Electronic Supplementary Material (ESI) for CrystEngComm.

Supporting Information

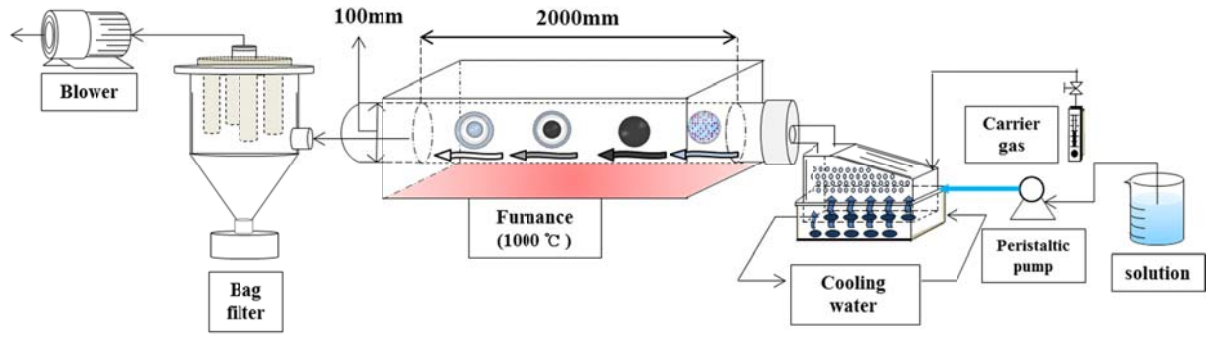
Yolk–Shell Structured $Y_2O_3:Eu^{3+}$ Phosphor Powders with Enhanced Photoluminescence Properties Prepared by Spray Pyrolysis

Jung Sang Cho, Kwang Min Yang, and Yun Chan Kang*

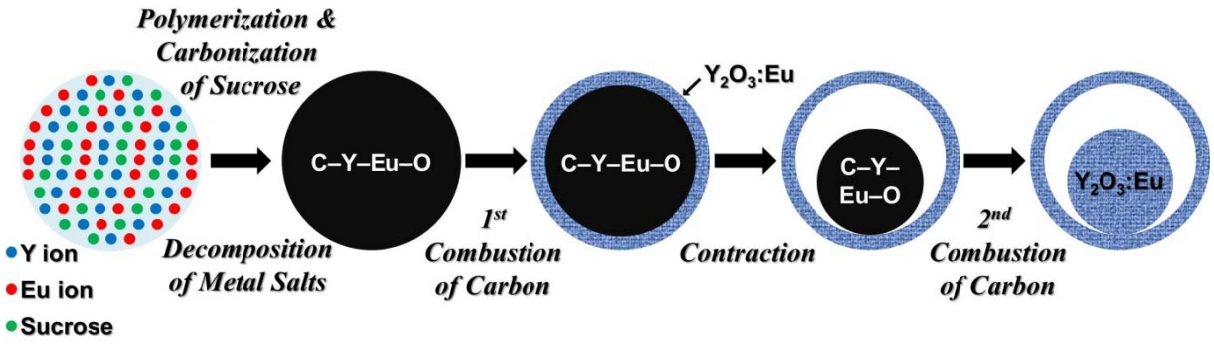
Department of Chemical Engineering, Konkuk University, 1 Hwayang-dong, Gwangjin-gu, Seoul 143-701, Republic of Korea

This file includes:

- Schematic diagram of the large scale ultrasonic spray pyrolysis process and formation mechanism of the yolk-shell-structured $Y_2O_3:Eu^{3+}$ phosphor powder.
- Thermogravimetric analysis of the $Y_2O_3:Eu^{3+}$ phosphor powders directly prepared by spray pyrolysis.
- SEM image of the $Y_2O_3:Eu^{3+}$ phosphor powders prepared from the spray solution without sucrose after post-treatment at 1200°C.
- XRD patterns of the post-treated $Y_2O_3:Eu^{3+}$ phosphor powders prepared from the spray solution (a) without sucrose at 1200°C and with sucrose at (b) 1000°C, (c) 1100°C, (d) 1200°C, (e) 1300°C.
- N_2 adsorption-desorption isotherms measured at 77 K for the $Y_2O_3:Eu^{3+}$ yolk-shell phosphor powders post-treated at various temperatures.
- SEM images of the powders prepared by spray drying process (a) before and (b) after post-treatment at 1200°C.
- Emission spectra of the yolk-shell and nano-structured $Y_2O_3:Eu^{3+}$ phosphor powders.
- SEM images of the $Y_2O_3:Eu^{3+}$ phosphor powders prepared from the spray solution with sucrose in N_2 atmosphere: (a) before heat-treatment and (b) after heat-treatment at 800°C under air atmosphere.



(a)



(b)

Fig. S1 Schematic diagram of the large scale ultrasonic spray pyrolysis process and formation mechanism of the yolk-shell-structured Y_2O_3:Eu^{3+} phosphor powder.

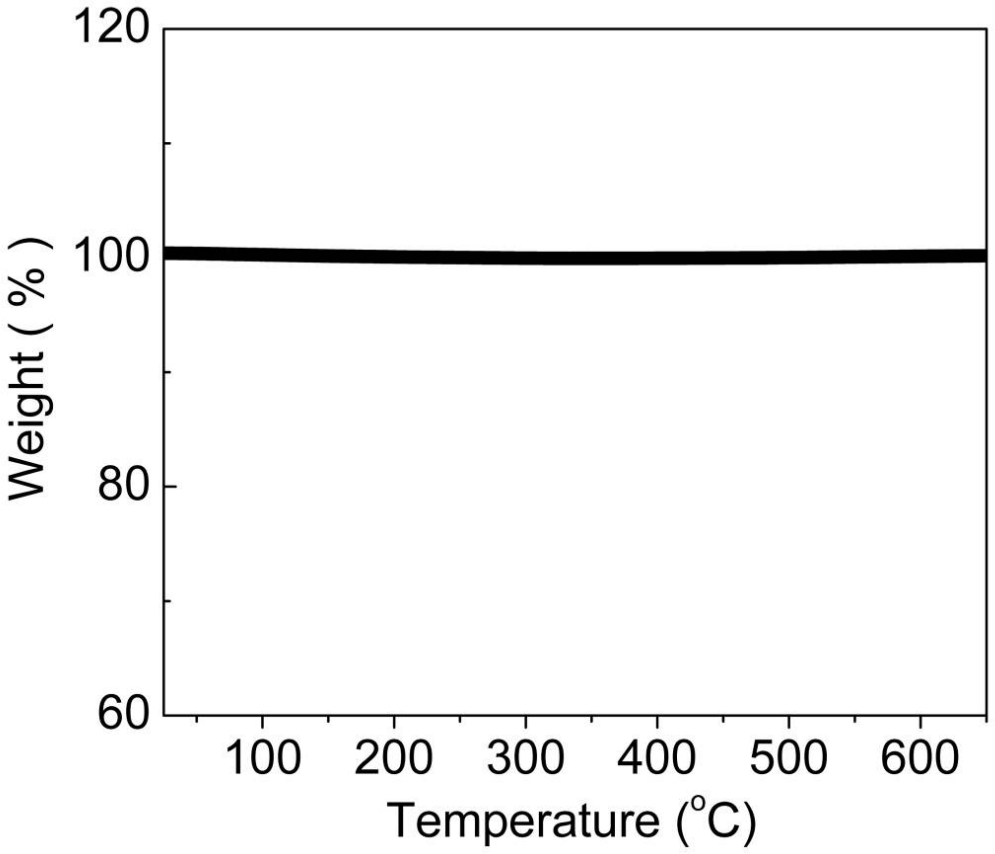


Fig. S2 Thermogravimetric analysis of the Y_2O_3:Eu^{3+} phosphor powders directly prepared by spray pyrolysis.

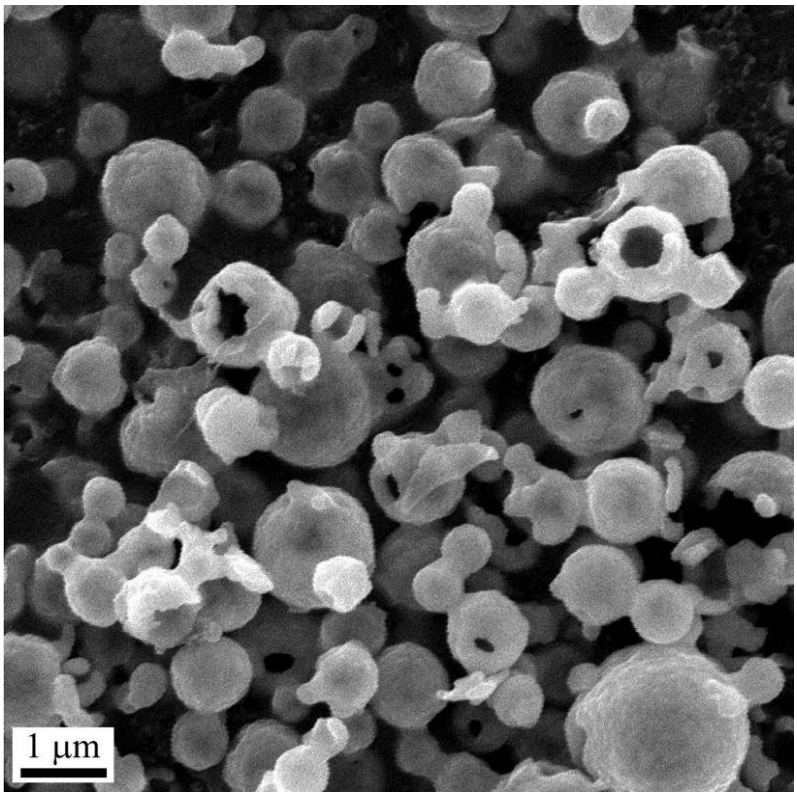


Fig. S3 SEM image of the $Y_2O_3:Eu^{3+}$ phosphor powders prepared from the spray solution without sucrose after post-treatment at 1200°C.

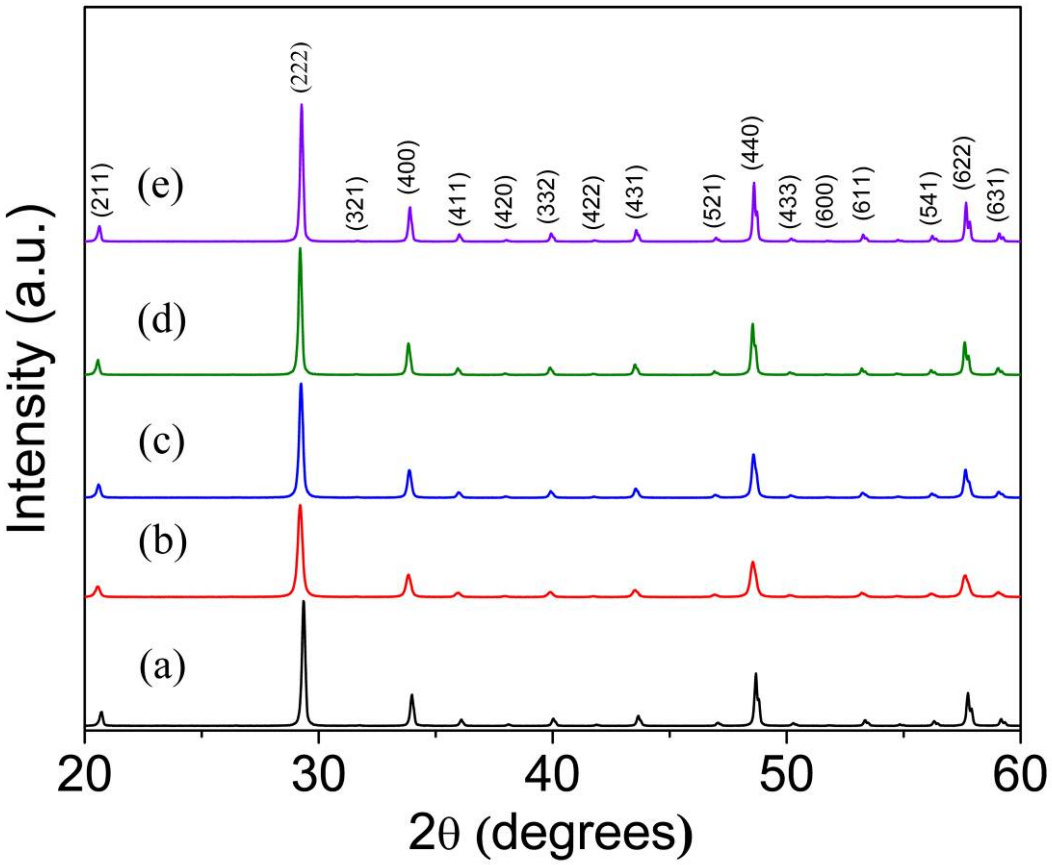


Fig. S4 XRD patterns of the post-treated Y_2O_3:Eu^{3+} phosphor powders prepared from the spray solution (a) without sucrose at 1200°C and with sucrose at (b) 1000°C, (c) 1100°C, (d) 1200°C, (e) 1300°C.

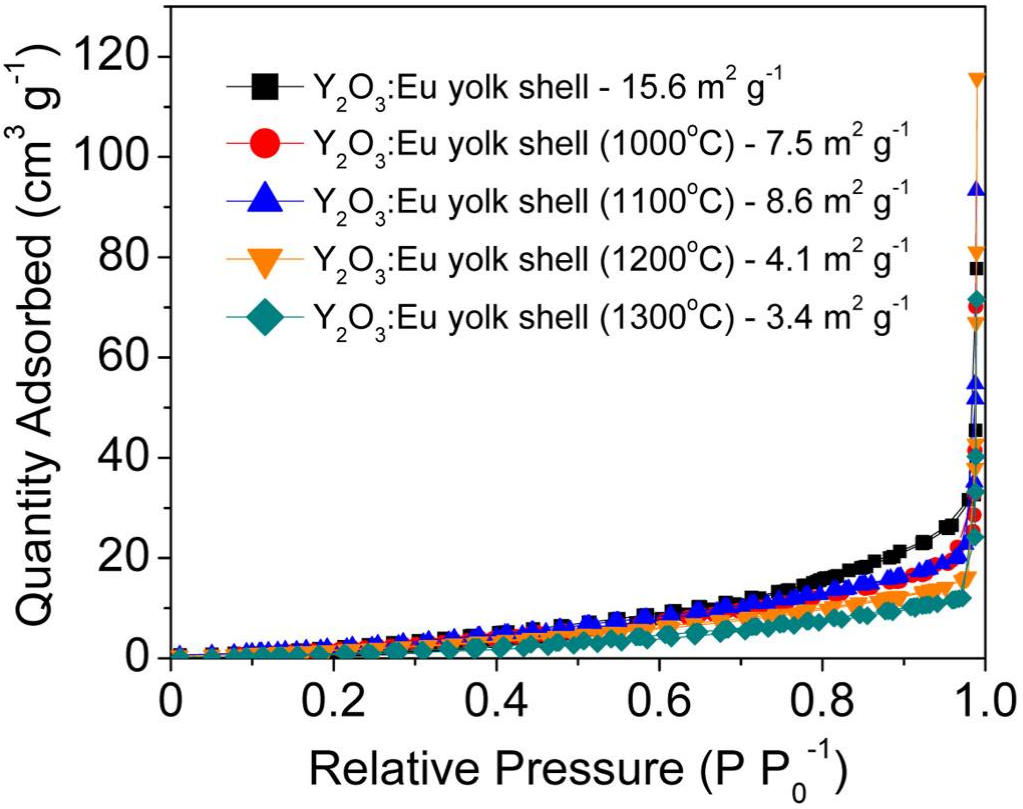


Fig. S5 N_2 adsorption-desorption isotherms measured at 77 K for the Y_2O_3:Eu^{3+} yolk-shell phosphor powders post-treated at various temperatures.

Nano-structured Y_2O_3:Eu phosphor powders were prepared by spray drying process applying citric acid (CA) as the chelating agent. The total concentration of Y and Eu components was fixed at 0.2 M, and the concentration of CA was fixed at 0.5 M. For the preparation of nano-structured powders, the intermediate hollow-structured precursor powders obtained by spray drying process were milled for 3 h by planetary mill. And then, it was post-treated at 1200°C. Subsequently, its photoluminescence property was compared with those of the hollow-structured and yolk-shell structured powders. As a result, the photoluminescence intensity of the Y_2O_3:Eu^{3+} yolk–shell phosphor was the highest compared to the other structures. The photoluminescence intensities of the nano-structured and hollow-structured phosphor powders were 74 %, and 59 %, respectively, of that of the yolk-shell phosphor powders prepared at the same post-treatment temperature of 1200°C.

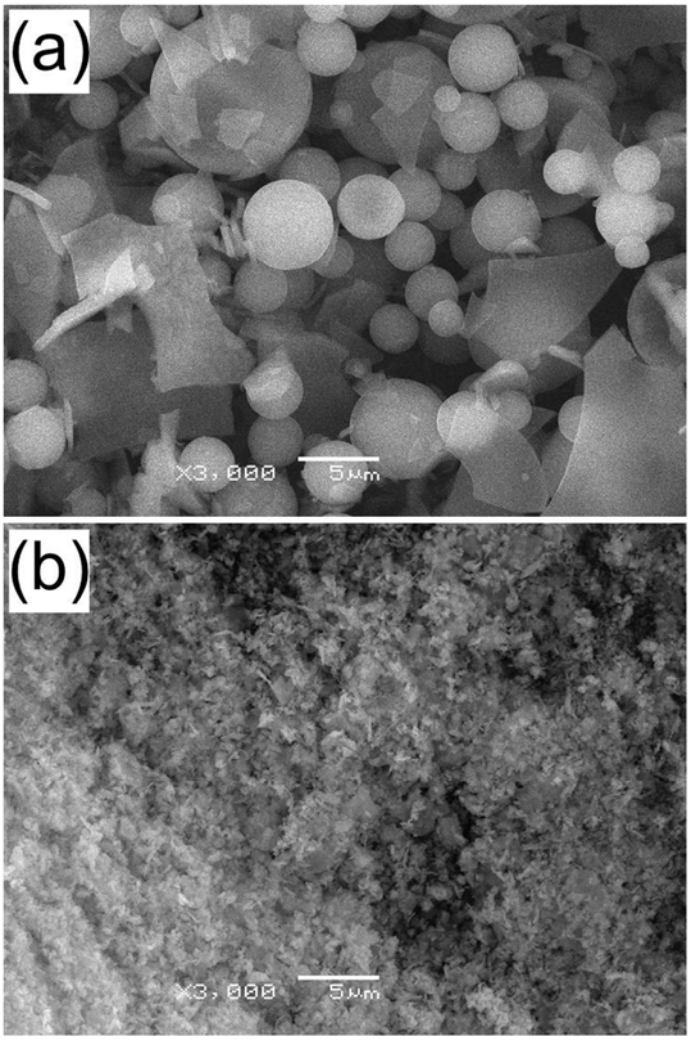


Fig. S6 SEM images of the powders prepared by spray drying process (a) before and (b) after post-treatment at 1200°C.

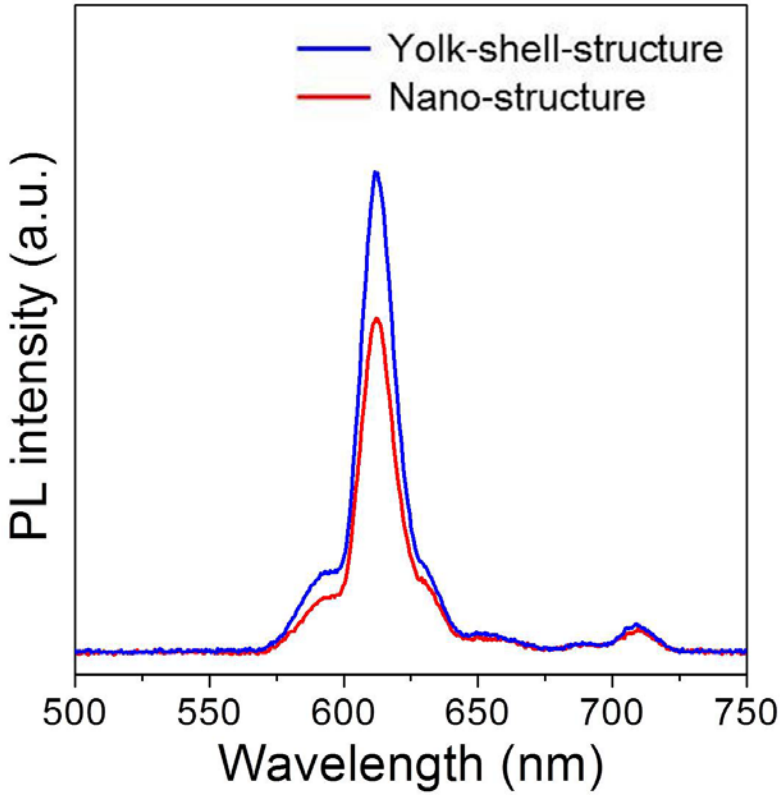


Fig. S7 Emission spectra of the yolk-shell and nano-structured Y_2O_3:Eu^{3+} phosphor powders.

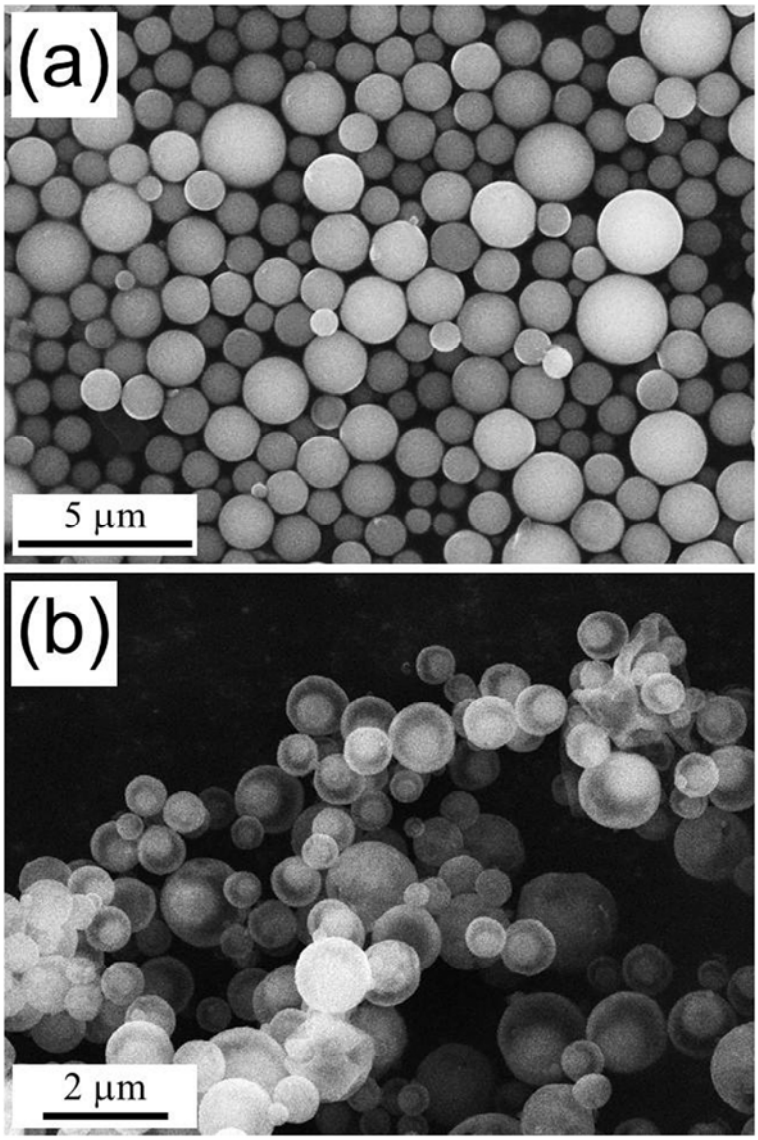


Fig. S8 SEM images of the Y_2O_3:Eu^{3+} phosphor powders prepared from the spray solution with sucrose in N_2 atmosphere: (a) before heat-treatment and (b) after heat-treatment at 800^{o}C under air atmosphere.