

^{151}Eu MÖSSBAUER STUDY OF LUMINESCENT $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ CORE-SHELL NANOPARTICLES

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More and more industrial interest was focused on semiconductor-based light-emitting diodes (LEDs). In their preparation the phosphors play a very important role. Among the phosphors Eu doped Y_2O_3 is one of the best luminophors regarding the emission efficiency of a red light. For the flat-panel display industry it became necessary to obtain nanoparticles with regular morphology and narrow size distribution.

In our study monodisperse $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ spherical nanoparticles and $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ core-shell structured nanoparticles were synthesized by homogeneous precipitation method. TEM confirmed that spherical particles were obtained. Photoluminescence emission spectra of samples were observed in the range of 550-650 nm. ^{151}Eu Mössbauer parameters (Table I) undoubtedly proves that Eu atoms exist only in oxidation state Eu^{3+} in all spherical $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ and $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ core-shell nanoparticles. We have found small but significant differences between the ^{151}Eu Mössbauer spectra (Fig. 1 (a) and (b)) and the corresponding parameters (Table 1) of spherical $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ and $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ core-shell nanoparticles. Higher isomer shift and V_{zz} and smaller linewidth are characteristic of the spherical $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ samples than those of belonging to the $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ core-shell samples. This can be well understood in terms of the different structures of these nanoparticles. In the case of the spherical $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ sample with 2.5% Eu^{3+} content the isomer shift is close to that reported for the Eu substitution in Y_2O_3 [1]. The relatively small linewidth also indicate that Eu occupy a well defined site in the lattice. The high V_{zz} in comparison to that of Eu in Eu_2O_3 can be originated from the change in the charge distribution probable due to lattice distortion appearing at the incorporation of Eu into the Y site. All these parameters indicate that Eu occupies the Y site in Y_2O_3 in the spherical $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ nanoparticles.

The observed isomer shift (Table 1) for all $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ core-shell samples resonantly agrees with that found earlier for Eu_2O_3 [2]. This reflects that Eu locates in Eu_2O_3 in the core-shell samples (Fig. 2). The very high linewidth is associated with a highly defected Eu_2O_3 occurring in the shell of these nanoparticles.

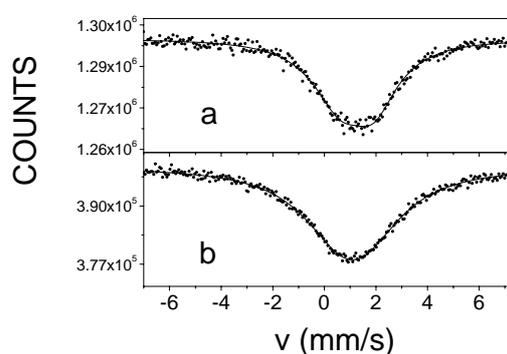


Figure 1. Typical room temperature ^{151}Eu Mössbauer spectra of $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ and $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ nanoparticles (a) $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ containing 10% Eu^{3+} (b) $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ with 75:25 of $\text{Y}_2\text{O}_3:\text{Eu}_2\text{O}_3$

Table I: ^{151}Eu Mössbauer parameters of $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ and $\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ nanoparticles

	$\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ 2.5% Eu^{3+}	$\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ 10% Eu^{3+}	$\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ 75:25 $\text{Y}_2\text{O}_3:\text{Eu}_2\text{O}_3$	$\text{Y}_2\text{O}_3@\text{Eu}^{3+}$ 10% Eu^{3+}
δ (mm/s)	1.28 (0.05)	1.19 (0.02)	1.03 (0.02)	1.02 (0.03)
V_{zz} (10^{21}V/m^2)	4.78 (0.52)	4.77 (0.16)	2.89 (0.81)	3.53 (0.95)
η	0.98 (0.21)	0.98 (0.07)	0.99 (0.38)	0.98 (0.34)
W (mm/s)	2.10 (0.22)	2.10 (0.08)	3.70 (0.27)	3.02 (0.40)

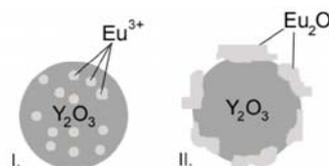


Figure 2. The schematic illustration of the nanoparticles

- [1] H.T. Hintzen, H.M.van Noort, Phys. Chem. Sol. 49, (1988) 873-881
 [2] E. Bauminger, G.M. Kalvius, I. Novik, In: Mössbauer Isomer Shifts (Eds. G. Shenoy, F. Wagner), North Holland, Amsterdam, New York, Oxford, 1978, pp.663-758.