Enhanced Luminescence and photomagnetic Properties of Surface-modified EuO Nanocrystals

Yasuchika Hasegawa, Supitcha Thongchant, Yuji Wada, and Shozo Yanagida*

Material and Life Science, Graduate School of Engineering, Osaka University, 2-1 Yamadaoka Suita, Osaka 565-0871 (Japan)

Europium^{II} oxide (EuO) has localized narrow 4f orbitals that exist as the degeneracy levels between the conduction band (5d orbitals of Eu^{II}) and the valence band (2p orbitals of O^{2-}).[1] The 4f-5d electron transition and spin configuration of EuO lead to unique optical, magnetic and electronic properties.[2] We recently successfully prepared of a spindle-shape EuO nanocrystals (mean diameter: 280 nm in length and 95 nm in width) from metal Eu in liquid ammonia. [3] The liquid phase reaction is a promising way to give smaller particle of EuO nanocrystals for practical optomagnetic materials. Here, we report the smaller EuO nanocrystals (average diameter: 3.4 nm) synthesized by the photochemical reduction of Eu(NO3)3 in methanol (Fig. 1).

The EuO nanocrystals were prepared in a N2 atmosphere as follows: in a quartz vessel, Eu(NO3)3 and urea were dissolved in methanol, then the solution was irradiated with a 500 W high-pressure mercury arc lamp at 300K. ICP-AES, TGA-DTA and IR analysis verified that the formation of polyurea did in fact occur. TEM observation revealed that the sample consisted of EuO nanocrystals with an average diameter of 3.4 nm. The size distribution of the EuO is much smaller than that of the recently prepared EuO nanocrystal.[3] The electron diffraction patterns of the initial nanocrystals is in agreement with those of the NaCl-type EuO.

The EuO nanocrystals exhibited two un-conventional photophysical properties; emission quantum yield of the EuO nanocrystals in methanol was 49±5% at 300K, which is the highest efficiency reported for EuO. We also observed a dramatic increase in magnetization of the EuO nanocrystals under UV irradiation at room temperature. This increase in magnetization under UV irradiation can be explained by the occurrence of a *d-f* exchange interaction of conductive electrons in the 5d band (magnetic exciton: Fig. 2). We suggest that the mechanism of the photo-magnetization increase should be attributable to the presence of an exciton band in the UV region in accordance with the highly efficient luminescence from the polyurea modified EuO nanocrystals. In order to confirm the magnetic exciton of EuO nanocrystals, we carried out the EPR measurements under UV irradiation. Integral curves of EPR spectrum under irradiation shows the formation of photo-active species in EuO nanocrystals (Fig. 3). In this conference, we are going to report about EPR analysis.

[1]P. Wachter, *Handbook on the physics and chemistry of rare earths*, North-holland Publishing Company, **1979**, ed. 2, 189.
[2]T. Kasuya et al, *Rev. Mod. Phys.***1968**,*40*, 684.
[3]S. Yanagida et al, *Chem. Lett.*,**2001**, 1274.

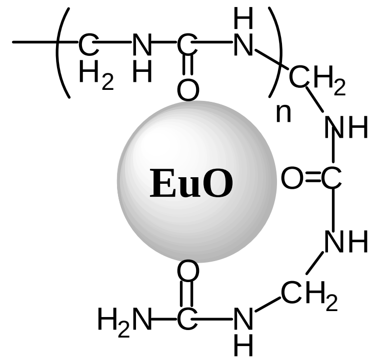

Fig. 1 Image of EuO nanocrystals with polyurea

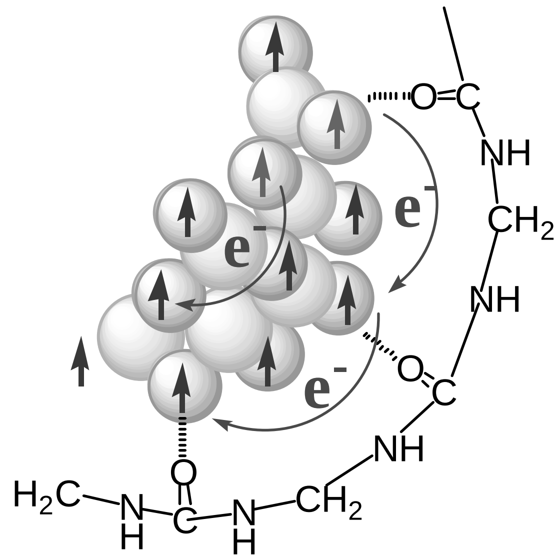

Fig. 2 Formation of magnetic exition by *d-f* exchange interaction of conductive electrons in the 5d band.

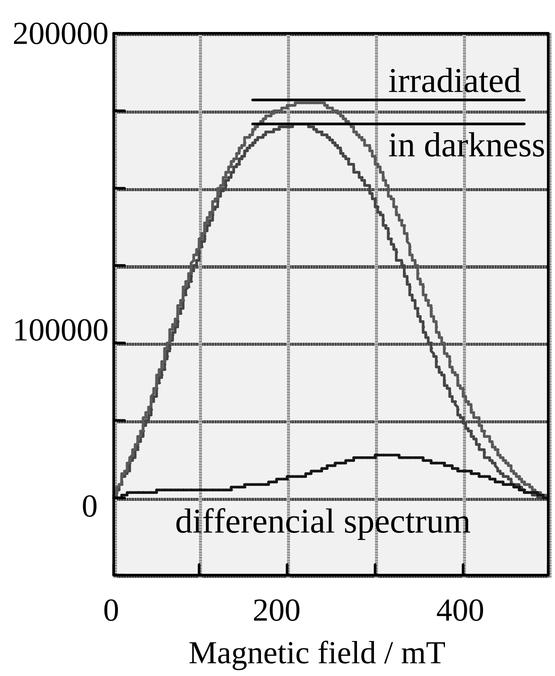

Fig. 3 Integral curve of EPR spectra of EuO nanocrystals at 273K.