

# Supplementary Data

## Ultra-simple synthetic approach to the fabrication of CeO<sub>2</sub>-ZrO<sub>2</sub> mixed nanoparticles into homogeneous, domain, and core-shell structures in mesoporous spherical morphologies using supercritical alcohols

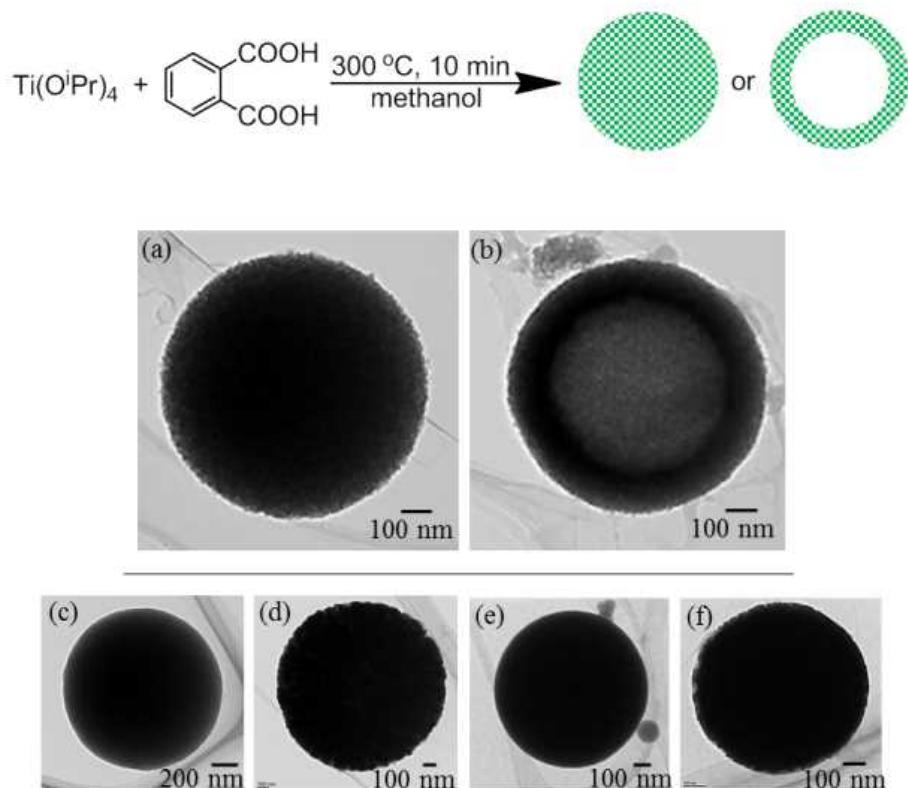
Ellawala K. C. Pradeep, Teppei Habu, Hiroko Tooriyama, Masataka Ohtani, and Kazuya Kobiro\*

*School of Environmental Science and Engineering, Kochi University of Technology, 185 Miyanokuchi, Tosayamada, Kochi 782-8502, Japan*

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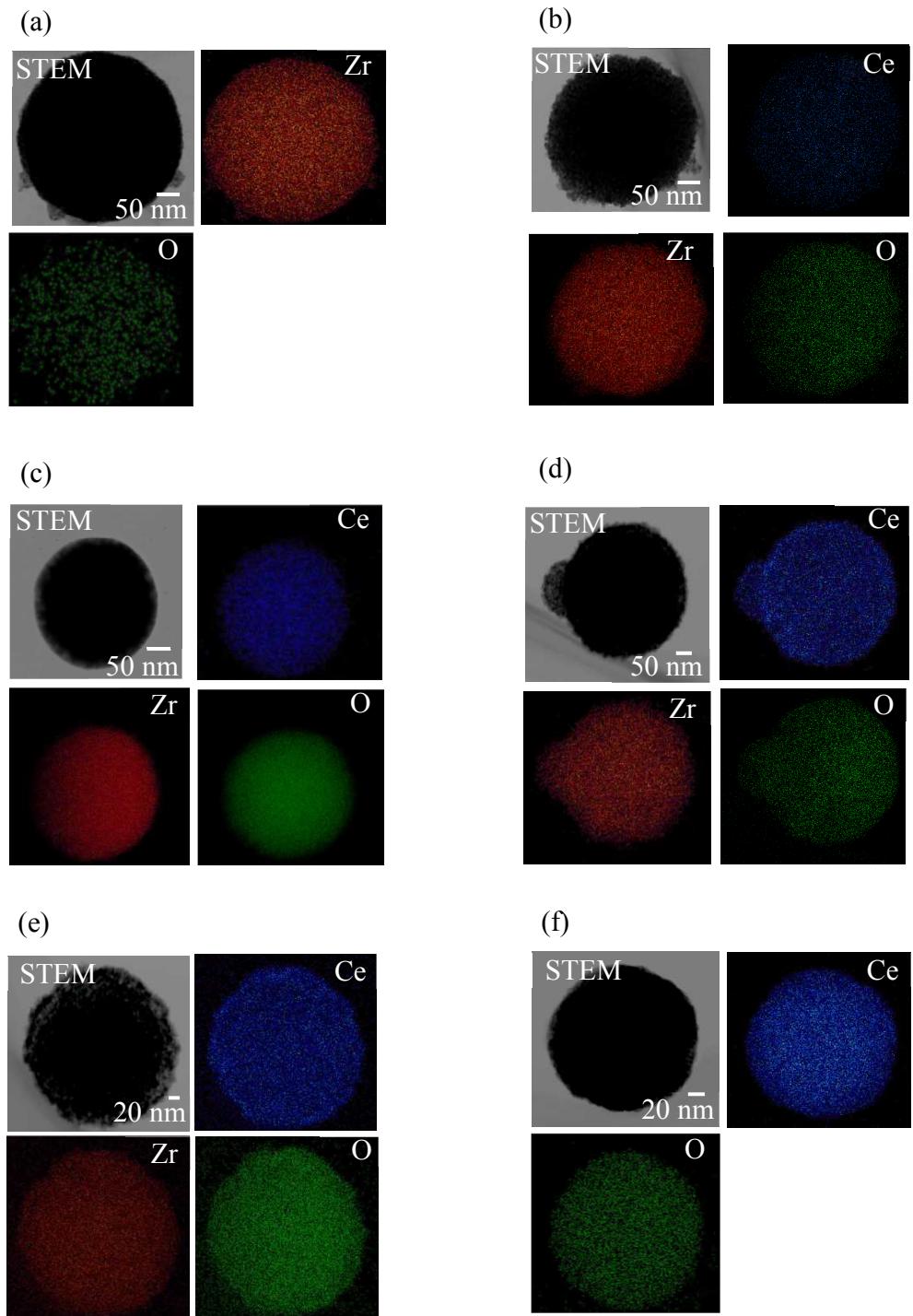
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1. Synthetic of varieties of MARIMOs.



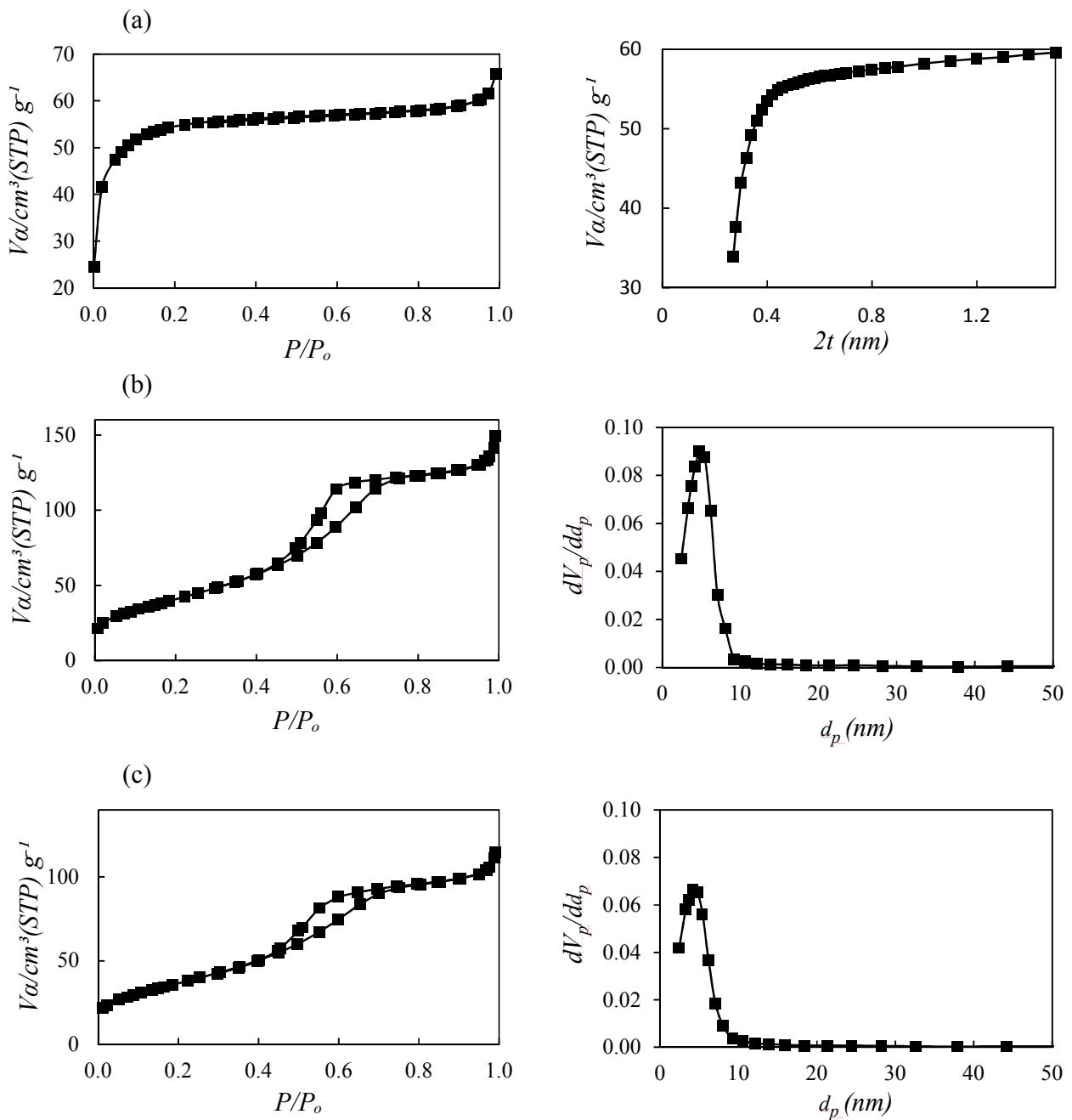
**Fig. S1.** Reaction scheme to yield solid and hollow MARIMO  $\text{TiO}_2$  and transmission electron microscope (TEM) images of hollow and solid spherical metal oxide NPs synthesized in one pot single process: (a) solid MARIMO  $\text{TiO}_2$ , (b) hollow MARIMO  $\text{TiO}_2$ , (c) solid MARIMO  $\text{SiO}_2$ , (d) solid MARIMO  $\text{ZnO}$ , (e) solid MARIMO  $\text{ZrO}_2$ , and (f) solid MARIMO  $\text{CeO}_2$ .

**2.** EDX mapping images of homogeneous MARIMO Ce/ZrO<sub>2</sub> NPs.

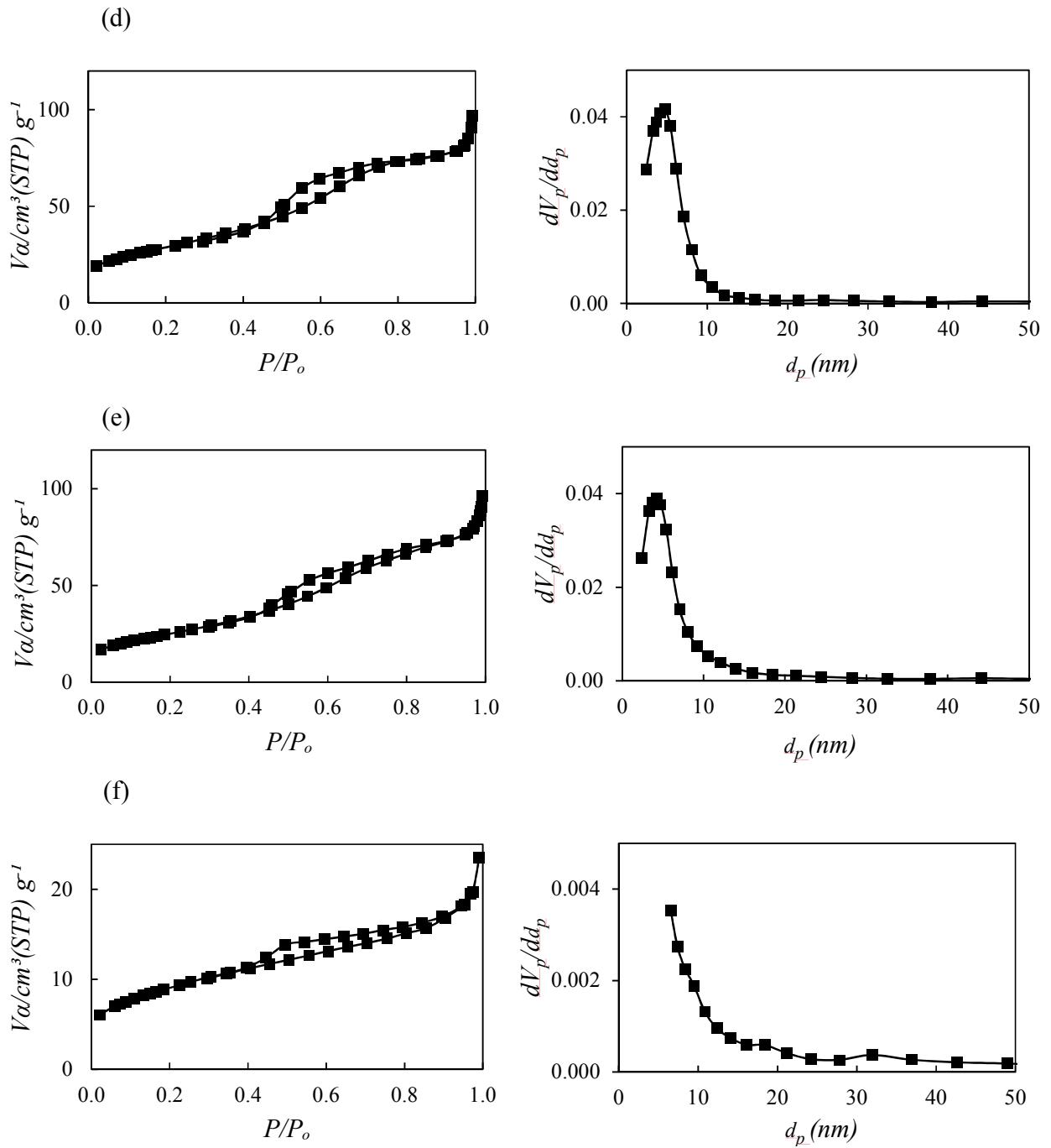


**Fig. S2.** EDX mapping images of homogeneous MARIMO (a) ZrO<sub>2</sub>, (b) Ce/ZrO<sub>2</sub>-0.25 (c) Ce/ZrO<sub>2</sub>-0.33, (d) Ce/ZrO<sub>2</sub>-0.50, (e) Ce/ZrO<sub>2</sub>-0.66, and (f) CeO<sub>2</sub> NPs.

3. Nitrogen adsorption-desorption isotherms and pore size distributions.

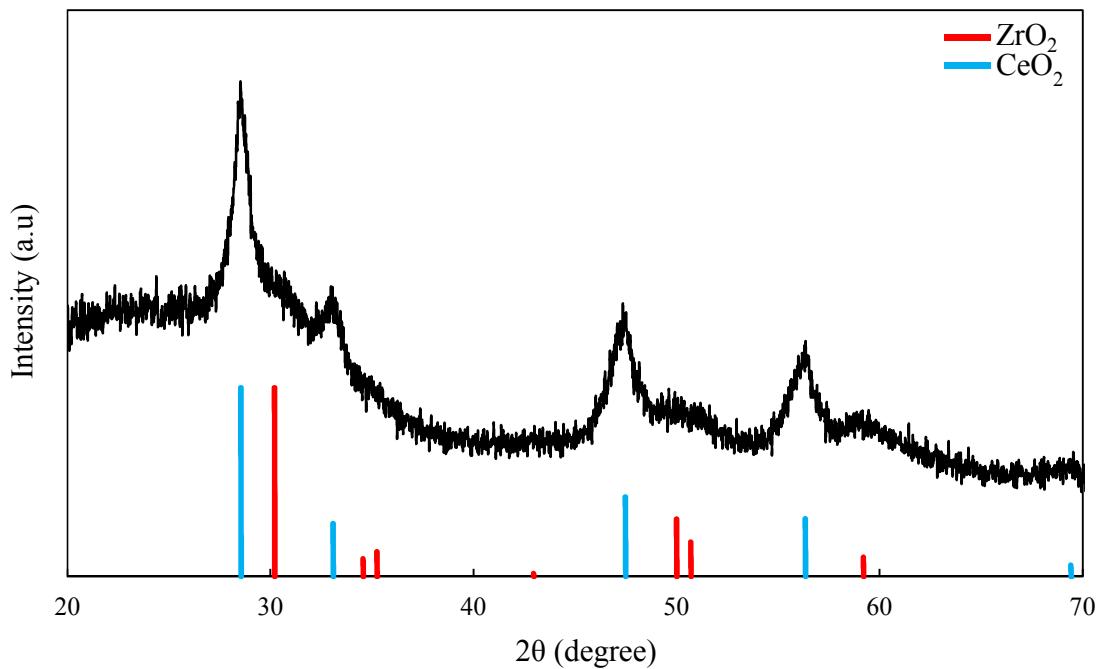


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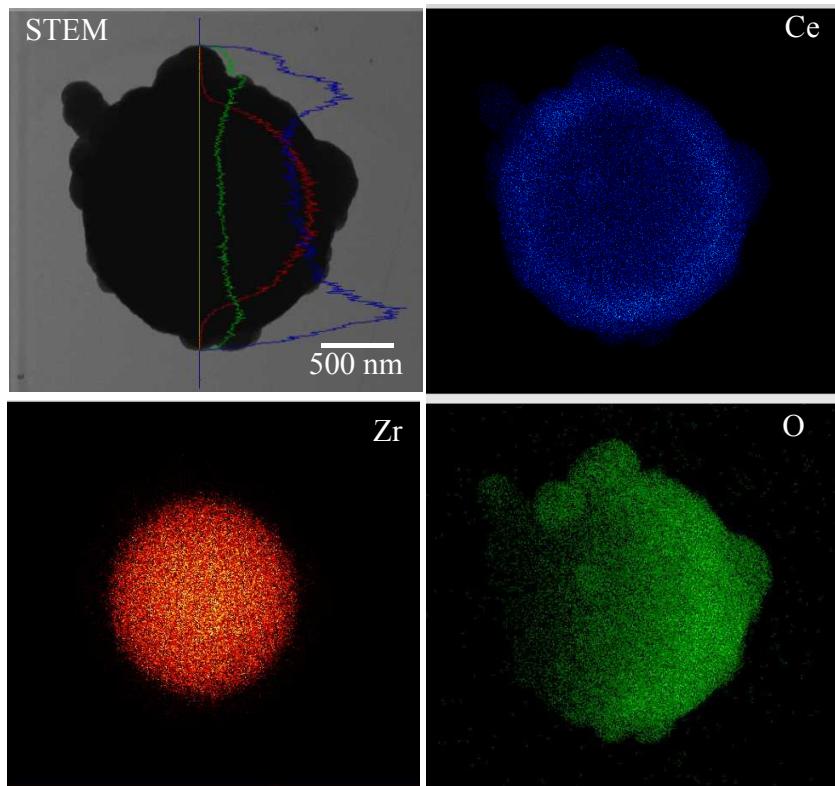
**Fig. S3.** Nitrogen adsorption-desorption isotherms, *t*-plot or BJH pore size distributions of homogenous MARIMO (a) ZrO<sub>2</sub>, (b) Ce/ZrO<sub>2</sub>-0.25 (c) Ce/ZrO<sub>2</sub>-0.33, (d) Ce/ZrO<sub>2</sub>-0.50, (e) Ce/ZrO<sub>2</sub>-0.66, and (f) CeO<sub>2</sub> NPs.

4. XRD patterns of 1:2 (*w/w*) mixture of MARIMO CeO<sub>2</sub> and MARIMO ZrO<sub>2</sub> NPs.



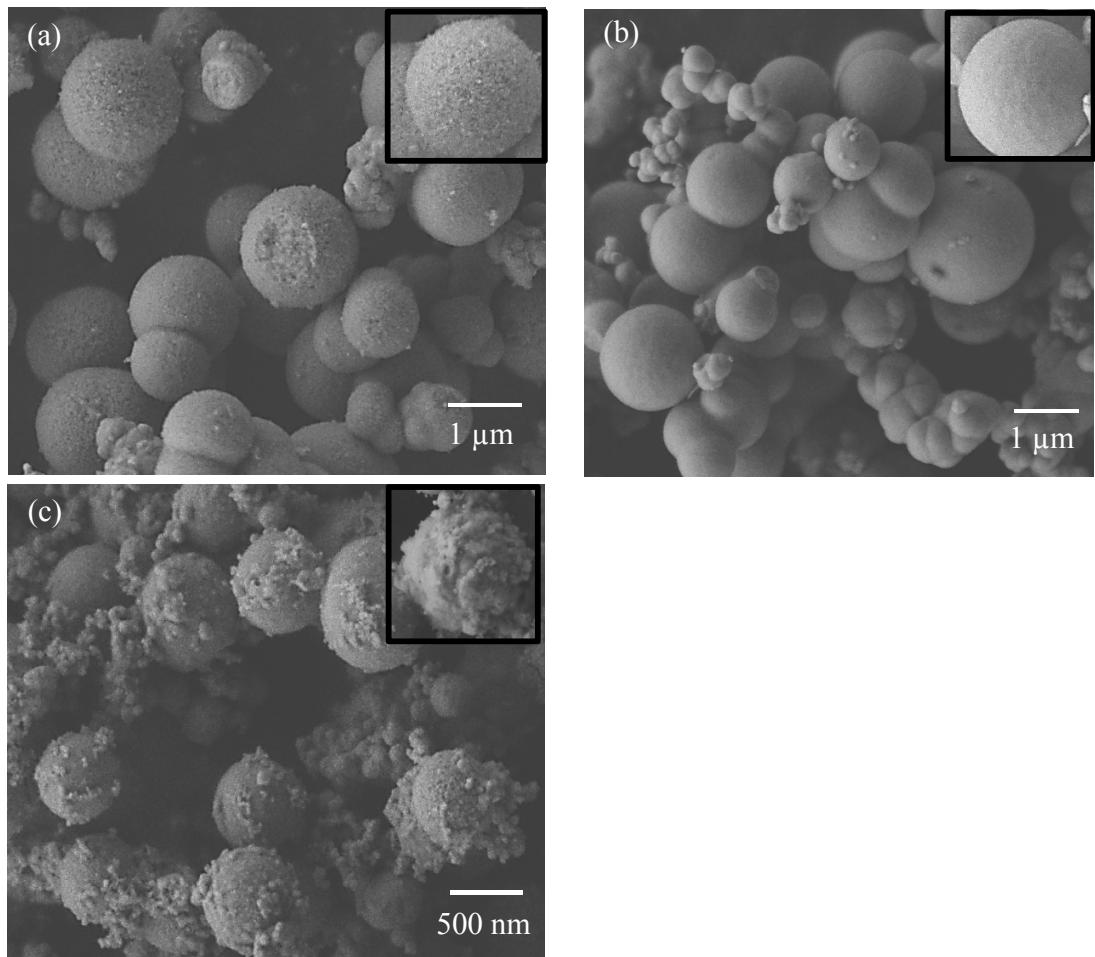
**Fig. S4.** XRD patterns of 1:2 (*w/w*) mixture of MARIMO CeO<sub>2</sub> and MARIMO ZrO<sub>2</sub> NPs. (Peak positions of cubic CeO<sub>2</sub> and tetragonal ZrO<sub>2</sub> are shown with blue and red lines, respectively.)

5. EDX mapping images of core-shell type NPs in  $\text{ZrO}_2@\text{CeO}_2$ -MeOH.



**Fig. S5.** EDX mapping images of core-shell type NPs in  $\text{ZrO}_2@\text{CeO}_2$ -MeOH.

6. SEM images of CeO<sub>2</sub>-ZrO<sub>2</sub> and ZrO<sub>2</sub>@CeO<sub>2</sub> NPs.



**Fig. S6.** SEM images of (a) CeO<sub>2</sub>-ZrO<sub>2</sub>-SH, (b) ZrO<sub>2</sub>@CeO<sub>2</sub>-MeOH, and (c) ZrO<sub>2</sub>@CeO<sub>2</sub>-<sup>i</sup>PrOH NPs.

7. BET specific surface area and pore diameter of CeO<sub>2</sub>-ZrO<sub>2</sub> and ZrO<sub>2</sub>@CeO<sub>2</sub> NPs.

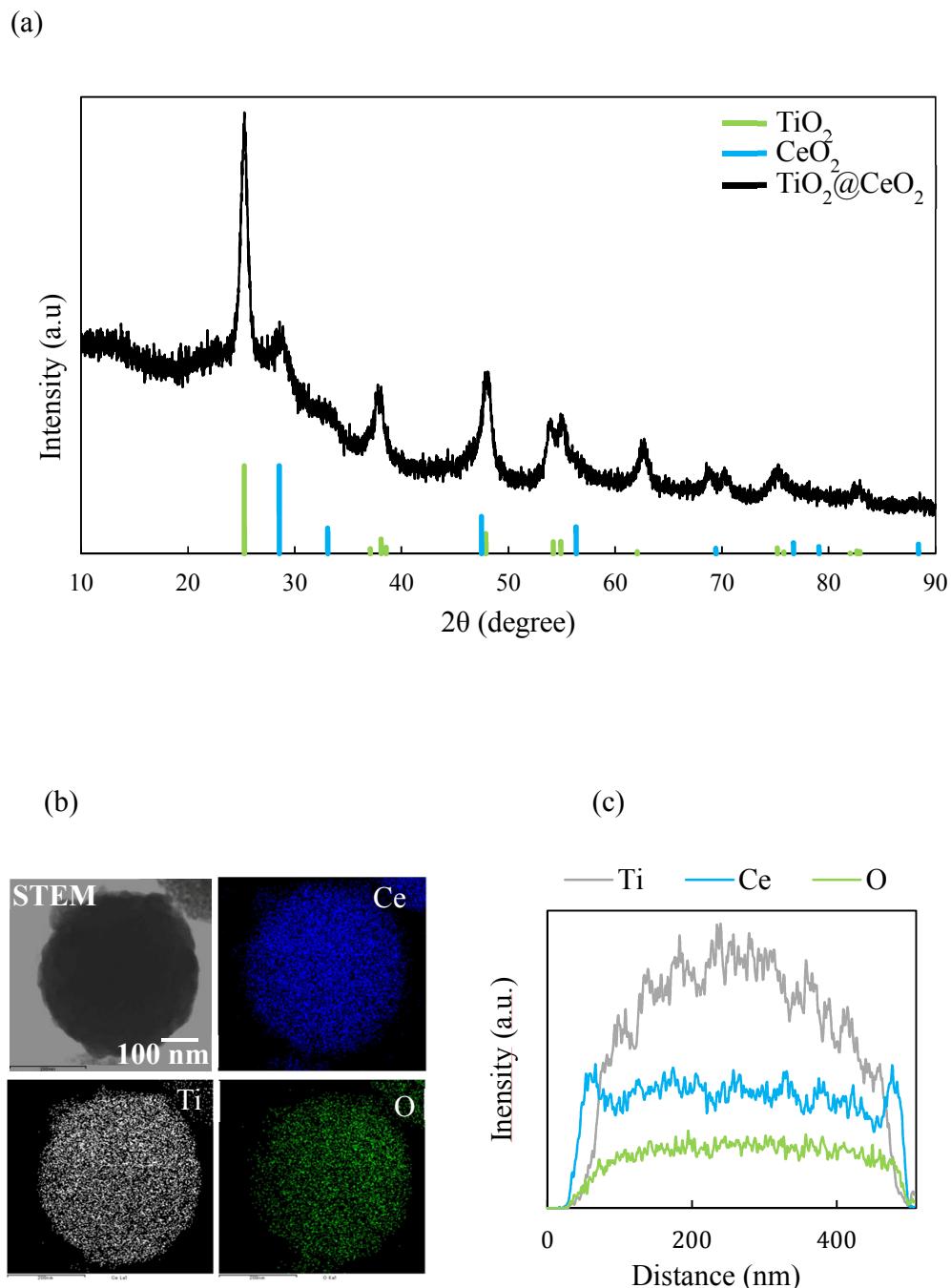
**Table S1.** BET specific surface area and pore diameter of CeO<sub>2</sub>-ZrO<sub>2</sub> and ZrO<sub>2</sub>@CeO<sub>2</sub> core-shell NPs.

Sample name	BET specific surface area (m <sup>2</sup> g <sup>-1</sup> )	Pore diameter (nm)
CeO <sub>2</sub> -ZrO <sub>2</sub> -SH	129	8.1 <sup>a</sup>
ZrO <sub>2</sub> @CeO <sub>2</sub> -MeOH	103	1.3 <sup>b</sup>
ZrO <sub>2</sub> @CeO <sub>2</sub> - <i>i</i> -PrOH	126	1.4 <sup>b</sup>

<sup>a</sup> Calculated by BJH method.

<sup>b</sup> Calculated by *t*-method.

8.  $\text{TiO}_2@\text{CeO}_2$  core-shell NPs



**Fig. S7.** (a) XRD patterns, (b) EDX mapping images, and (c) line scans of  $\text{TiO}_2@\text{CeO}_2$  core-shell NPs. (XRD peak positions of anatase  $\text{TiO}_2$  and cubic  $\text{CeO}_2$  are shown with green and blue lines, respectively.)