Electronic Supplementary Information

Morphological Control and Upconversion Luminescence of Hollow CeO₂ and Er³⁺–Yb³⁺ Codoped CeO₂ Particles

Mitsunori Yada,* Takashi Miyaguchi, Daiki Watanabe, Yukako Hayashi, Tatsuya Ayabe, Toshio Torikai, and Takanori Watari

Saga University, Department of Chemistry and Applied Chemistry, Faculty of Science and Engineering, 1 Honjo, Saga, 840-8502 (Japan), E-mail: yada@cc.saga-u.ac.jp



Fig. S1 XRD patterns of 2 (a), 3 (b), 2' (c), and 3' (d). Peak assignment: \circ , Ce(OH)CO₃; \bullet , CeO₂.



Fig. S2 SEM images of the fracture sections of the hollow structures of 1' (a), 2' (b), and 3' (c). Yellow arrows indicate the locations where the hollow structures had collapsed.



Fig. S3 XRD patterns of **1**" (a) and **1**" calcined at 500 °C (b). Peak assignment: \circ , Ce(OH)CO₃; •, CeO₂.



a



b





Fig. S5 SEM images of 5 (a), 5' (b), 5' calcined at 750 °C (c), 5' calcined at 1000 °C (d), and 5' calcined at 1250 °C (e). Yellow arrows indicate the locations where the hollow structures had collapsed.



Fig. S6 SEM images of 6 (a), 6' (b), 6' calcined at 750 °C (c), 6' calcined at 1000 °C (d), and 6' calcined at 1250 °C (e). Yellow arrows indicate the locations where the hollow structures had collapsed.



Fig. S7 XRD patterns of **5** (a), **5'** (b), **5'** calcined at 750 °C (c), **5'** calcined at 1000 °C (d), and **5'** calcined at 1250 °C (e). Peak assignment: \circ , Ce(OH)CO₃; •, CeO₂.



Fig. S8 XRD patterns of **6** (a), **6'** (b), **6'** calcined at 750 °C (c), **6'** calcined at 1000 °C (d), and **6'** calcined at 1250 °C (e). Peak assignment: \circ , Ce(OH)CO₃; •, CeO₂.



Fig. S9 Upconversion emission spectra of **5'** calcined at 750 °C (blue), **5'** calcined at 1000 °C (green), and **5'** calcined at 1250 °C (red).



Fig. S10 Upconversion emission spectra of **6'** calcined at 750 °C (blue), **6'** calcined at 1000 °C (green), and **6'** calcined at 1250 °C (red).



Fig. S11 SEM images of 4 calcined at 750 °C (a), 4 calcined at 1000 °C (b), and 4 calcined at 1250 °C (c).



Fig. S12 XRD patterns of 4 (a), 4 calcined at 750 °C (b), 4 calcined at 1000 °C (c), and 4 calcined at 1250 °C (d). Peak assignment: \circ , Ce(OH)CO₃; \bullet , CeO₂.