Photoluminescence Spectral Change in Self-Assembled Layered Titanate Oxide Intercalated with Eu^{3+}

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A number of interesting photoluminescence properties of titanate layered oxide intercalated with hydrated Eu^{3+} by the electrostatic self-assembly deposition method have been demonstrated. The emission intensity of Eu^{3+} immediately decreased upon UV irradiation at energies higher than the band gap energy of the host TiO layer. The decrease in the emission intensity depended on the amount of interlayer water. A comparison of the emission spectra obtained by measurement in D_2O and H_2O revealed that the emission intensities in D_2O were larger than those in H_2O, indicating that the photoluminescence properties of Eu/TiO-films are strongly dependent on the hydration state of the water molecules surrounding Eu^{3+} ions in the interlayer. The layer distances of Eu/TiO-films before and after irradiation were the same, indicating that the decrease in emission intensity was not due to the decomposition of interlayer water by UV irradiation. Rather, the decrease was due to the decrease in the energy transfer from the host TiO layer to Eu^{3+} as a result of the change in the hydration state of water molecules surrounding Eu^{3+}, which is caused by the hole produced in the TiO valence band. When the irradiation was discontinued, the emission intensity recovered after a certain period of time. This indicates that the hydration state of water molecules surrounding Eu^{3+} changes under irradiation and returns to its initial state after discontinuation of irradiation. The excitation spectra changed drastically upon UV irradiation with the corresponding wavelength of UV light. Comparing the excitation spectra before and after irradiation shows that only the excitation peak at around the irradiation wavelength was decreased by irradiation, in similar fashion to spectral hole burning. This unique phenomenon suggests that the hydration state of water molecules surrounding Eu^{3+} ions changes depending on the wavelength of the irradiation. This may be explained by the layered structure of the Eu/TiO-film, which resembles a superlattice structure, producing holes at different energy levels.

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