Supporting Information

Lithiophilic Nanoskin–Enabled Dendrite-Free Li Deposition in Pomegranate-like Carbon Microclusters

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Material characterization

The morphologies and detailed structures of the prepared composites were analyzed using field-emission scanning electron microscopy (FE SEM, HITACHI S-4300) and field-emission transmission electron microscopy (FE TEM, JEM-2100F, Korea Basic Science Institute (Daegu)). Powder X-ray diffraction (XRD) spectra were obtained using an X'Pert PRO diffractometer with Cu-Kα radiation (λ = 1.5418 Å) at the Korea Basic Science Institute (Daegu). To determine the carbon content of the composites, X-ray photoelectron spectroscopy (XPS) was used to measure the chemical content of the composites. Raman spectroscopy (Horiba JY HR LabRam800, Korea Basic Science Institute (Gwangju)) was conducted to analyze the carbon structures of the composites.

Electrochemical measurement

The electrochemical properties of the P-CM@PDA composites were assessed using a standard 2032-type coin cell. The LMB electrodes were prepared by mixing the active material and polyvinylidene fluoride (PVDF) (weight ratio = 4:1) in N-Methyl-2-pyrrolidone (NMP), which was then applied onto a copper foil using a doctor blade. The coin cell was manufactured in a glove box and consisted of lithium metal as the counter electrode, a celgard 2400 as the separator, and 1 M lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) dissolved in 1,3-dioxolane (DOL) and 1,2-dimethoxyethane (DME) as the electrolyte. Coulombic efficiency, symmetric cell and full cell tests were conducted using a battery analyzer (WonATech, WBCS3000L). Electrochemical impedance spectroscopy (EIS) measurements of the coin cells were conducted in the range of 0.1–100 kHz. For the full cell test, cathode electrodes were prepared by mixing the LFP, Super P, and polyvinylidene difluoride (PVDF) (weight ratio = 8:1:1) with N-methyl-2-pyrrolidone (NMP).

This file includes:

- **Figure S1** SEM images of SiO_2@RF precursor (a, b) and the derived a-SiO_2@C microstructures (c, d).
- **Figure S2** TEM images of P-CM showing a microcluster composed of densely packed hollow carbon spheres (a) and the thin carbon shell structure of individual subunits (b).
- **Figure S3** SEM images of P-CM@PDA before (a) and after (b) Li deposition.
- **Figure S4** Cyclic voltammetry (CV) curves of symmetric cells using (a) HCS, (b) P-CM, and (c) PCM@PDA electrodes recorded at scan rates from 1 to 10 mV s^{-1}.
- **Figure S5** (a–c) Galvanostatic charge–discharge (GCD) profiles of full cells assembled with HCS, P-CM, and P-CM@PDA anodes paired with LFP cathodes over extended cycling. (d) Nyquist plots after 55 cycles.

Supplementary Figures and Table

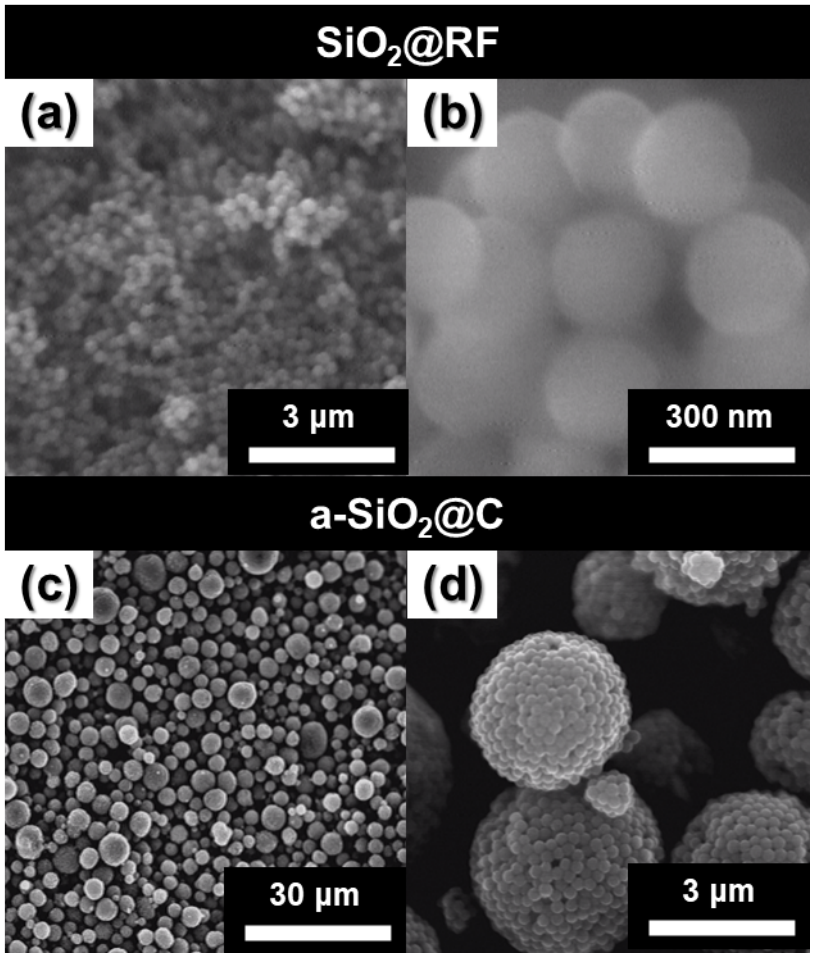

Figure S1 SEM images of SiO_2@RF precursor (a, b) and the derived a-SiO_2@C microstructures (c, d).

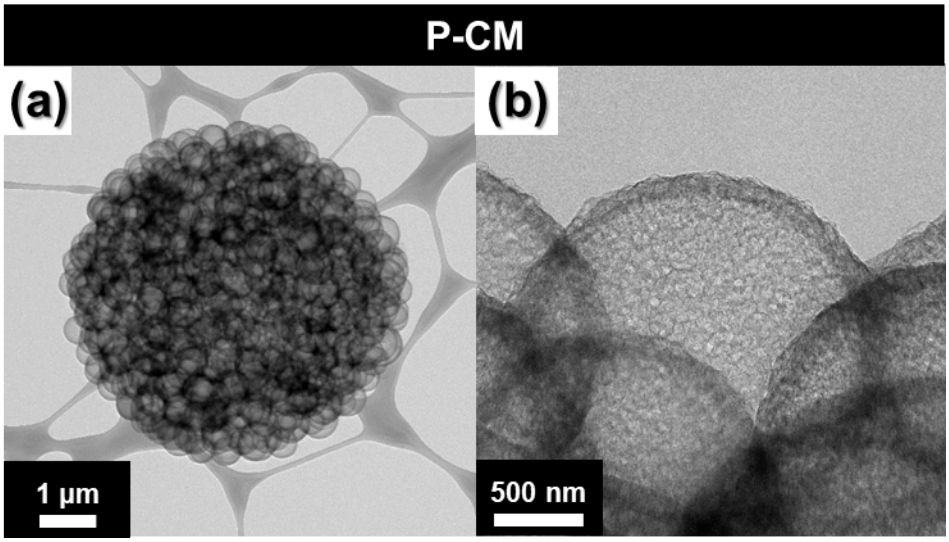

Figure S2 TEM images of P-CM showing a microcluster composed of densely packed hollow carbon spheres (a) and the thin carbon shell structure of individual subunits (b).

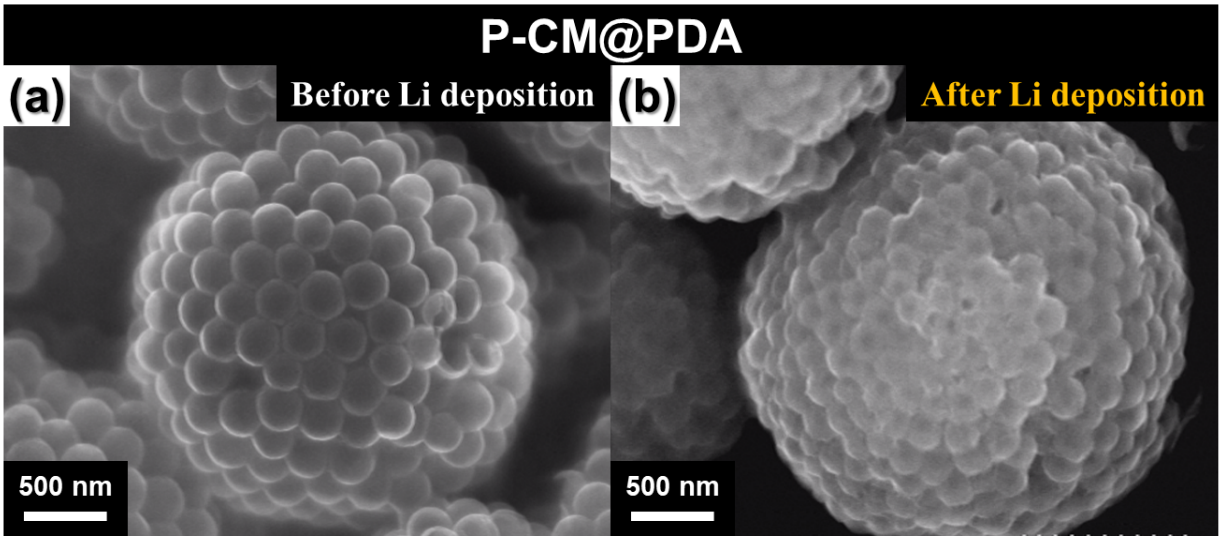

Figure S3 SEM images of P-CM@PDA before (a) and after (b) Li deposition.

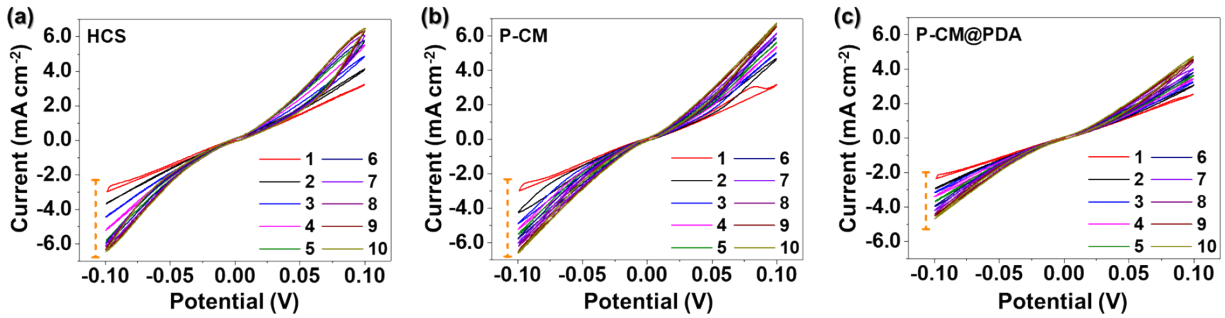

Figure S4 Cyclic voltammetry (CV) curves of symmetric cells using (a) HCS, (b) P-CM, and (c) PCM@PDA electrodes recorded at scan rates from 1 to 10 mV s^{-1}.

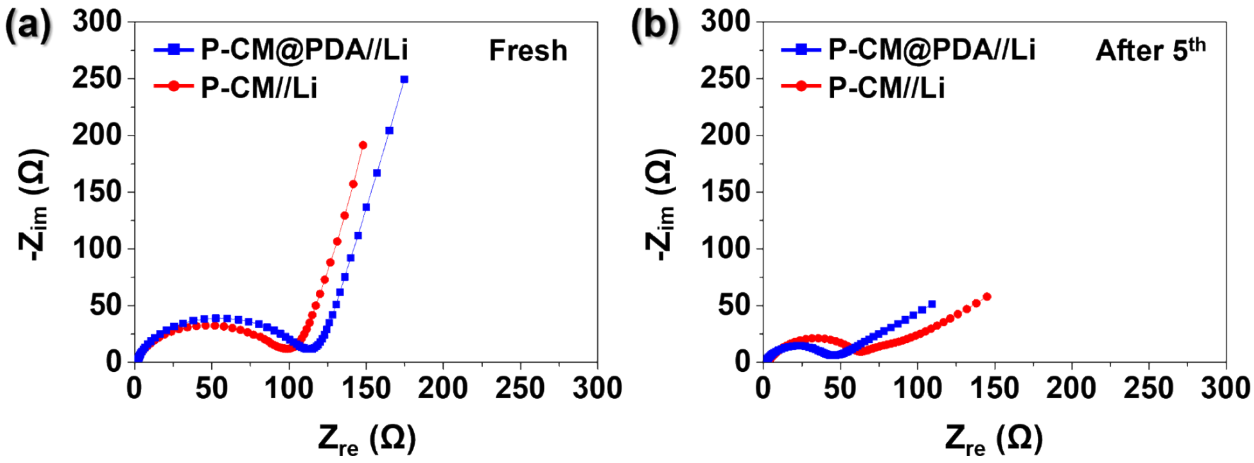

Figure S5 Nyquist plots of P-CM/Li and P-CM@PDA/Li asymmetric-cells recorded (a) before cycling and (b) after 5 cycles.

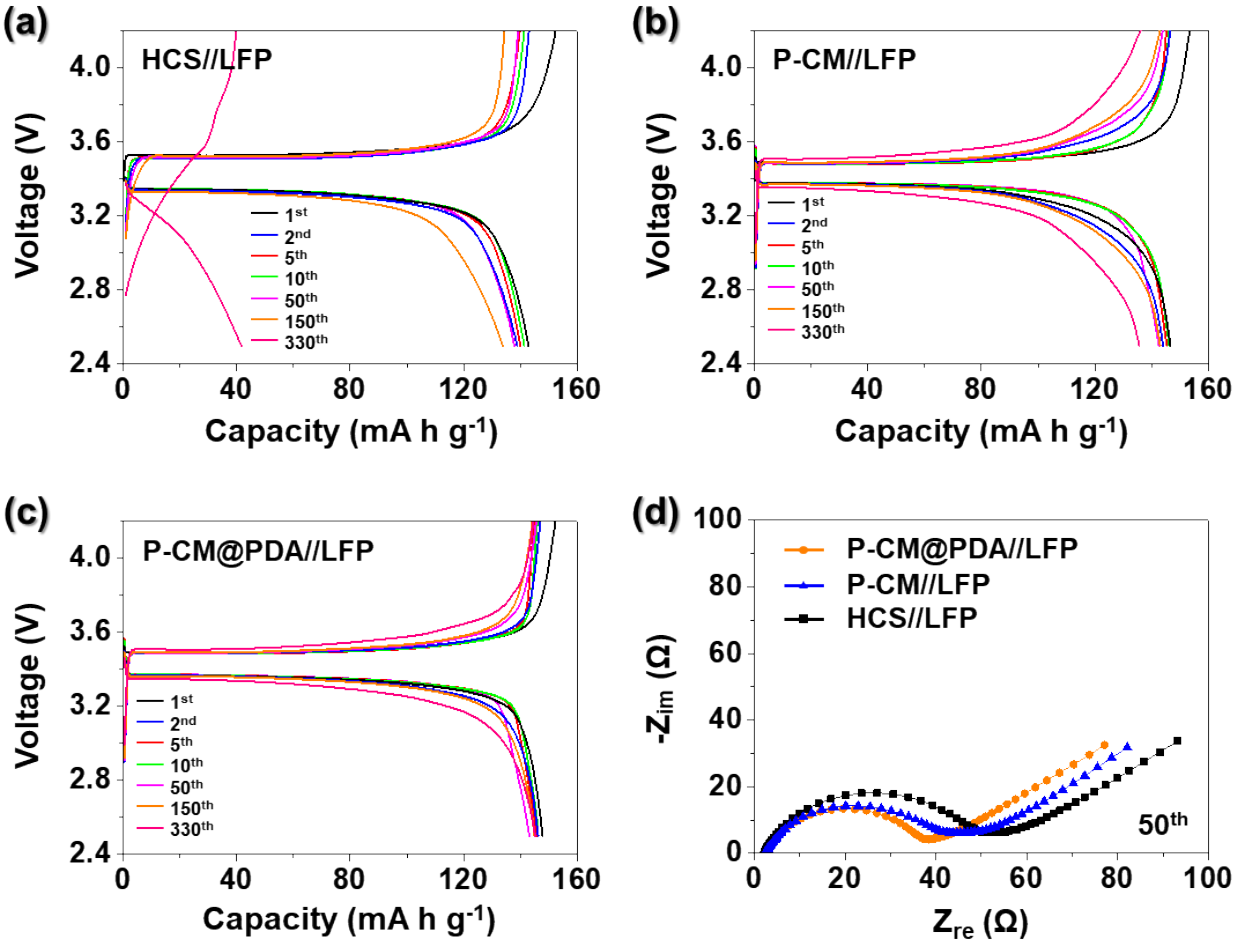

Figure S6 (a–c) Galvanostatic charge–discharge (GCD) profiles of full cells assembled with HCS, P-CM, and P-CM@PDA anodes paired with LFP cathodes over extended cycling. (d) Nyquist plots after 55 cycles.