

## Supplementary Information

### Template-free formation of various V<sub>2</sub>O<sub>5</sub> hierarchical structures as cathode materials for lithium-ion batteries

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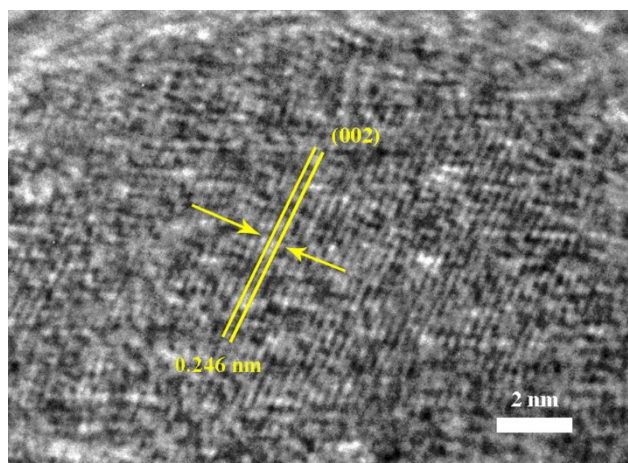
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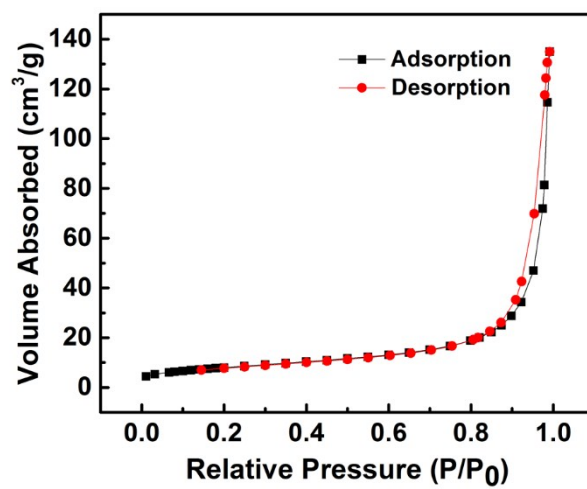
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Advanced Industrial Science and Technology (AIST), Nagoya 463-8560, Japan

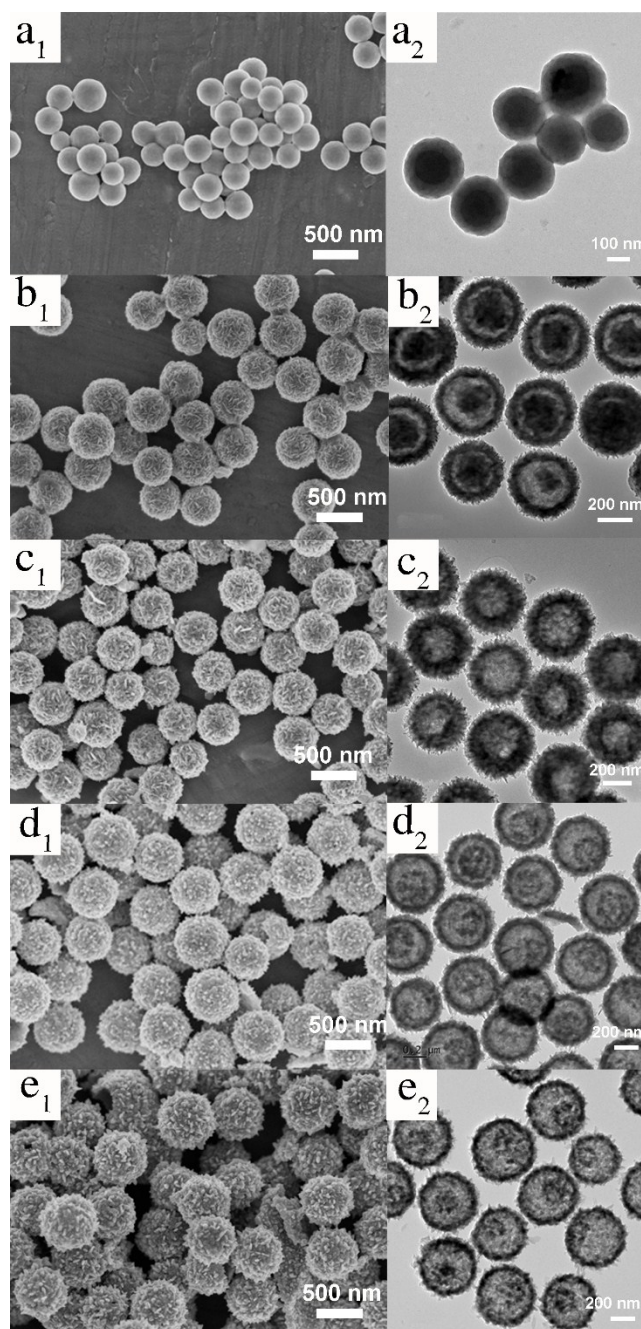
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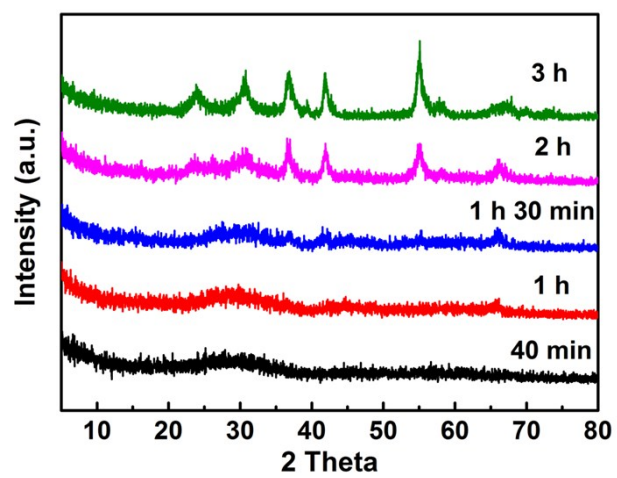
**Fig. S1** High-resolution TEM image of the yolk-shell VO<sub>2</sub> sub-microspheres synthesized at 200 °C after solvothermal treatment for 3 h.



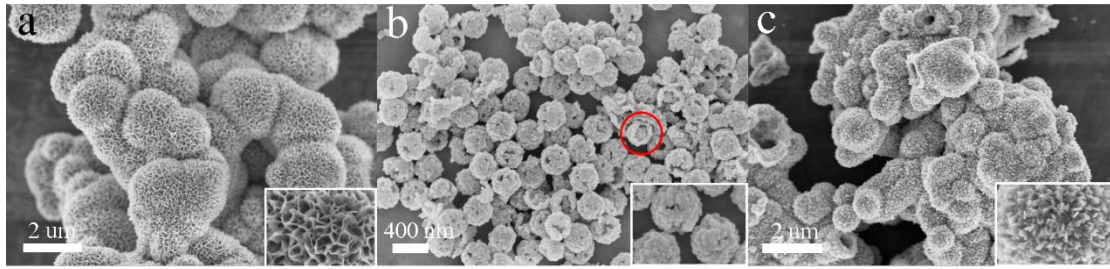
**Fig. S2** N<sub>2</sub> adsorption–desorption isotherms of the yolk-shell VO<sub>2</sub> sub-microspheres after solvothermal reaction for 3 h.



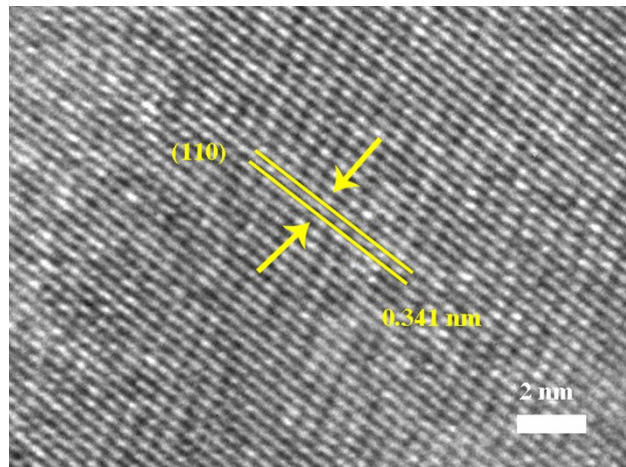
**Fig. S3** Low magnification FESEM and TEM images of the sub-microspheres prepared with different solvothermal reaction time: (a) 40 min, (b) 1 h, (c) 1.5 h, (d) 2 h and (e) 3 h.



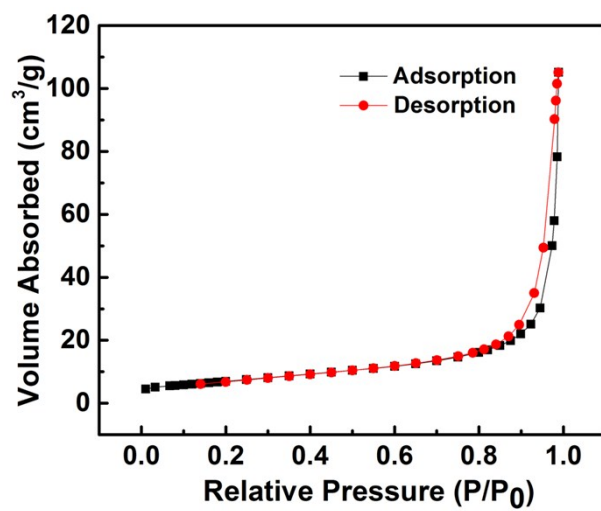
**Fig. S4** XRD patterns of the solvothermal products with different reaction duration (40 min, 1 h, 1.5 h, 2 h and 3 h).



**Fig. S5** FESEM images of the solvothermal reaction products using different amount of hydrogen peroxide solution: (a) 0 ml, (b) 1 ml, (c) 3 ml.

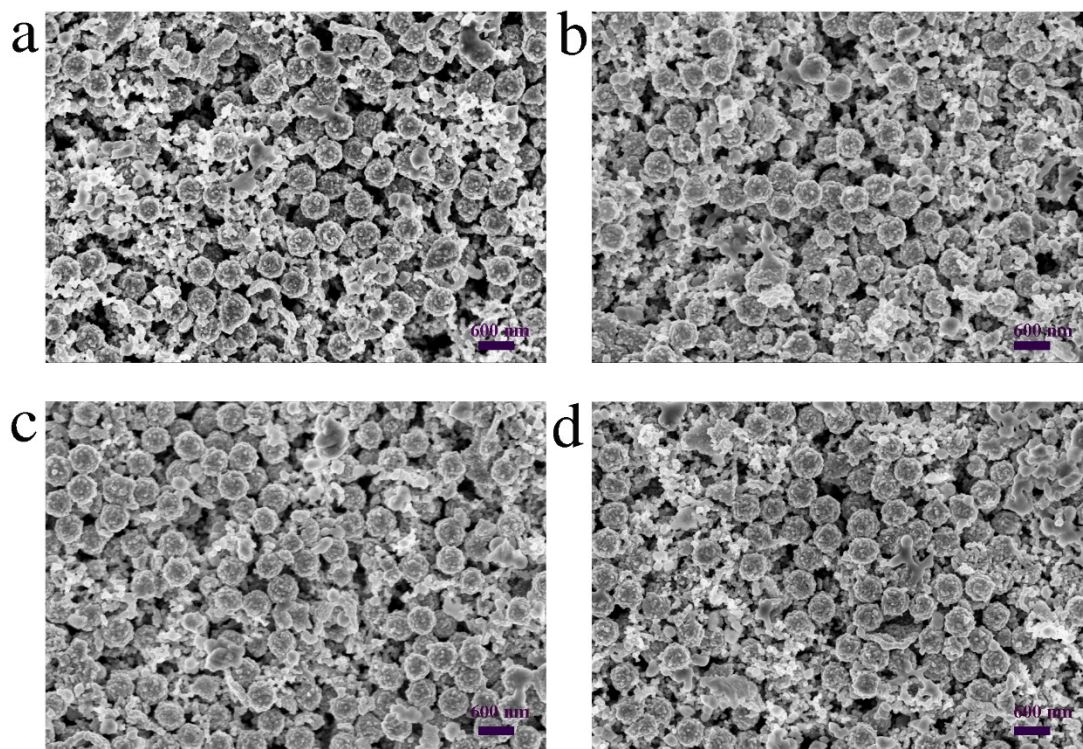


**Fig. S6** High-resolution TEM image of the yolk-shell V<sub>2</sub>O<sub>5</sub> sub-microspheres synthesized by annealing yolk-shell VO<sub>2</sub> sub-microspheres via 3 h solvothermal treatment.

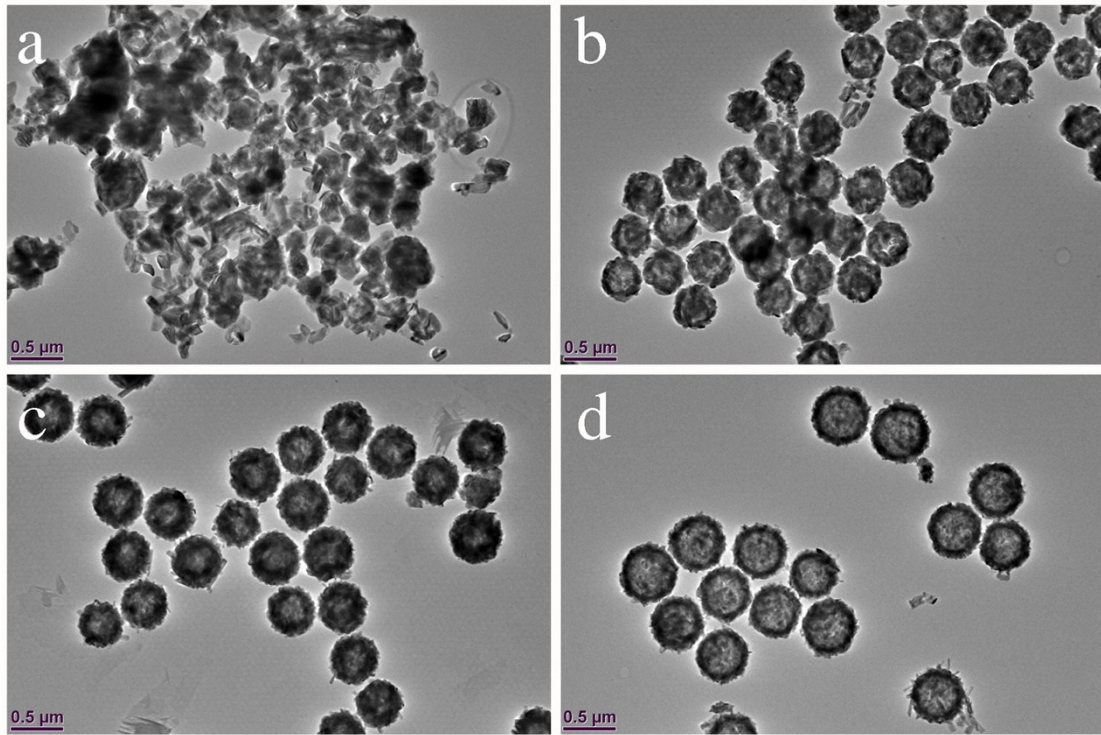


**Fig. S7** N<sub>2</sub> adsorption–desorption isotherms of the yolk-shell V<sub>2</sub>O<sub>5</sub> sub-microspheres synthesized by annealing yolk-shell VO<sub>2</sub> sub-microspheres.





**Fig.S8** FESEM images of the yolk-shell  $V_2O_5$  sub-microsphere electrodes after 80<sup>th</sup> cycle at different current density: (a) 1 C, (b) 2 C, (c) 3 C, (d) 4 C.



**Fig. S9** Low magnification TEM images of the various V<sub>2</sub>O<sub>5</sub> hierarchical structures:

(a) V<sub>2</sub>O<sub>5</sub>-1, (b) V<sub>2</sub>O<sub>5</sub>-2, (c) V<sub>2</sub>O<sub>5</sub>-3 and V<sub>2</sub>O<sub>5</sub>-4.