Supporting Information

Fabrication of Binder-Free Pencil-Trace Electrode for Lithium-Ion Battery: Simplicity and High Performance

Hyean-Yeol Park,[†] Min-Sik Kim,[†] Tae-Sung Bae,[‡] Jinliang Yuan[,§] and Jong-Sung Yu*[,†]*

[†] Department of Energy Systems Engineering, DGIST, Daegu, 42988, Republic of Korea

[‡] Korea Basic Science Institute, Jeonju, Jeonbuk 561-756, Republic of Korea

[§] Department of Energy Sciences, Faculty of Engineering, Lund University, Box 118, 22100, Lund, Sweden.

Corresponding Author

*,[†] J. -S. Yu. E-mail: jsyu@dgist.ac.kr. Tel.: (+82) 53-785-6443. Fax: (+82) 53-785-6409.

*,[§] J. Yuan. E-mail: jinliang.yuan@energy.lth.se. Tel.: (+46) 46-222-4813.

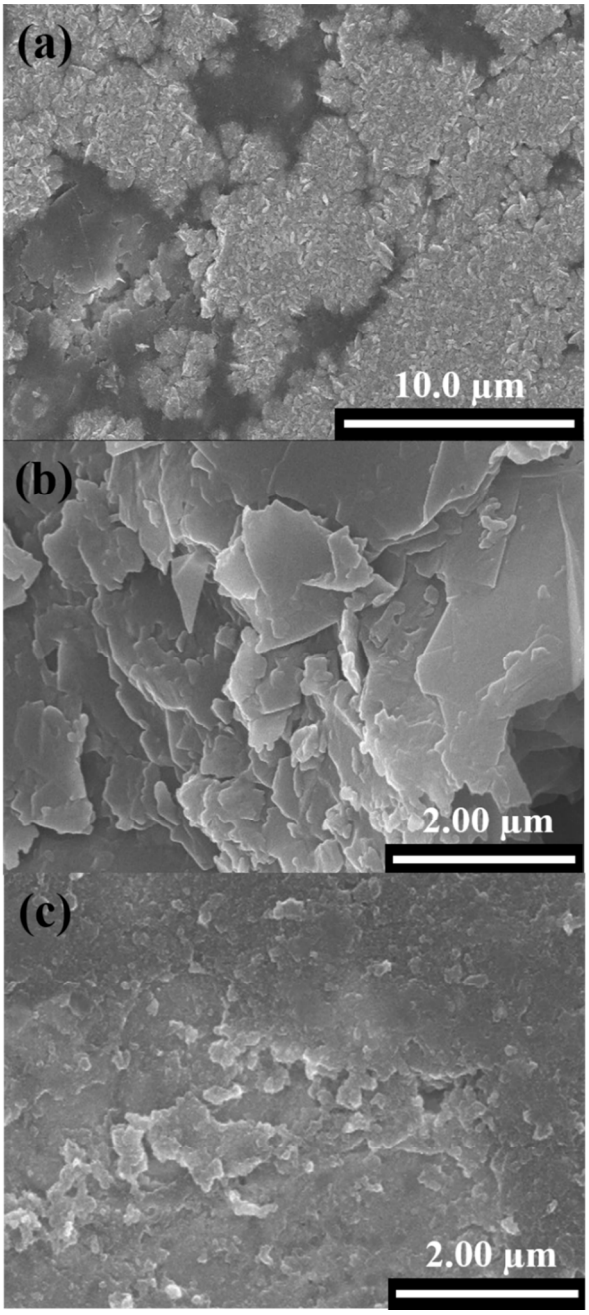

Figure S1. (a) and (b) SEM images of pencil-trace electrode on a copper current collector surface with different magnification before cycling. (c) SEM image of pencil-trace electrode after 100 cycles.

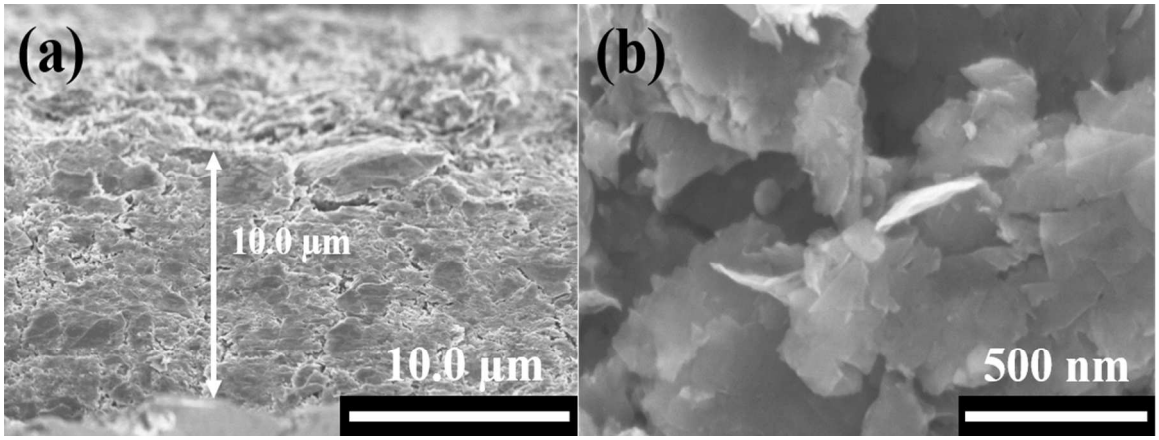

Figure S2. (a) and (b) cross-section SEM images of pencil-trace electrode on a copper current collector surface with different magnification before cycling.

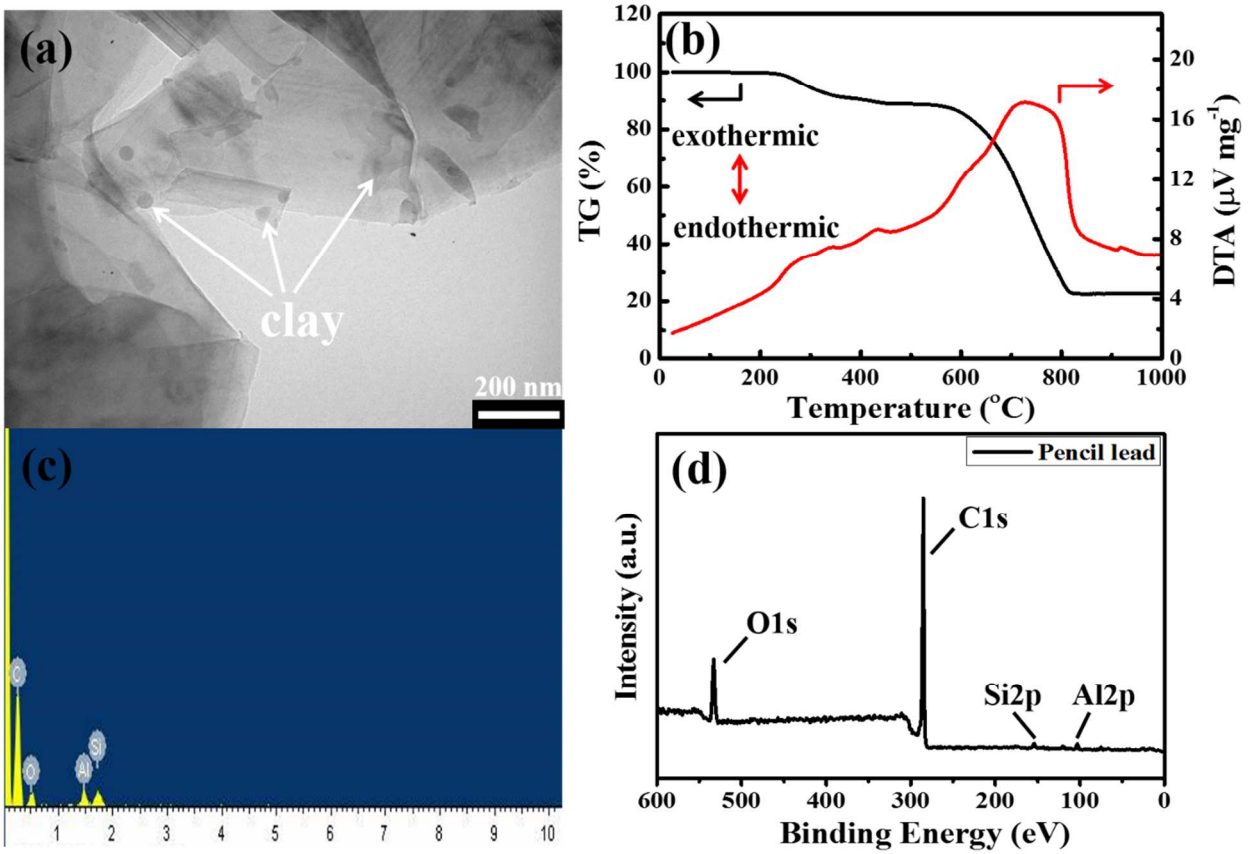

Figure S3. (a) TEM image, (b) TGA-DTA in air, (c) energy dispersive X-ray (EDX), and (d) XPS spectra study for 4B grade pencil-trace electrode.

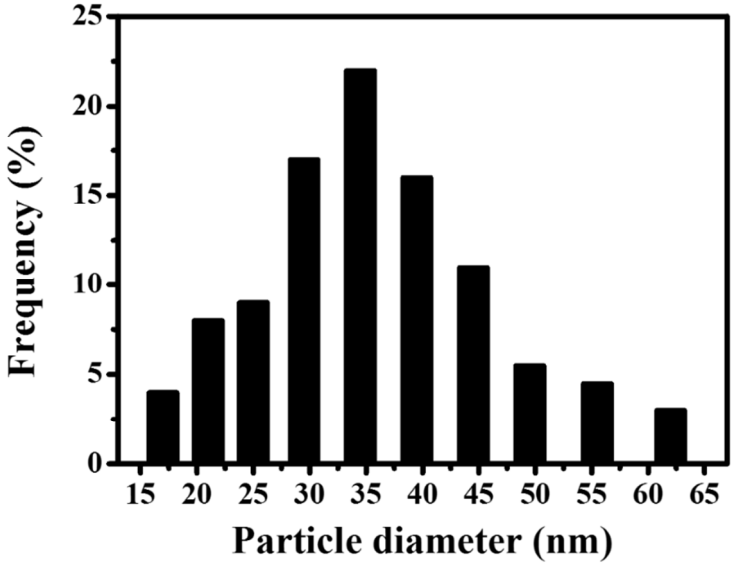

Figure S4. Particle size distribution histogram of clay particles intercalated into pencil lead.

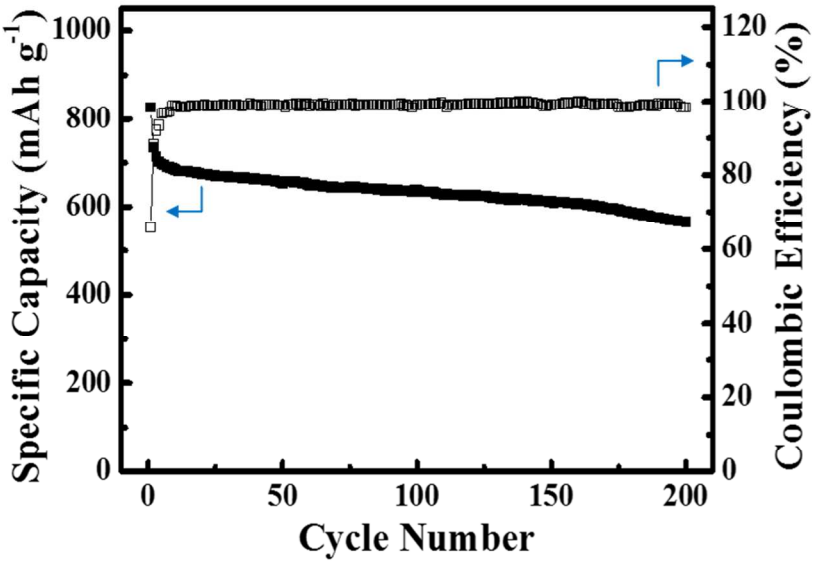

Figure S5. Long-term cycling stability of pencil-trace electrode under 100 mA g^{-1}.

Table S1 Elemental composition in atomic % of the 4B grade pencil from XPS and EDX.

Sample	XPS (At. %)					EDX (At. %)				
	C_{1s}	O_{1s}	Si_{2p}	Al_{2p}	Total	C_{1s}	O_{1s}	Si_{2p}	Al_{2p}	Total
Pencil	84.2	11.5	2.2	2.1	100	78.9	16	2.6	2.5	100

Table S2 Kinetic parameters derived from the Nyquist plots for the fresh cells made from pure graphite with binder and binder-free pencil-trace.

Sample	R_S (Ω)	R_{CT} (Ω)	Z_W (Ω)
Commercial graphite with binder	6.82	85.6	79.1
Binder-free pencil-trace	6.58	68.3	37.2