Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Bottom-up, Hard Template and Scalable Approaches toward Designing Nanostructured Li_2S for High Performance Lithium Sulfur Batteries

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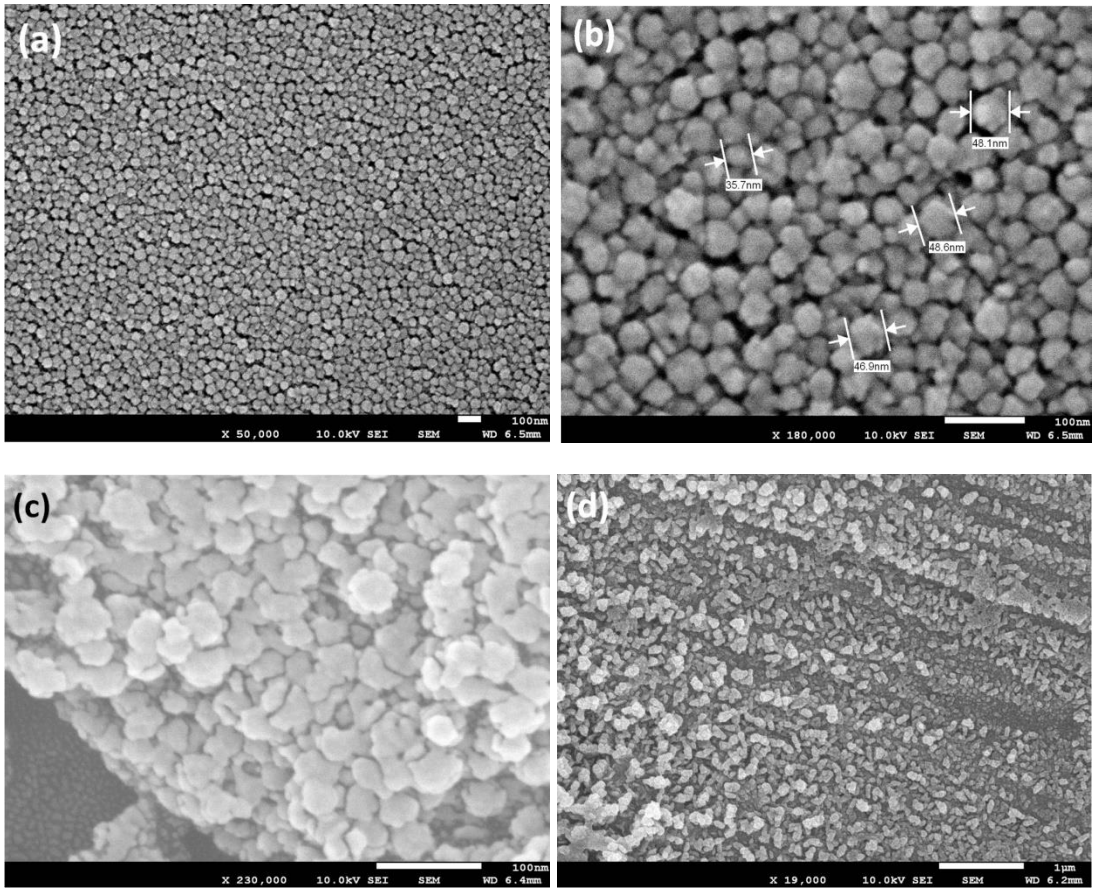

Figure S1. (a-b) FESEM images of polystyrene (PS) dispersed in aqueous solution from Nanocs, (c) FESEM image of PS after freeze-drying, (d) FESEM image of nanoLi_2S@C.

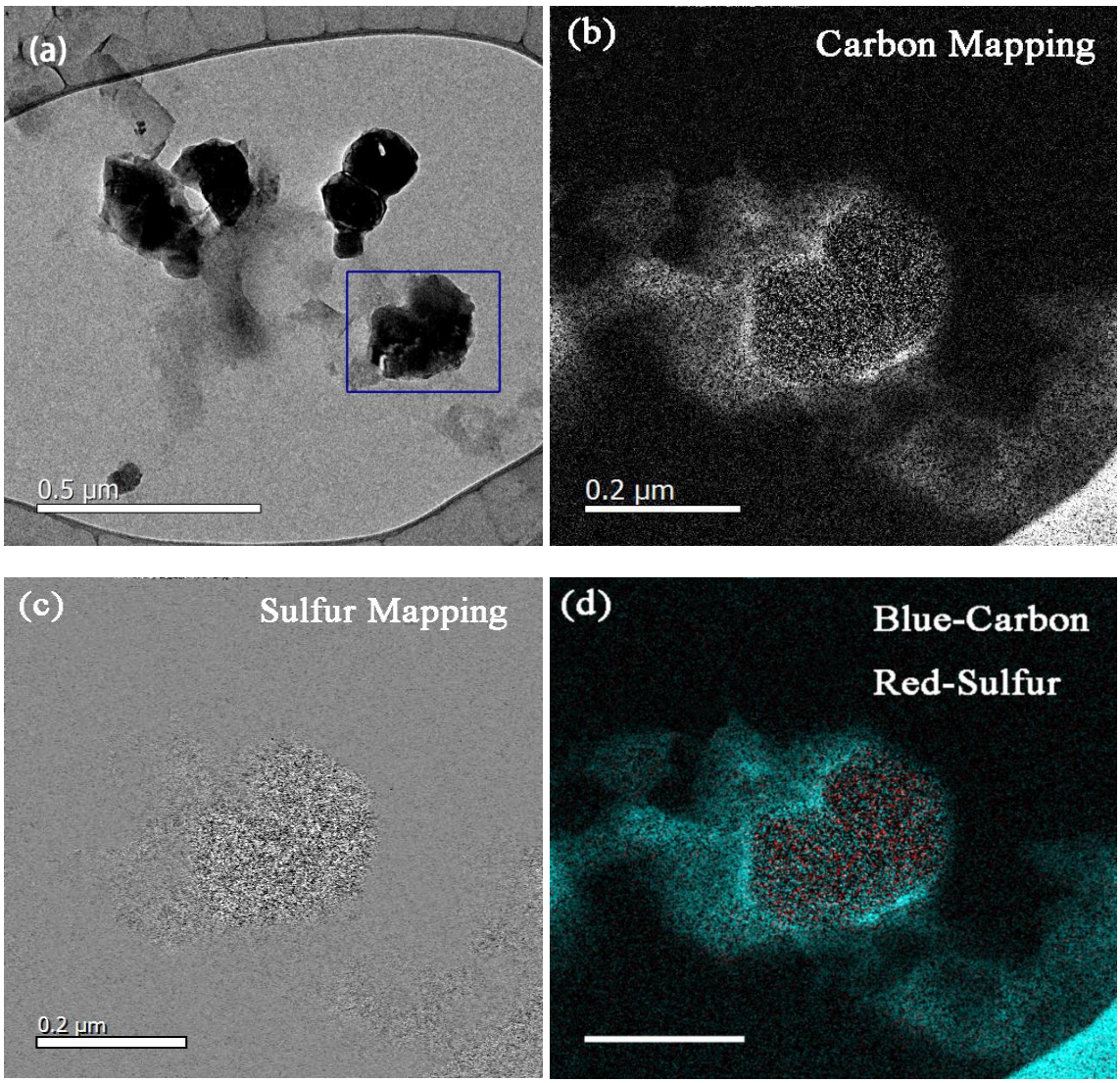

Figure S2. (a) FETEM image of nanoLi_2S@C; the nanoparticle within blue circle is used for EFTEM elemental mapping, (b) Carbon mapping, (c) Sulfur mapping, (d) Combined elemental mapping, Scale bar: 200 nm.

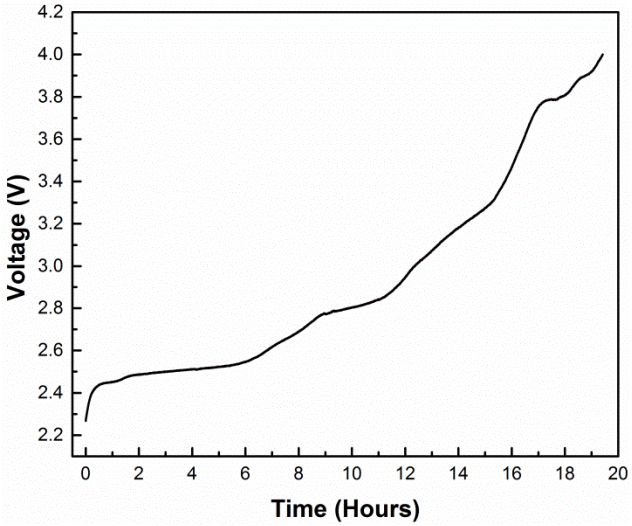

Figure S3. First charge profile for activiation of Li_2S.

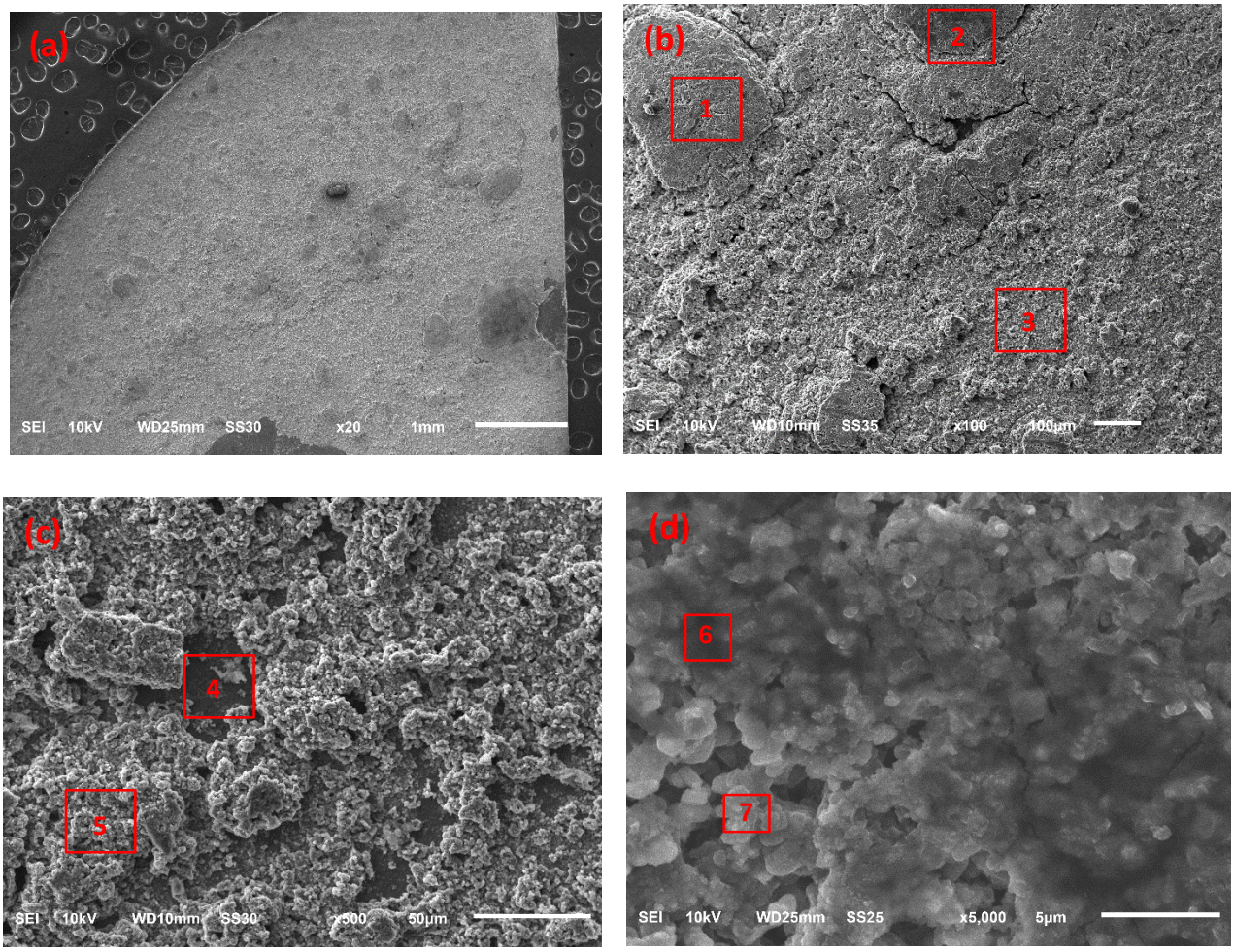

Figure S4. SEM images of a nanoLi_2S@C-based cathode after 200 charge/discharge cycles at 0.2 C with different magnifications. The red boxes with numbers in (b), (c) and (d) show the locations where EDS data were collected.

Table S1: EDS analysis of a nanoLi_2S@C-based cathode*

Label	**1**	**2**	**3**	**4**	**5**	**6**	**7**
C	57.69	50.48	54.34	23.89	57.05	44.25	50.46
O	27.62	32.37	26.35	3.32	25.43	35.55	28.35
F	6.14	9.30	6.49	3.05	5.81	11.77	7.44
Al			2.56	62.27			0.07
Si		0.11		0.73		0.17	
S	8.55	7.74	10.26	6.75	11.71	8.27	13.69
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* The label 1, 2, 3 and so no correspond to the locations shown in the red boxes of Figure S4. The Al signal is from the Al current collector.

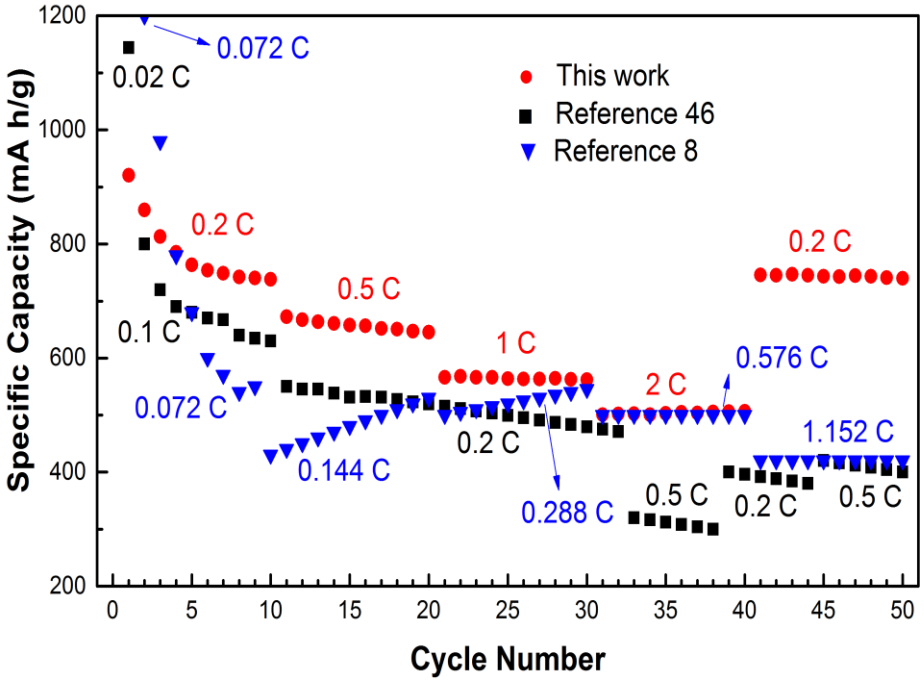

Figure S5. Rate capacity comparison between this work and other references. Black squares and blue triangles correspond to Reference 46 and Reference 8, respectively, whereas the red dots are this work's results.

In the comparison above, all cells have nearly the same mass loading of Li_2S on electrodes. The current rates used for these cycles are indicated for each cycling segment. Note that ultrahigh initial capacities were obtained from the two references [8,46] using the current rates of 0.07 C and 0.02 C, respectively. In this study, the initial high specific capacity of 915 mAh/g is obtained at 0.2 C. It can be seen that the rate capability and capacity retention of the present study are much better than those reported by Refs. 8 and 46. Specifically, the present study demonstrates higher specific capacities at various higher rates from the 5th to 40th cycle than both references. Furthermore, when the current rate after 40 cycles is switched back to 0.2 C, the cell of the present study exhibits a specific capacity of 745 mAh/g. This value is significantly higher than the specific capacity of the cell in Ref. 46 (~400 mAh/g at the 41st cycle with the same current rate). When compared with Ref. 8, the specific capacity of ~510 mAh/g displayed by the cell of the present study is the same as that exhibited by the cell in Ref. 8. However, the current rate of the present study is 4 times that of Ref. 8. The well-recovered capacity at 0.2 C after experiencing different and high cycling rates verifies the effectiveness of the greatly maintained core-shell nanostructures for housing polysulfides via the bottom-up hard template technique.