

Studies of the Doping Effects of YCrO_3 Biferroic Materials by XAS

C.-L. Chan (詹承濂)¹, S. Taran¹, C.-P. Sun (孫家彬)¹,
C.-C. Chou (周志杰)¹, J.-Y. Lin (林俊源)², and H.-D. Yang (楊弘敦)¹

¹Department of Physics, National Sun Yat-Sen University, Kaohsiung, Taiwan

²Institute of Physics, National Chiao Tung University, Hsinchu, Taiwan

The interesting biferroic materials, YCrO_3 , was discovered and showed ferroelectric transition at 473 K and antiferromagnetic transition at 140 K (T_N) [1]. The single valence of Cr ion was expected in YCrO_3 . It is of interest to see if carrier doping should affect the magnetic and electric properties in this insulating compound. We prepared the hole (Ca^{2+}) doped samples to study the possibly mixed valence effects on the magnetic and dielectric properties. In this context, the hole doped (Ca^{2+}) samples, $\text{Y}_{1-x}\text{Ca}_x\text{CrO}_3$ ($x=0\sim 0.15$), were synthesized.

In Fig. 1, we show the x-ray absorption spectroscopy (XAS) measurements. The oxygen K-edge spectra show that Ca is indeed likely to be doped in YCrO_3 . With increasing Ca doping, two extra peaks emerge between 527 eV and 530 eV. The mixed valence effect of Cr^{3+} and Cr^{4+} is expected in the samples. Therefore, the emerging pre-edge features manifest the unoccupied d states of Cr due to hole doping. The successful Ca doping is verified by the spectroscopic evidence. Whether this hole doping would increase the conductivity of YCrO_3 is currently under study.

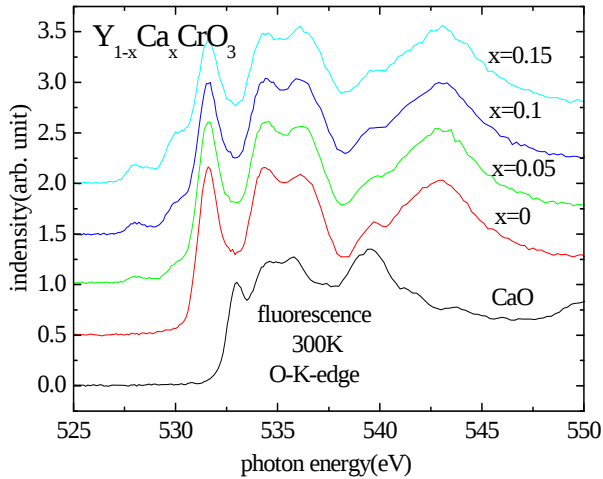


Fig. 1: Room temperature fluorescence K-edge of Oxygen in $\text{Y}_{1-x}\text{Ca}_x\text{CrO}_3$

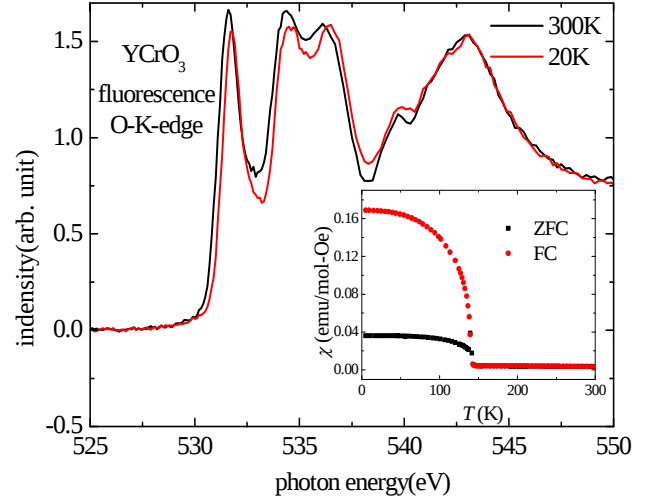


Fig. 2: Oxygen K-edge of YCrO_3 at 300 K and 20 K, respectively. The temperature dependence of the magnetic susceptibility is shown in the inset.

In Fig. 2, the antiferromagnetism and weak ferromagnetism phase transitions are shown in the inset. We have found the magnetic hysteresis loop at low temperatures. Furthermore, the increasing in Ca doping leads to a decreased in the magnetic transition temperature (data not shown). It seems that the induced vacant d states weaken the magnetic ordering. These results would be valuable in searching for the microscopic mechanism of the magnetic ordering in YCrO_3 . The main peak energy shift in the oxygen K-edge spectra between at room temperature and at low temperatures is noticed. The origin of this blue shift at low temperatures is currently unknown

In conclusion, the O K-edge spectroscopy helps to verify the successful Ca doping in YCrO_3 . Spectroscopic evidence shows the induced unoccupied Cr d states and probably holes. The hole doping effects on the physical properties of YCrO_3 are certainly interesting and would the studies are to be carried on.

Reference

- [1] C. R. Serrao, A. K. Kundu, S. B. Krupanidhi, U. V. Waghmare, and C. N. R. Rao, Phys. Rev. B **72**, 220101(R) (2005).