Characterization of (Y,Gd) BO_3:Eu Phosphors Prepared by Urea Hydrolysis Method

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Abstract

Uniform cylinder-shaped precursors for (Y,Gd)BO_3:Eu phosphors were prepared by urea hydrolysis reaction. After heating the precursors at lower temperature than general synthetic methods, the phosphor powders were well dispersed and held their original shapes. Their emissions under vacuum-ultraviolet (VUV) excitation appeared with the peaks at 593nm due to magnetic dipole transition from $^5D_0$ to $^7F_1$, 612nm and 627nm due to electric dipole transition from $^5D_0$ to $^7F_2$

1. Introduction

A plasma display panel (PDP) is high-lighted as the candidate for the flat panel display. As phosphors are most important element that influence to the performance of display panel, the luminous efficiency, lifetime and color purity must be improved. So, it is necessary to be advanced properties of phosphors through both a new host material and synthetic technique.[1,2]

Most researchers have used the solid state method or the sol-gel process to the synthesis of (Y,Gd)BO_3:Eu phosphor.[3-5] In the present work, we have designed urea hydrolysis process to control the shape of (Y,Gd)BO_3:Eu phosphor.

2. Experimental

For the synthesis, the raw materials were used yttrium oxide (Y_2O_3, 99.99%), gadolinium oxide (Gd_2O_3, 99.9%), europium oxide (Eu_2O_3, 99.9%) and boric acid (H_3BO_3, 99.99%). To manufacture the precursor, we adopted urea hydrolysis. First of all, 1.6M stock solution, Yittrium and Gadolinium and Europium ion were mixed morality ratio, was prepared in distillated water with nitric acid. After boric acid and urea was dissolved distillated water, and Metal ion of 0.02mol in this solution was then added in 500ml round botton flask. The total reaction voloum is 250ml. The whole mixture was heated to boiling until 6hr after precipitation. The resultant precipitate was filtered, washed and allowed to dry. This precursor fired at 850℃ in the air. Crystalline phase was characterized by powder X-ray diffraction (XRD). The morphology of the phosphor particles was observed by field emission scanning electron microscopy (FE-SEM). Photoluminescence measuring system was set up in order to achieve VUV excitation, which includes D_2 lamp ranging from 100 to 300nm, vacuum chamber, excitation monochromator with sodium salicylate powder, emission monochromater, photomultiplier tubes, and a controlled under the excitation of 147 nm, so that the PL characteristics in the similar environment to the actual PDP could be investigated.

3. Results and discussion

In making the (Y,Gd)BO_3:Eu phosphor, the precursor prepared by urea hydrolysis method took cylindrical shape. The unfired precipitate consist of uniform cylinder-shaped particles and their size was about 2㎛ (see fig 1).

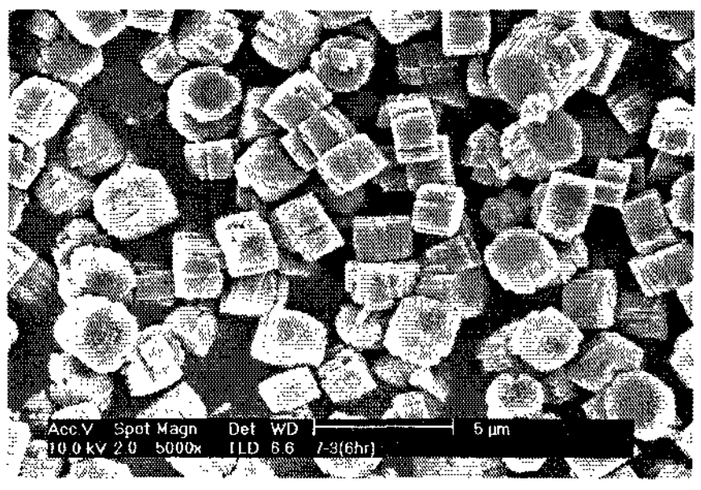
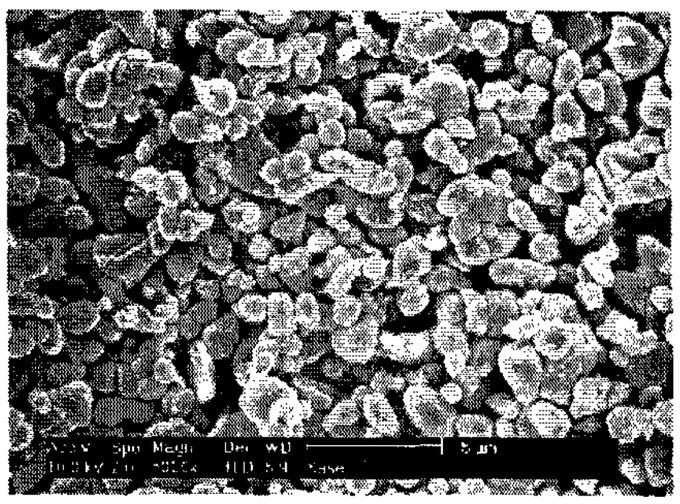
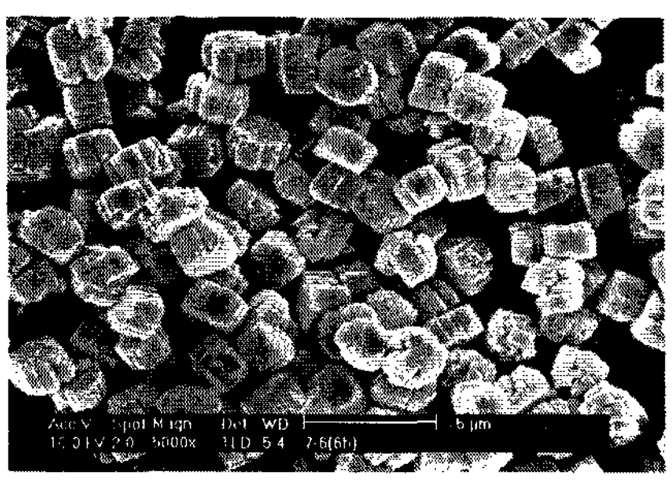


Fig 1. Morphology of precursors prepared by urea hydrolysis method.

After heat treatment of this precursor, the shapes of the powder held their shapes. On the SEM image, the uniform and dispersed shape of the phosphor particles will probably be useful for the deposition of the phosphor to a pixel of plasma display. It is investigated that the commercial phosphor has non-vivid morphology and damaged surface because of the ball milling to crash the agglomerated coarse particle by low melting point of boron oxide[4] (see fig 2(a)). on the other hand, the morphology of our sample is made on observation almost uniform and dispersed shape with about 2㎛ particle size by the homogeneous precipitation (see fig 2(b)). The uniform and dispersed shape of the phosphor particles will probably be suitable for the deposition of the phosphor to a plasma display substrate. The crystalline phase of the phosphor prepared by this method and commercial phosphor have only YBO_3 (16-0277) phase of JCPDS (see fig 3).



(a)



(b)

Fig 2. Morphology of (a) commercial red phosphors (b) (Y,Gd)BO_3:Eu phosphors. (850℃x 3hr)

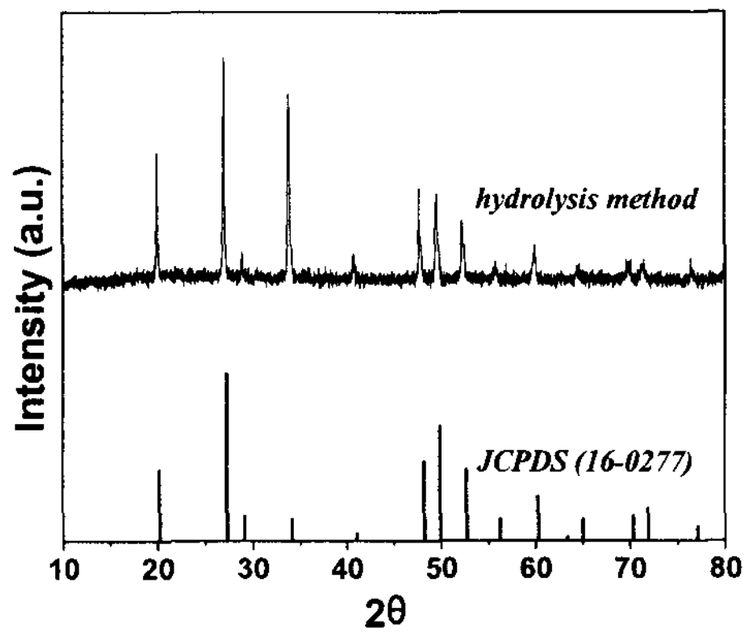


Fig 3. X-ray diffraction pattern of prepared sample.

The luminescence properties are investigated under the excitation of 147nm. The PL intensity is exhibited about 85% of the commercial. The emission spectra of the prepared (Y,Gd)BO_3:Eu phosphor exhibits $^5D_0 \rightarrow {}^7F_1$ transition (magnetic dipole transition) of 593 nm, $^5D_0 \rightarrow {}^7F_2$ transition (electric dipole transition) of 612 nm and 627 nm, and $^5D_0 \rightarrow {}^7F_3$ transition of 651 nm and 674 nm. In this case, our sample's magnetic dipole transition gab is lower than electric dipole transition gab. It is judged the report of other research group that magnetic dipole transition and electric dipole transition are affected composition of Eu and Gd at (Y,Gd)BO_3:Eu phosphor.[7]

4. Conclusions

In the present work, (Y,Gd)BO_3:Eu red phosphor preparation was designed by urea hydrolysis method. The morphology of (Y,Gd)BO_3:Eu has uniform cylindrical type. During a heat treatment on the air, the precursor was maintain their shape. This phosphor was lower heated than existing synthetic method. And then, characters of the luminescence of phosphor prepared by the above method were showed about 85% of commercial phosphor.

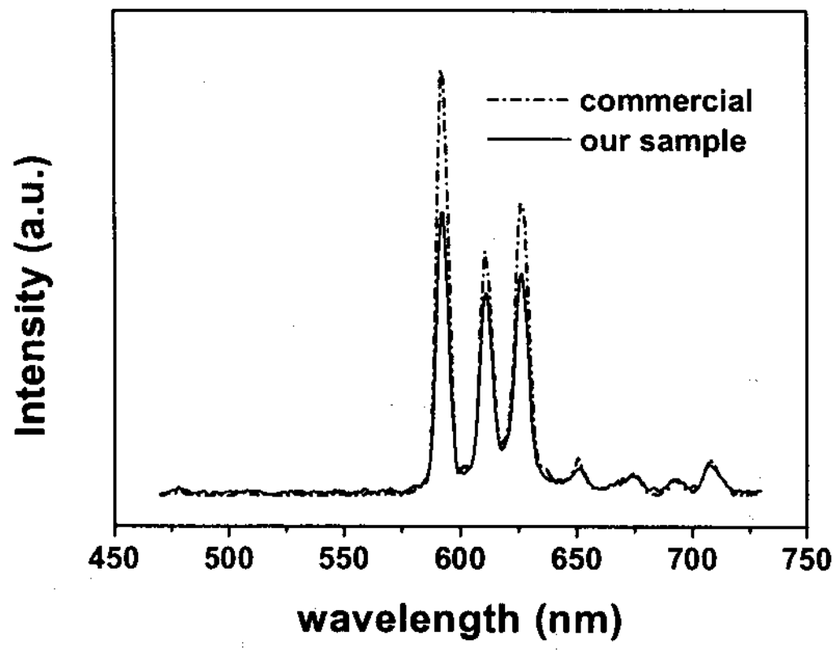


Fig 4. Emission spectra of our and commercial sample

5. References

1. H.-K. Jung, D.-S. Park, Y.C. Park, *Mater. Res Bull*, *34(1)*, 43. (1999).
2. H.-K. Jung, K.-S. Sohn, B. Y. Sung, H.D. Park, *J. Information Display*, *1(1)*, 35, (2000).
3. G. Chadeyron, A. Arbus M.-T. Rournier, D. Zambon, J.C. Cousseins, *C. R. Acad. Sci. Paris, , t. 320, Serie II b*, 199. (1995)
4. D. Boyer, G. B.-Chadeyron, R. Mahiou, C. Caperaa, J.-C. Cousseins, *J. Mater. Chem.*, , *9*, 211, (1999).
5. G. B.-Chadeyron, M. El-Ghozzi, D. Boyer, R. Mahiou, J.C. Cousseins, *J. Alloy Compd*, *317-318*, 183, (2001).
6. W. park, R. Y. Lee, C. J. Summers, Y. R. Do, H. G. Yang, *Mater. Sci. Eng.*, *B78*. 28, (2000)
7. G. Chadeyron, R. Mahiou, M. El-Ghozzi, A. Arbus, D. Zambon, J. C. Cousseins, *J. Lumin.*, *72-74*, 564, (1997)