Encapsulation and Magnetic Properties of
EuO Nanoclusters in Zeolite X

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Europium(II)oxide (EuO) is a magnetic semiconductor which presents a ferromagnetic phase at temperatures below the Curie temperature (Tc = 70 K). The seven *f* electrons that locate between the valence band (*2p* of O^{2-}) and the conduction band (*5d* of Eu^{2+}) in EuO lead to the *4f-5d* transition and optomagnetic properties such as Faraday and Kerr effects.[1-3] EuO is a promising material for optical isolators and optomagnetic devices because of its unique magnetic properties.

Generally, EuO is prepared by the solid phase reaction of Eu_2O_3 with europium metal at high temperature (>1000 ^oC).[4] Recently, it was found that optical properties of nanoscale EuS in zeolite Y and optomagnetic properties of EuO doped in glass were different from those of bulk semiconductors.[5-6] In 2001, we reported the low temperature synthesis of sup-micron spindle type EuO crystals by the reaction of europium metal in liquid ammonia.[7] Here, we report the magnetic properties of EuO nanoclusters in zeolite X.

Eu(II)X and Eu(III)X were prepared by the ion-exchange reaction of NaX with $EuCl_2$ and $EuCl_3$, respectively. The samples were washed for 10 times in order to remove excess amount of europium ions on the surface before dried in vacuum. The degree of metal exchange (Eu(II)X α ~ 40%, Eu(III)X α ~ 85%) was determined by ICP-AES. Fluorescent spectrum showed that the europium ions in Eu(II)X were partly turned to Eu(III) ions (Figure 1). X-ray Photoelectron Spectrometer revealed that the electronic state of Eu(II)X sample was apparently different from that of Eu(III)X.

The magnetic measurement of Eu(II)X and Eu(III)X and NaX samples were performed using superconducting quantum interface device (SQUID). As a result, the correlation between magnetization and temperature showed that Eu(II)X turned into ferromagnetic phase at 70 K consisted with that of bulk EuO and gave a histerysis curves of magnetization and magnetic at 10 K (Figure 2, 3). On the other hand, Eu(III)X and NaX samples were found to be paramagnetic and diamagnetism, respectively (Figure 2).

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Figure 1. Emission spectra of Eu(II)X (solid line) and Eu(III)X (dot line). Emission of Eu(II) and Eu(III) were observed at 480 nm and 615 nm, respectively.

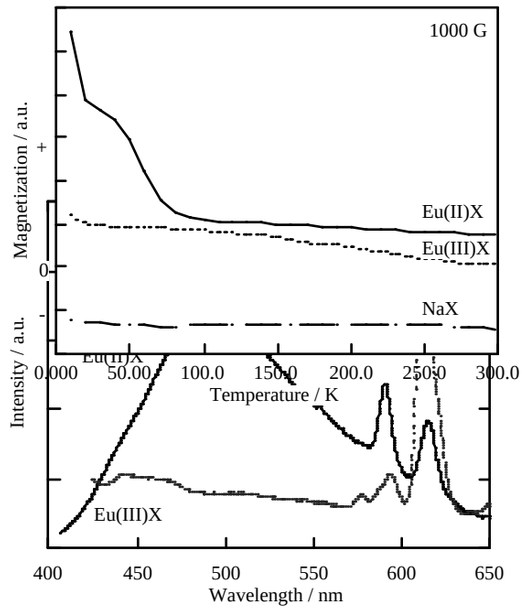

Figure 2. Correlation of temperature and magnetization of Eu(II)X (solid line), Eu(III)X (dot line) and NaX (dash line).

Figure 3. Correlation of magnetic filed and magnetization of Eu(II)X at 10 K.