

## EMISSION LINES OF LANTHANOIDS CONTAINED AS IMPURITIES IN RARE EARTH COMPOUNDS

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Rare earth compounds contain as impurities trace amounts of lanthanoids, and characteristic emission lines can be observed from the lanthanoids of the order of  $10^{-4}$  mass % or less in the compounds.<sup>1,2</sup> These emission lines reflect the structure and state of the host materials, and thus the host materials are expected to be characterized using these emission lines. This nondestructive characterization method could provide information on the microstructure of rare earth compounds without any pretreatment. In this study, the photoluminescence (PL) of CeO<sub>2</sub>-ZrO<sub>2</sub> powder and it sintered have been measured, and we have found the characteristic emission lines of Dy<sup>3+</sup> contained as impurities in the CeO<sub>2</sub>-ZrO<sub>2</sub> samples.

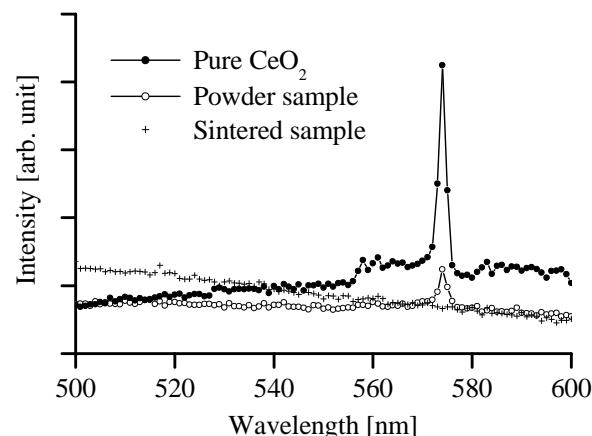
The 10 mol % CeO<sub>2</sub>-ZrO<sub>2</sub> powder used was a commercially available powder from Tosoh Co. The powder (referred to as the powder sample) was pressed into a pellet by a cold isostatic pressing method. The pellet was sintered at 1773 K for 4 hours, and then one surface of the pellet was polished (referred to as the sintered sample). The PL and PL excitation spectra of the samples were measured at room temperature with a Spex Fluorolog3-22 spectrophotometer. The spectrophotometer consisted of a 450 W xenon lamp used as the excitation light source, two double monochromators (one in the excitation side and another in the emission side), and a Peltier-cooled photomultiplier. The x-ray diffraction patterns of the samples were obtained using a Rigaku x-ray diffractometer with Cu K $\alpha$  radiation, and their grain sizes were estimated from the half-widths of the highest and second highest peaks. The Dy concentration of the powder sample was determined by inductively coupled plasma mass spectrometry using a Perkin-Elmer Elan 6000 mass spectrometer.

The characteristic emission lines of Dy<sup>3+</sup> were observed from the powder sample and the pure CeO<sub>2</sub> powder (>99.995 %), but not from the sintered sample. Figure 1 shows the PL spectra of the pure CeO<sub>2</sub> powder and the CeO<sub>2</sub>-ZrO<sub>2</sub> samples taken for excitation at 280 nm. The emission lines at 574 nm from the powder sample and the pure CeO<sub>2</sub> powder agree with those of Dy<sup>3+</sup> previously reported.<sup>1,3,4</sup> Thus, the emission lines at 574 nm could be attributed to  $^4F_{9/2} \rightarrow ^6H_{13/2}$  transition of Dy<sup>3+</sup>. It is noteworthy that the intensity of the emission line of Dy<sup>3+</sup> from the pure CeO<sub>2</sub> powder is 4 times that from the powder sample, although the Dy concentration in the pure CeO<sub>2</sub> powder (0.2 ppm) is one-third that in the powder sample (0.6 ppm). By considering these results, valuable information on the structures of the pure CeO<sub>2</sub> powder and the CeO<sub>2</sub>-ZrO<sub>2</sub> samples is expected to be obtained.

We are going to provide an explanation for these results and to try to apply the PL probe method in this study to other rare earth compounds.

### References

1. L. Ozawa et al., *Anal. Chem.*, **40**, 187 (1968).
2. H. Nakajima et al., *Solid State Commun.*, **129**, 421 (2004).
3. R. C. Ropp, *J. Electrochem. Soc.*, **111**, 311 (1964).
4. G. S. Raghuvanshi et al., *J. Phys. Chem. Solids*, **43**, 781 (1982).



**Figure 1.** PL spectra of the powder and sintered samples of 10 mol % CeO<sub>2</sub>-ZrO<sub>2</sub>, and the pure CeO<sub>2</sub> powder. The excitation wavelength was 280 nm.