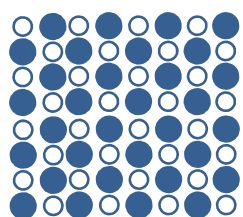
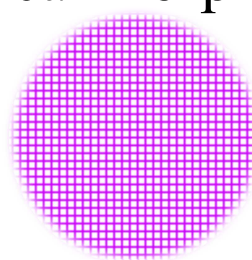
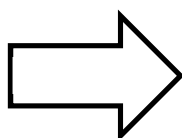


Nano structures

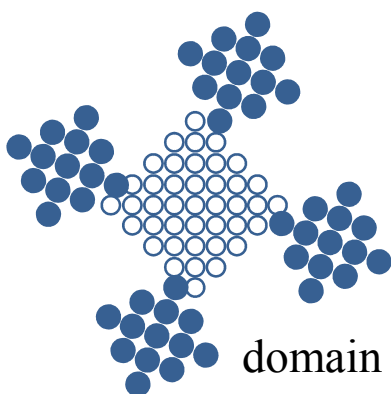
Spherical morphology



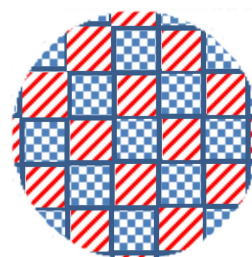
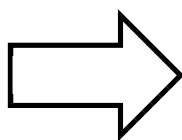
homogeneous



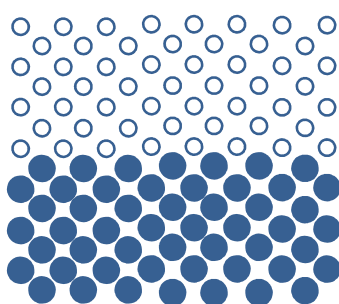
homogeneous



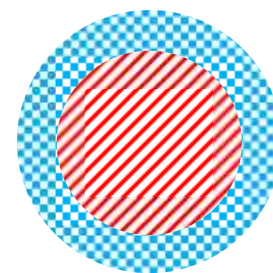
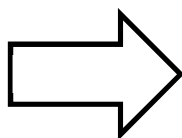
domain



domain



layer



core-shell

Fig. 1. Schematic of material design structures of metal oxides NPs. ● and ○ represent different nanocrystals.

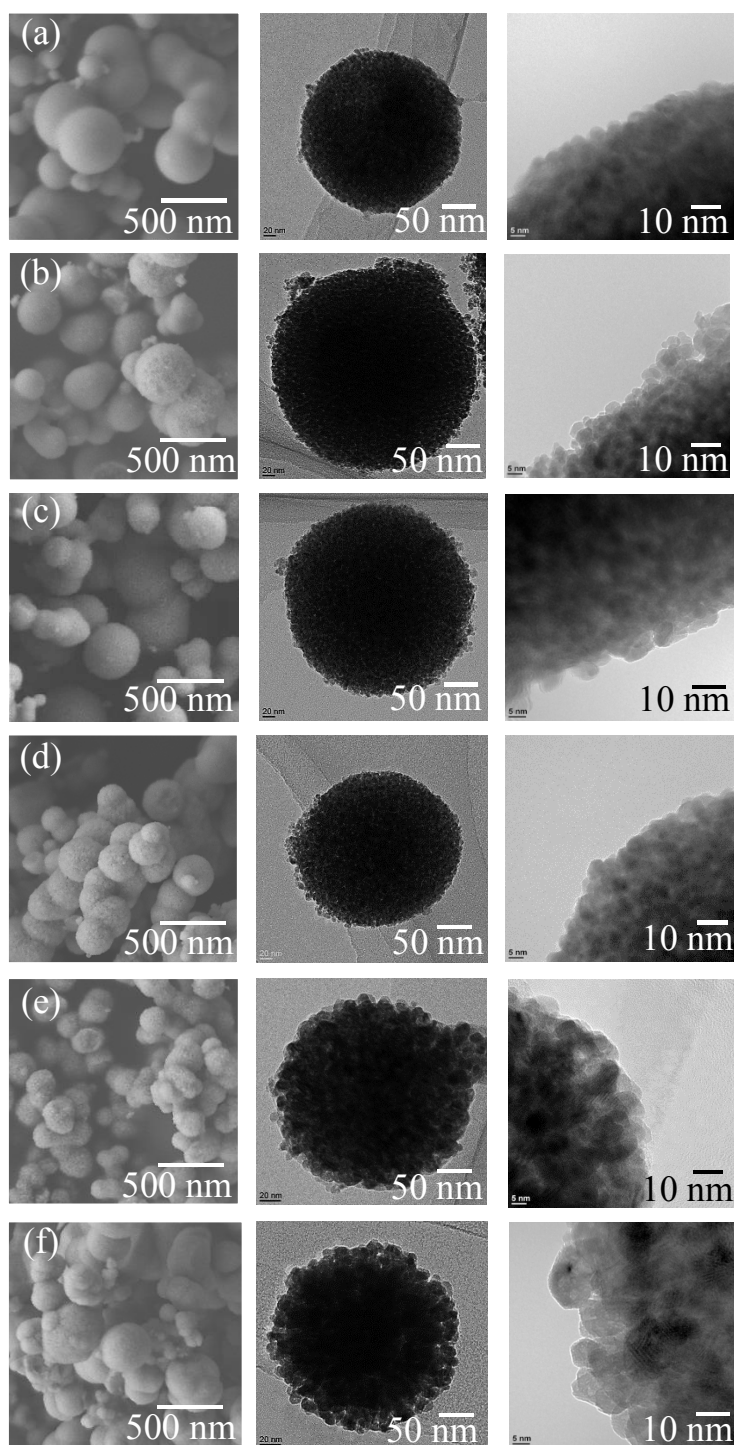


Fig. 2. SEM (left), TEM (center) and HRTEM (right) images of MARIMO NPs: (a) ZrO_2 , (b) $\text{Ce/ZrO}_2\text{-0.25}$, (c) $\text{Ce/ZrO}_2\text{-0.33}$, (d) $\text{Ce/ZrO}_2\text{-0.50}$, (e) $\text{CeZrO}_2\text{-0.66}$, and (f) CeO_2 .

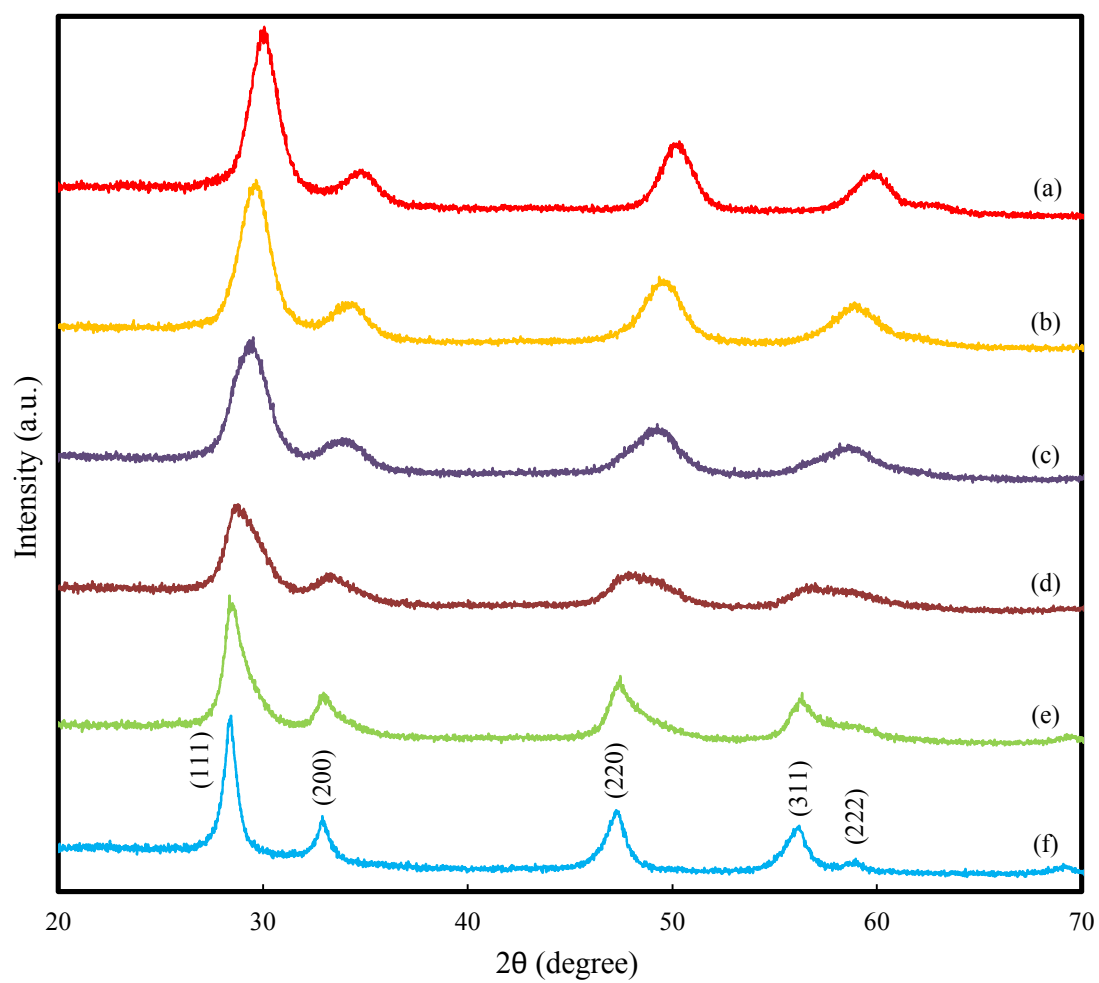


Fig. 3. XRD patterns of MARIMO NPs: (a) ZrO_2 , (b) $\text{Ce}/\text{ZrO}_2\text{-}0.25$, (c) $\text{Ce}/\text{ZrO}_2\text{-}0.33$, (d) $\text{Ce}/\text{ZrO}_2\text{-}0.50$, (e) $\text{Ce}/\text{ZrO}_2\text{-}0.66$, and (f) CeO_2 .

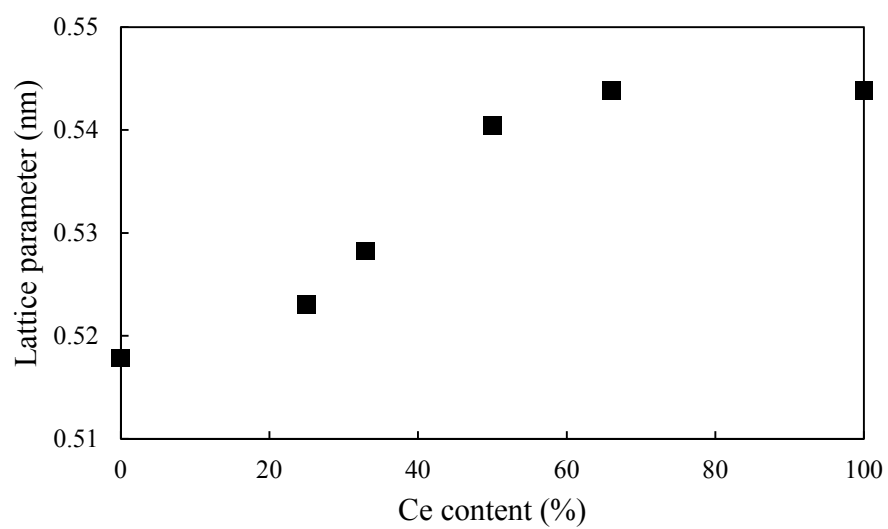


Fig. 4. Lattice parameter vs. Ce content in precursor solution.

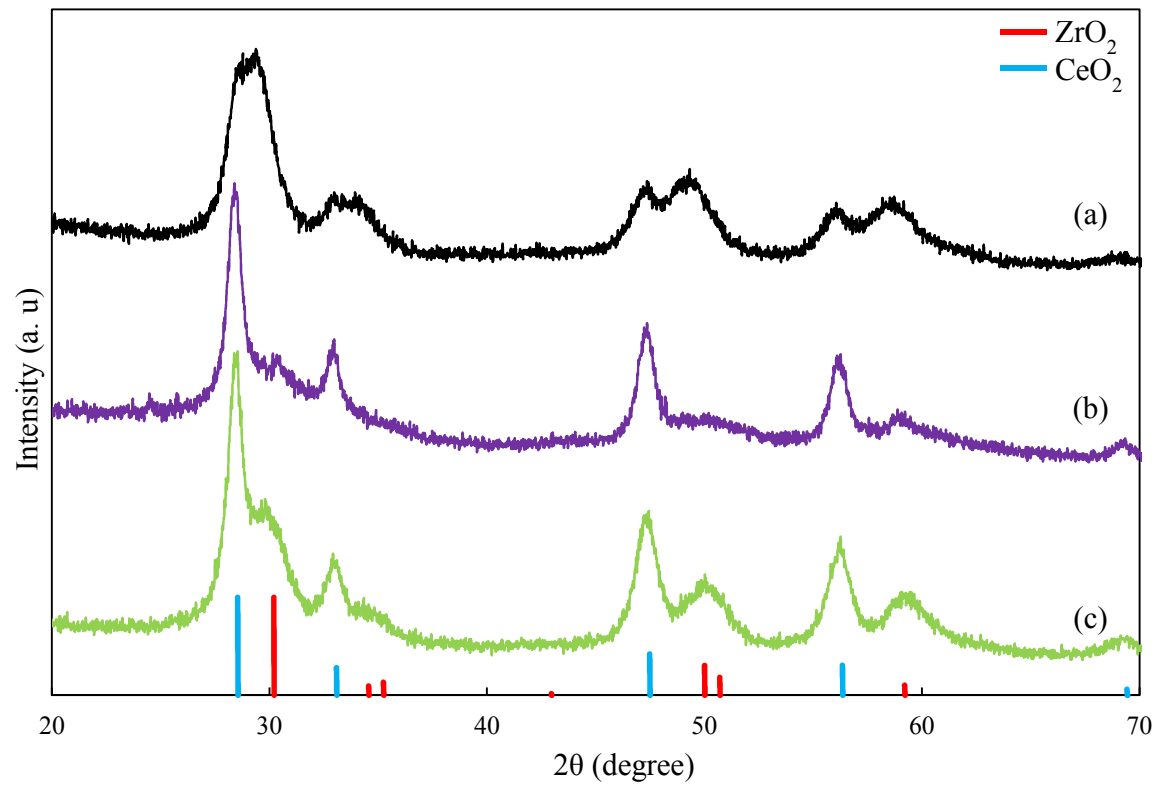


Fig. 5. XRD patterns of (a) $\text{CeO}_2\text{-ZrO}_2\text{-SH}$, (b) $\text{ZrO}_2@\text{CeO}_2\text{-MeOH}$, and (c) $\text{ZrO}_2@\text{CeO}_2\text{-}i\text{PrOH}$. (Peak positions of cubic CeO_2 and tetragonal ZrO_2 are shown with blue and red lines, respectively)

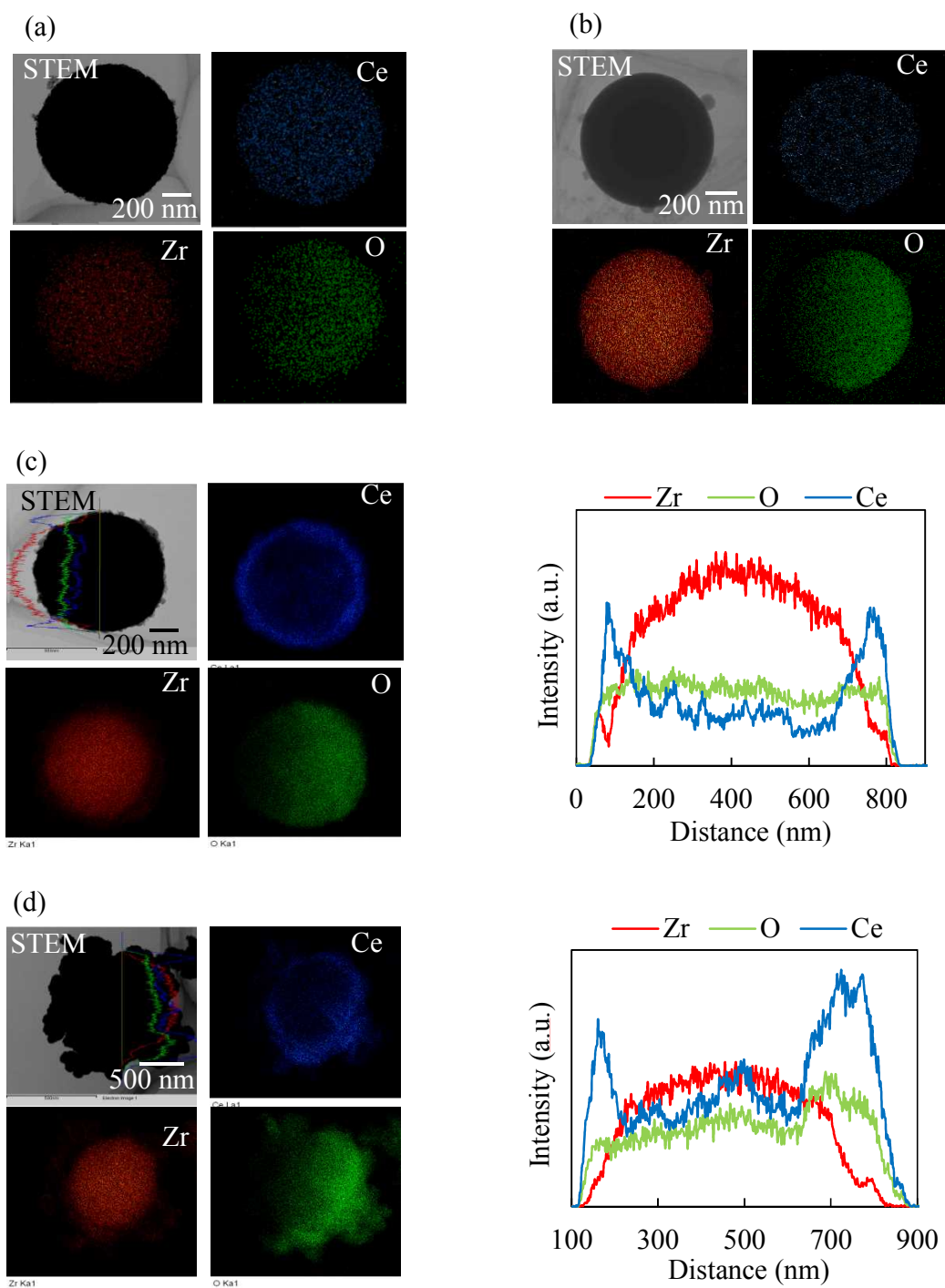


Fig. 6. EDX mapping images of (a) ZrO₂-CeO₂-SH, (b) ZrO₂@CeO₂-MeOH, and EDX mapping images (left) and line scans (right) of ZrO₂@CeO₂-*i*PrOH (c) perfect and (d) rugged NPs.

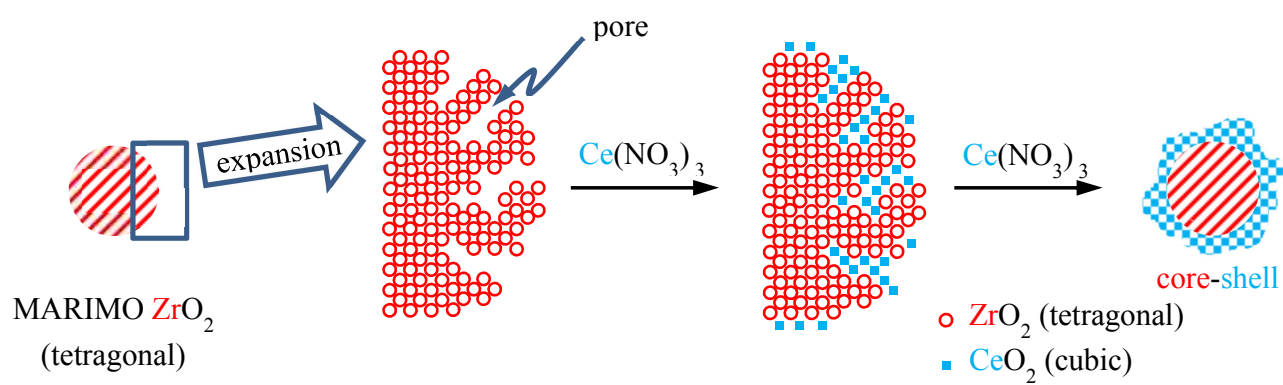


Fig. 7. Proposed formation mechanism for the $\text{ZrO}_2@\text{CeO}_2$ core-shell structure.