# Supplementary Information

## One-Step Vapor-Solid Reaction Growth of Sn@C Core-Shell Nanowires as an Anode Material for Li-Ion Batteries

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**Table S1.** Summary of electrochemical properties of Sn containing electrodes for rechargeable Li-ion batteries.

**Figure S1.** SEM image and energy dispersive X-ray spectrum (EDX) of product **A**.

**Figure S2.** XRD patterns of products **A** and **B**.

**Figure S3.** Raman spectra of product **A** and $SnO_2$. (Excitation wavelength: 785 nm, power: 5 mW)

**Figure S4.** Thermogravimetric analysis (TGA) profile of **A**. The Sn and C contents are estimated to be 46.8 wt % (8.1 at %) and 53.2 wt % (91.9 at %), respectively. The analysis was taken in $O_2$ using a heating rate of 10 K $min^{-1}$.

**Figure S5.** SEM images of samples prepared at (a) 873 K for 60 min, (b) 923 K for 30 min, (c) 973 K for 30 min, (d) 1073 K for 30 min, and (e) 1123 K for 30 min. $C_2H_2$ was flowing at 3 sccm under atmospheric pressure.

**Figure S6.** SEM images of the electrode prepared from Sn@C core-shell NWs. (a) Low and (b) high magnification views. (c) Low and (d) high magnification views of the electrode after 100 cycles of lithiation and delithiation. The electrode was fabricated with a mixture of carbon black and binder.

**Figure S7.** SEM images of (a) the commercial Sn powder, (b) the electrode prepared from the powder, and (c) low and (d) high magnification views of the electrode after 50 cycles of lithiation and delithiation. The Sn particles shown in (b) and (c) were mixed with carbon black and binder used for the electrode fabrication.

**Table S1**. Summary of electrochemical properties of Sn containing electrodes for rechargeable Li-ion batteries.

| Electrode material | Morphology and Composition | Electrochemical Performance | | | Cathode | Ref |
|---|---|---|---|---|---|---|
| | | Working Potential (V) | Cycling Rate | Capacity | | |
| $SnO_2$ NTs | Diameter: 180 – 230 nm | 0.005 – 2 | 80 cycles at 0.05 $mA \cdot cm^{-2}$ | 525 mAh/g | Li foil | 21[a] |
| $SnO_2$@C core/shell NTs | $SnO_2$ NPs: 10 nm<br>CNT diameter: 200 nm<br>($SnO_2$: 73.3 wt %) | 0.005 – 3 | 200 cycles at 0.3 $mA \cdot cm^{-2}$<br>(0.3 $mA \cdot cm^{-2} \cong$ 0.5 C) | 540 mAh/g<br>(200 mAh/g from CNT) | Li foil | 22[b] |
| Hydrobenzamide-capped Sn NPs | Particle size: 50 nm | 0 – 1.5 | 30 cycles at 0.2 C<br>(1 C = 900 mA/g) | 500 mAh/g | Li foil | 23[c] |
| Vertical arrays of Sn NWs on Si substrates | Diameter: 50 – 100 nm | 0.01 – 1.2 | 15 cycles at 4200 mA/g | 400 mAh/g | Li foil | 24[d] |
| Sn@C nanocomposite | Sn@C rambutan-like nanoarchitecture<br>(C: 73 wt %; Sn: 23 wt %) | 0.005 – 2 | 200 cycles at 100 mA/g | 311 mAh/g<br>(168 mAh/g from C sphere) | Li foil | 10[e] |
| Sn@C@CNT nanostructures | Sn NPs: 50 – 170 nm<br>C layer: 3 – 10 nm<br>arrays of CNTs: length 30 μm diameter 180 – 280 nm | 0.005 – 3 | 80 cycles at 0.1 $mA \cdot cm^{-2}$ | 490 mAh/g | Li foil | 9[f] |
| Sn@Cu core/shell type NPs | Core, Sn NP: 8.65 nm<br>Outer layer, Cu: 1.35 nm | 2.7 – 4.3 | 170 cycles at 0.8 C<br>(1C = 600 mA/g) | 560 mAh/g | $LiCoO_2$ | 25[g] |
| Nanoporous Au-supported nanocrystalline Sn | Nanoporous Au<br>Sn NPs<br>(Au: 17.2 wt %; Sn: 82.8 wt %) | 0.005 – 2<br>0.005 – 1 | 140 cycles at 0.1 C<br>(1C = 1000 mA/g)<br>140 cycles at 8 C<br>(1C = 1000 mA/g) | 440 mAh/g<br>260 mAh/g | Li foil | 11[h] |
| Sn@C core/shell NWs | Core/shell NW<br>diameter: 100 – 350 nm<br>shell thickness: 30 – 70 nm<br>length: tens μm<br>(C: 91.9 at %; Sn: 8.1 at %) | 0.005 – 2 | 100 cycles at 100 mA/g<br>100 cycles at 1000 mA/g<br>100 cycles at 3000 mA/g | 525 mAh/g<br>486 mAh/g<br>290 mAh/g | Li foil | This work |

a. Y. Wang, J. Y. Lee and H. C. Zeng, Chem. Mater., 2005, 17, 3899-3903.

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c. Y. Kwon, M. G. Kim, Y. Kim, Y. Lee and J. Cho, Electrochem. Solid-State Lett., 2006, 9, A34-A38.

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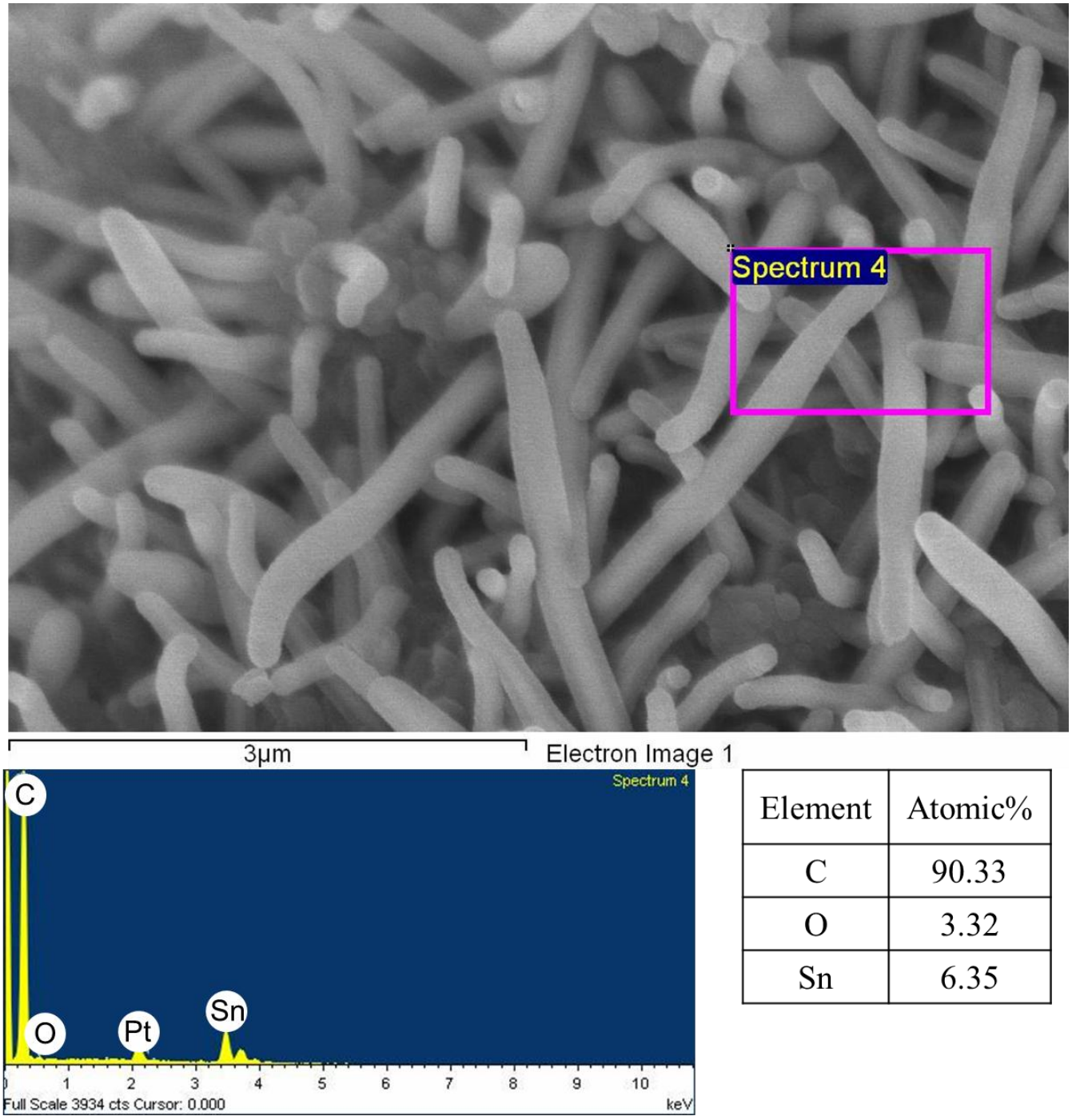
g. M. G. Kim, S. Sim and J. Cho, Adv. Mater., 2010, 22, 5154-5158.

h. Y. Yu, L. Gu, X. Lang, C. Zhu, T. Fujita, M. Chen and J. Maier, Adv. Mater., 2011, 23, 2443-2447.




| Element | Atomic% |
|---|---|
| C | 90.33 |
| O | 3.32 |
| Sn | 6.35 |

**Figure S1.** SEM image and energy dispersive X-ray spectrum (EDX) of product **A**.

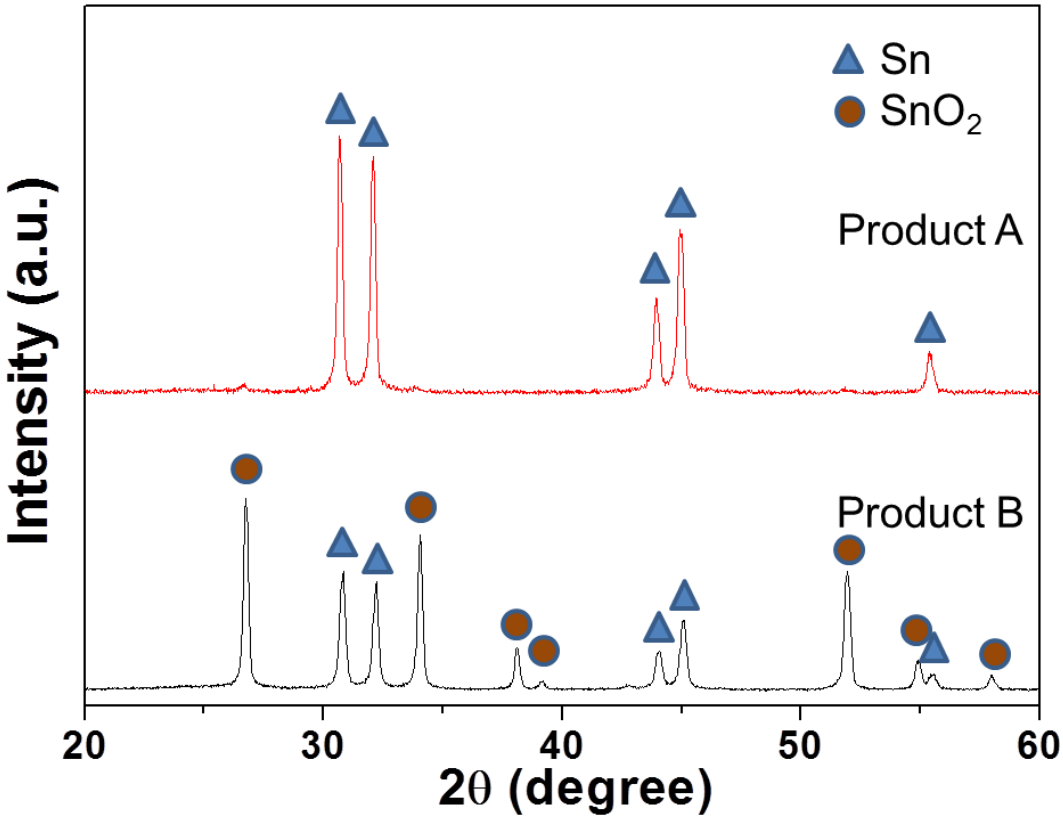



**Figure S2.** XRD patterns of products **A** and **B**.

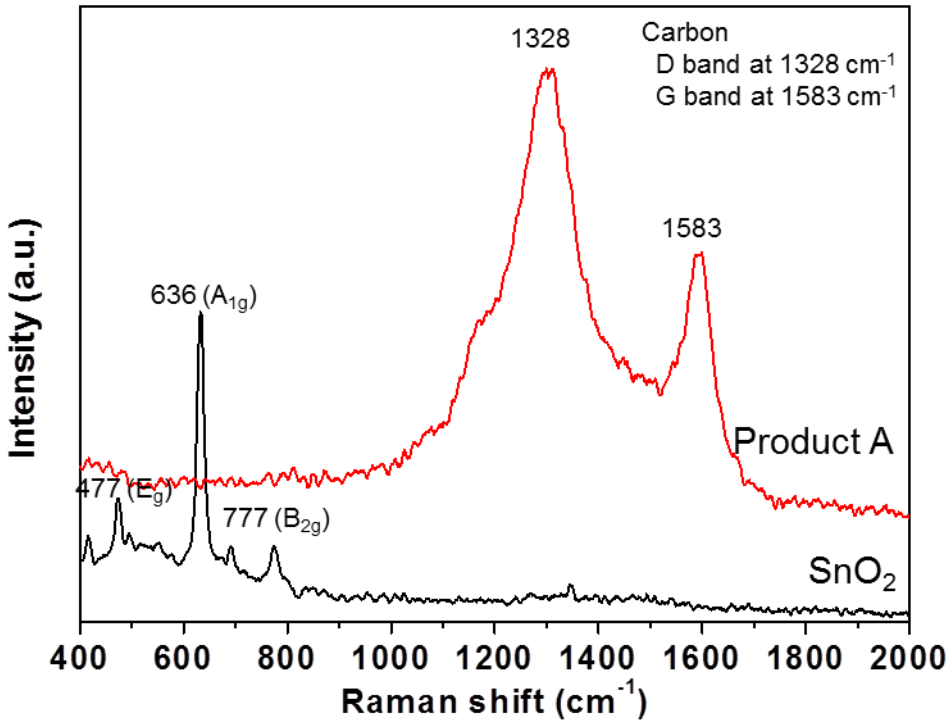
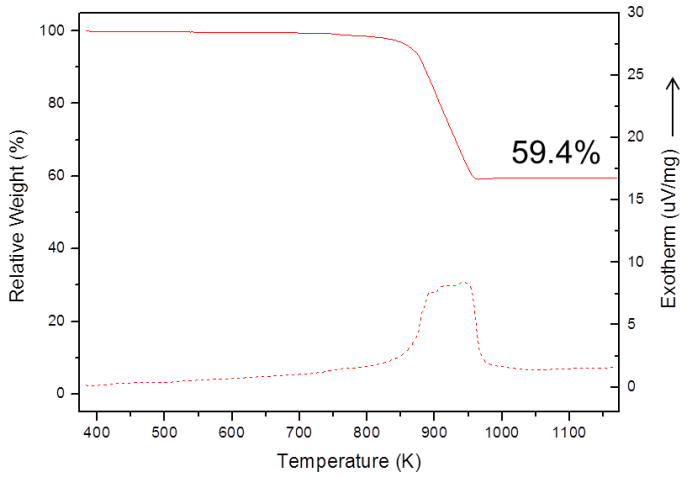


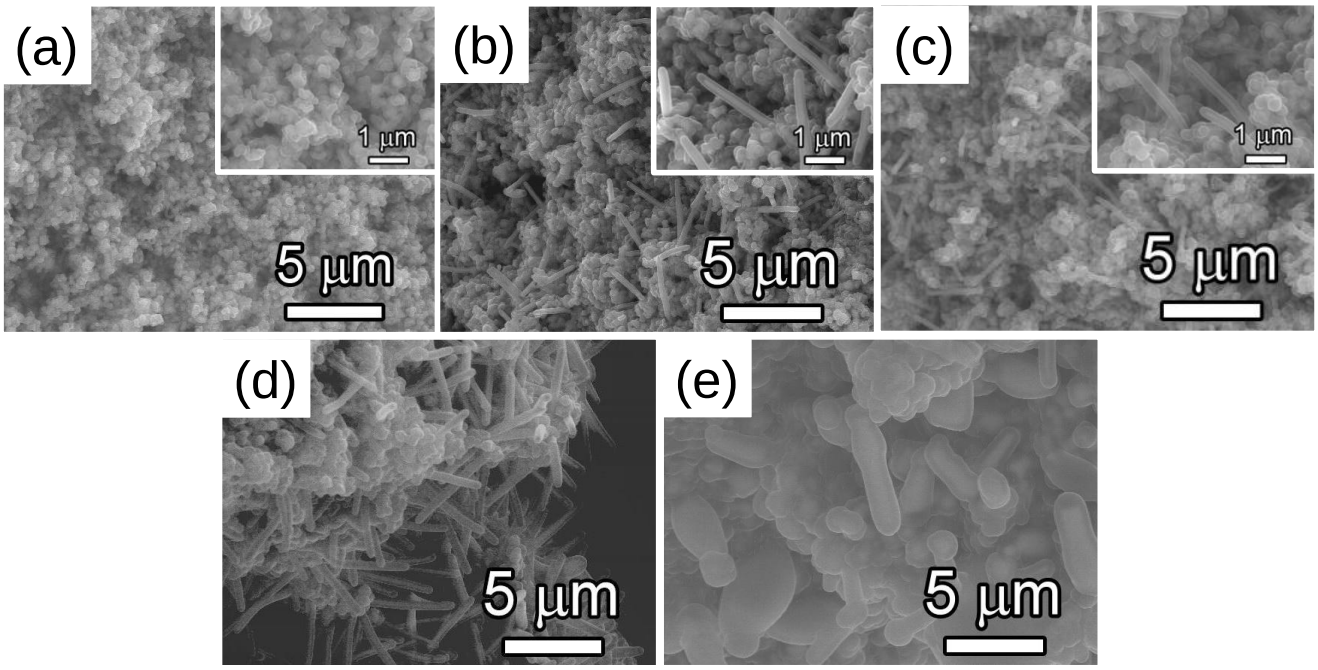

**Figure S3.** Raman spectra of product **A** and $SnO_2$. (Excitation wavelength: 785 nm, power: 5 mW)




$$Sn_{(s)} + C_{(s)} + O_{2(g)} \rightarrow SnO_{2(s)} + CO_{2(g)}$$

| $SnO_2$ wt % | Sn wt % | C wt % |
|---|---|---|
| 59.4% | 46.8% | 53.2% |

**Figure S4.** Thermogravimetric analysis (TGA) profile of **A**. The Sn and C contents are estimated to be 46.8 wt % (8.1 at %) and 53.2 wt % (91.9 at %), respectively. The analysis was taken in $O_2$ using a heating rate of 10 K $min^{-1}$.

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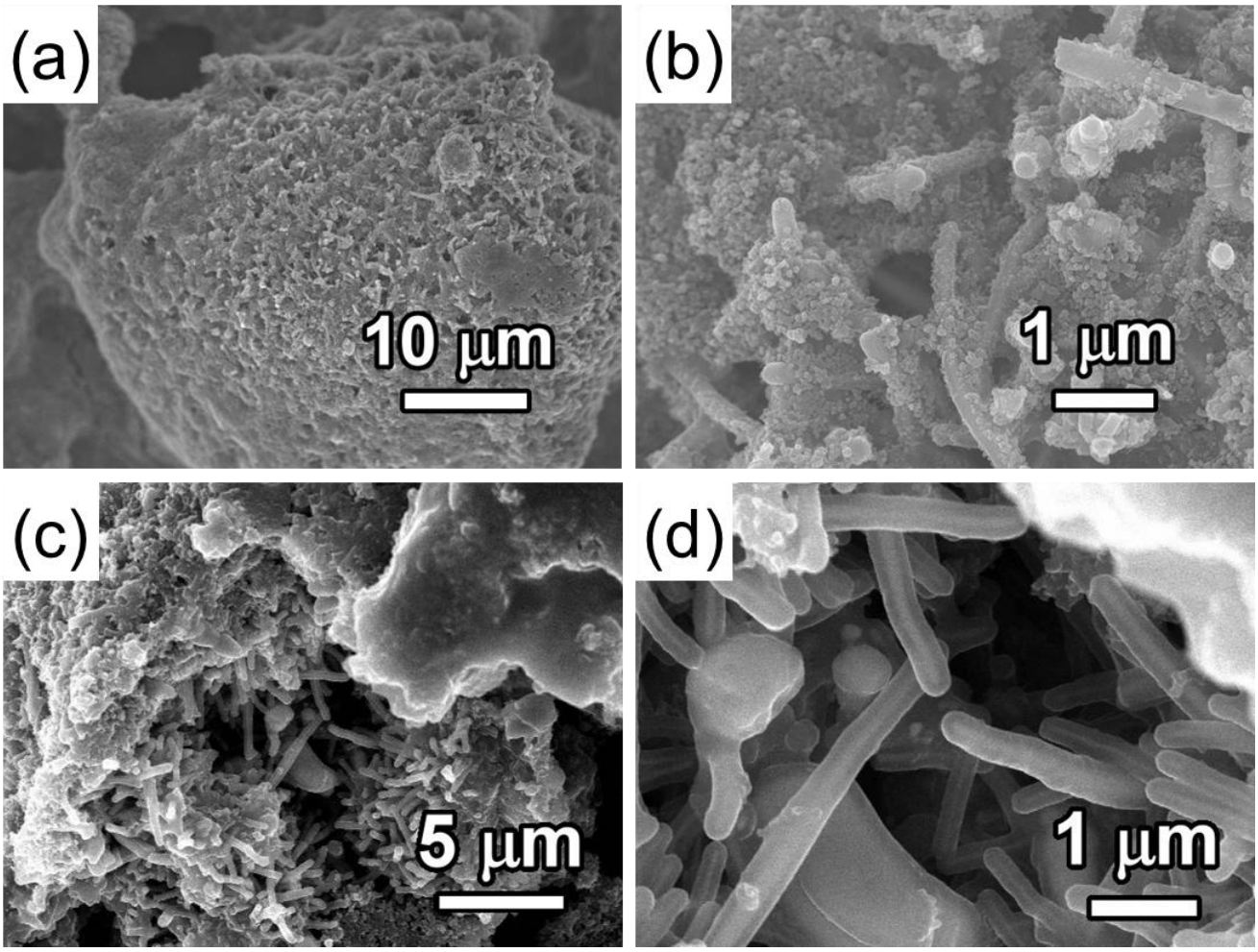


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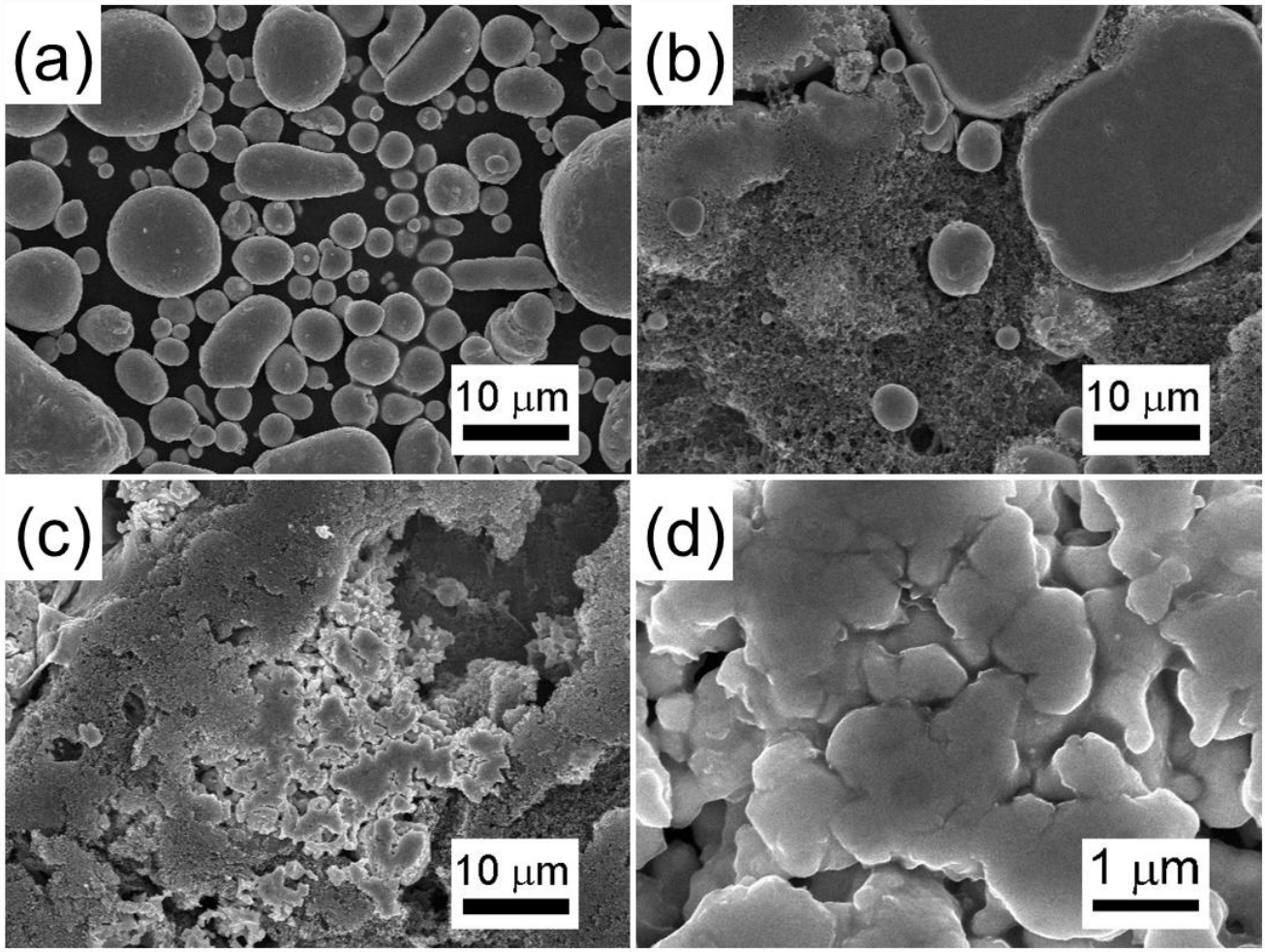


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