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Contamination during mechano-chemical process of Y_2O_2S:Eu phosphor

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Introduction

It is possible to obtain Y_2O_2S:Eu phosphor powder by a mechano-chemical process with a high speed ball-mill. The method is efficient for materials surveying, but one has to be careful about contamination from the vial and balls. This report describes the results of synchrotron X-ray fluorescence analysis.

Experimental

In the present study, a planetary ball mill (LA-PO.4, Itoh Seisakusho Ltd.) with a vial (80 cm^3) and 23 balls (10mm in diameter, about 7.9g), made of tungsten carbide alloy (WC 88%, Co 12%) was employed. The Y_2O_2S:Eu phosphor sample was prepared from the following starting materials, yttrium oxide (Y_2O_3, 99.9%, 2.1772g), europium oxide (Eu_2O_3, 99.99%, 0.1076g), and sulfur (S, 99.99%, 0.3351g). The rotation speed and the milling time were 250 rpm and 12 h., respectively. The atmosphere was argon. It was confirmed that the powder obtained generates luminescence with a wavelength of 660nm [1].

Results and Discussion

Figure 1 shows the X-ray diffraction pattern (Cu Kα radiation), which agrees well with that of Y_2O_2S found in the JCPDS database. The reaction was completed, because no additional peaks from the starting materials were found in the data. The pattern appears to be even identical to that of pure Y_2O_2S. This is because the doping amount of europium is not significant (at the most 5~6 atomic %). The influence of contamination, which is often the case with ball milling, is also not clear from X-ray diffraction data. As the X-ray fluorescence technique is sensitive enough to allow the observation of minor elements in such samples, the experiments were carried out as shown in Fig. 2. The primary X-ray energy was set as 16 keV (below Y-K edge) in order to suppress very strong X-ray fluorescence from yttrium. One can see several peaks from tungsten and cobalt, in addition to europium. This is due to contamination during ball milling, because those elements are identical to the constituents of the vial and the ball used for the synthesis. Meanwhile, it was found that the concentration was in the same order as that of europium. Such information is important when it comes to optimizing the luminescent properties of the phosphor. The authors would like to thank Professor A. Iida for his kind assistance during the experiment.

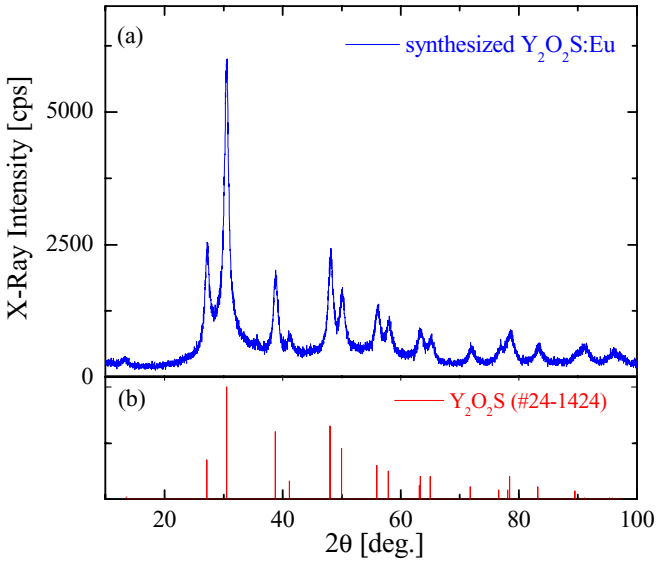

Figure 1 (a) XRD pattern of the synthesized phosphor powder, (b) data for pure Y_2O_2S registered in JCPDS database (#24-1424)

References

[1] H. Yamamoto, in "Phosphor Handbook", eds. S. Shionoya and W.M. Yen, (CRC press, Boca Raton, 1999), pp.113-121.

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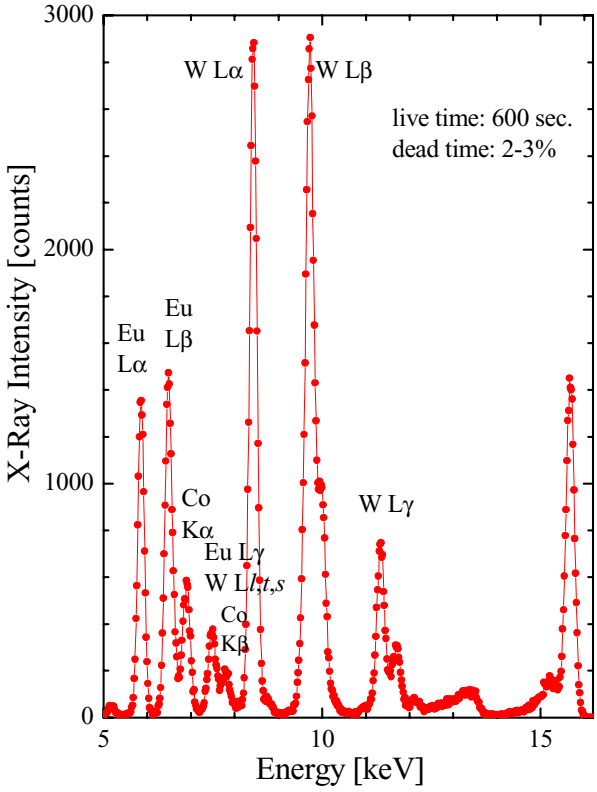

Figure 2 XRF spectra of the synthesized phosphor powder.