Electron Paramagnetic Resonance Studies on the Defects Formed in the Dy(III)-Doped $SrAl_2O_4$

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Photo-EPR investigations have been carried out for the $Sr_xAl_2O_4$ with a variety of x and the $SrAl_2O_4$:Dy in relevant to elucidate the mechanisms of long phosphorescence of $SrAl_2O_4$:Eu,Dy.

Photo-EPR experiments were carried out as follows: Samples were irradiated at –100 °C uv-light using Xenon lamp for 30 min. Afterwards, there were warmed up to room temperature, left for a certain period of time in order to release carriers from traps, and then cooled again to –100 °C for the measurements.

Figure 1 shows the uv-irradiated EPR spectra of the $SrAl_2O_4$ and decay characteristics at room temperature. They showed the EPR spectra with eleven hyperfine lines independent of dysprosium(III)-doping. Taking into account of the $SrAl_2O_4$ framework consisting of tetrahedral AlO_4^- network and of aluminium nuclear spin I_{Al} = 5/2, they were assigned to $[AlO_3\text{-}O\text{-}AlO_3]^0$, indicating that the reaction $[AlO_3\text{-}O\text{-}AlO_3]^- + h^+ \rightarrow [AlO_3\text{-}O\text{-}AlO_3]^0$ occurs by uv-irradiation. Also, an anisotropic resonance with a *g* value of 2.007 at the cross-over point was observed in addition to the hyperfine lines. This signal is assigned to a hole trapped at strontium vacancies because they are highly distorted. From the comparison of the decay characteristics of both EPR signals it is found that after the uv-irradiation the anisotropic signal disappears more rapidly than the $[AlO_3\text{-}O\text{-}AlO_3]^0$ signal.

Figure 2 shows the uv-irradiated EPR spectra of the $Sr_{0.995}Dy_{0.005}Al_2O_4$. It is noticed that when the $Sr_{0.995}Dy_{0.005}Al_2O_4$ is irradiated by uv-light, the anisotropic signal with g = 2.007 increases in intensity. Simultaneously, eleven hyperfine line assigned to the $[AlO_3\text{-}O\text{-}AlO_3]^0$ appear, and the signal at g = 1.999 assigned to trapped electron is growing in intensity.

It should be note that the observed EPR spectrum under uv-irradiation is similar to that of $SrAl_2O_4$ (Fig.1), while their decay characteristics are completely different each other. The intensity of the signal at g = 2.007 decreases very slowly, while the latter hyperfine lines disappear in 3 min after uv-irradiation. Slow decay of the former signal indicates that they are enough in energy to release hole gradually by thermal excitation at room temperature. This is in agreement with the results examined by thermoluminescence spectroscopy that a hole trap with a deep level of 0.82 eV is formed by dysprosium(III)-doping.

Consequently, it is deduced that the dysprosium(II)-doping modulates the energy levels of oxygen defects trapping electrons near dysprosium(III) as well as the formation of strontium vacancy.

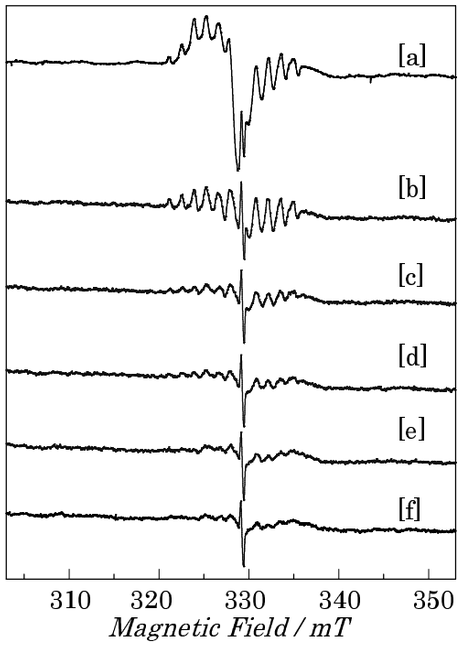

Fig. 1 EPR spectra [a] uv-irradiated [b] 5 min [c] 30min [d] 1h [e] 3h and [f] 6h of $SrAl_2O_4$ and this decay characteristic at room temperature.

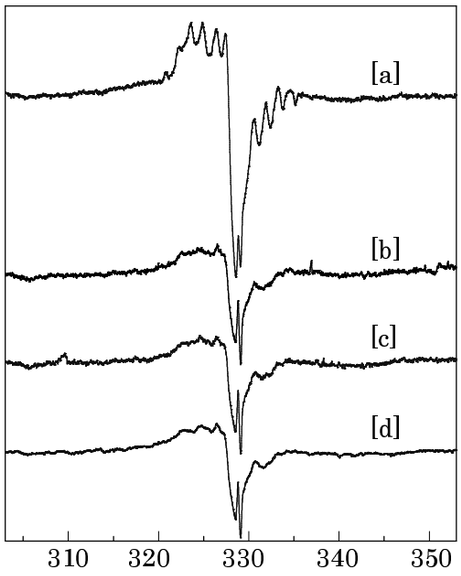

Fig. 2 EPR spectra [a] uv-irradiated [b] 5 min [c] 30min and [d] 3h of $Sr_{0.995}Dy_{0.005}Al_2O_4$ and this decay characteristic at room temperature.