

XAFS study of Eu doped zinc oxide nanoparticles

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Introduction

There is growing interest in zinc oxide because zinc oxide phosphors are stable and need low voltage, compared with zinc sulphides. Thus, zinc oxide is promising for field emission display. We can obtain a required wavelength for luminescence by doping rare earth ions. To achieve better spatial resolution, it is important to develop a synthetic route of zinc oxide nanoparticles. Recently, Ashtaputre et al. developed a facile, inexpensive, and low temperature synthetic route [1]. Now, several interesting problems have come up; where the europium ions exist in zinc oxide nanoparticles, what the valency of europium ions is, and how the local atomic structures of zinc and europium are. We investigated these issues by XAFS.

Experimental

Powdered samples were prepared from zinc oxide and $(\text{CH}_3\text{CO})_2\text{EuH}_2\text{O}$ (i.e. Eu^{3+}) and annealed in air according to the literature [1]. Doping concentration and annealing temperature were variously changed. They were diluted by BN and pressed into disks. Zn *K*-edge XAFS and Eu *L*_{III}-edge XAFS spectra were measured at 20K with the transmission mode at BL-12C using a Si(111) double crystal monochromator.

Results and Discussion

Zn *K*-edge XAFS

Zn *K*-edge EXAFS spectra from the nanoparticles are almost same as that from the bulk zinc oxide, indicating the basic structures of nanoparticles are same as the bulk ZnO.

Eu *L*_{III}-edge XAFS

Fourier transforms of Eu *L*_{III}-edge EXAFS are shown in Fig. 1. The main peak is assigned to Eu-O scattering.

The peak intensity at the higher shell decreases with the doping concentration, indicating the increase of disorder with dopants. EXAFS analysis suggests europium ions are on the surfaces of the nanoparticles.

Eu *L*_{III}-edge XANES spectra are shown in Fig. 2. Main peak at 6985 eV is assigned to the white line from Eu^{3+} . A shoulder structure was observed for annealed zinc oxide nanoparticles doped with 0.3% europium ions, which is attributed to Eu^{2+} . This structure is not observed for the nanoparticles without annealing. Usually, the reduction of rare earth ions is done with H_2 , or NH_3 , activated carbon, or CO. But, in this case the sample was reduced in air, and kept stable in air. In fact, the reduction of Eu^{3+} ions in air was reported previously for Eu doping in Sr^{2+} oxide

[2]. In that report, the reduction process is explained as follows. Doped Eu^{3+} ions substitute Sr^{2+} , and the defects with negative charge are created. Annealing causes electrons in the defects to transfer to the doped europium ions. Because ion radius of Eu^{2+} (1.30 Å) is comparable with that of Sr^{2+} (1.31 Å), Eu^{2+} are stable in the substituted positions. In the present case, however, the ionic radius of Zn^{2+} (0.75 Å) is much smaller than that of Eu^{2+} . To clarify the reduction mechanism, further experiments are underway.

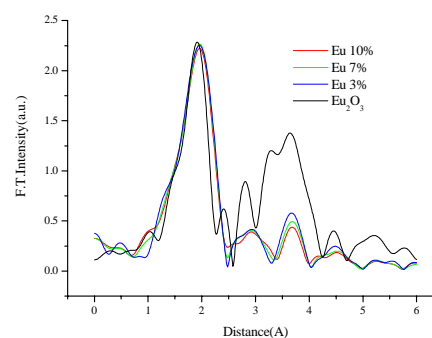


Fig.1 Eu *L*_{III}-edge EXAFS Fourier transform

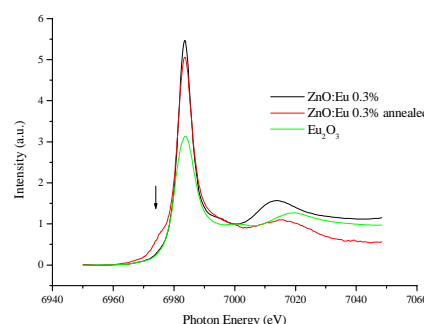


Fig.2 Eu *L*_{III}-edge XANES spectra

References

- [1] S.Ashtaputre et al, in press
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