Supplementary Material

***In-situ* study of lithium insertion on the electrochemical-mechanical coupling behavior of graphite composite electrodes**

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Volume fractions：

The electrodes used in the experiment were rectangular in shape, with dimensions of 1.5 cm in length, 0.3 cm in width, and 40 micrometers in thickness. The volume of the active layer can be expressed as:

$$\Phi_i = \frac{V_i}{V_{actual}} \times 100\% = \frac{M_i}{\rho_i \times V_{actual}} \times 100\% \quad \text{(S1)}$$

In this context, V represents the volume of each component, including silicon particles, conductive carbon black, binder, and voids, while ρ represents the density.

The porosity of the composite electrode can be expressed as:

$$Porosity = \frac{V_{actual} - V_c - V_{cb} - V_{CMC}}{V_{actual}} \times 100\% \quad \text{(S2)}$$

The volume fraction of each component can be determined.

DMA

In this work, two electrolytic copper foils with varying thicknesses (10um, 22um) were chosen as substrates and current connectors, with one rough side (Shenzhen Jingliang Copper Industry Corporation). The thickness of the current collectors and electrodes was measured using a Mitutoyo Micrometer, while Young's modulus was determined using a dynamic mechanical analyzer (DMA Q800). Table 1 summarizes the mechanical parameters of different types of current collectors.

Supplementary Table S1. mechanical parameters current collector.

Parameter	Full name	Sample-1	Sample-3	Measurement method
h_c	Thickness	10μm	22μm	Mitutoyo Micrometer
E_c	Young's modulus	55Gpa	36.9Gpa	DMA Q800
Γ_c	Tensile stiffness	550kNm^{-1}	811.8kNm^{-1}	$E_c h_c$

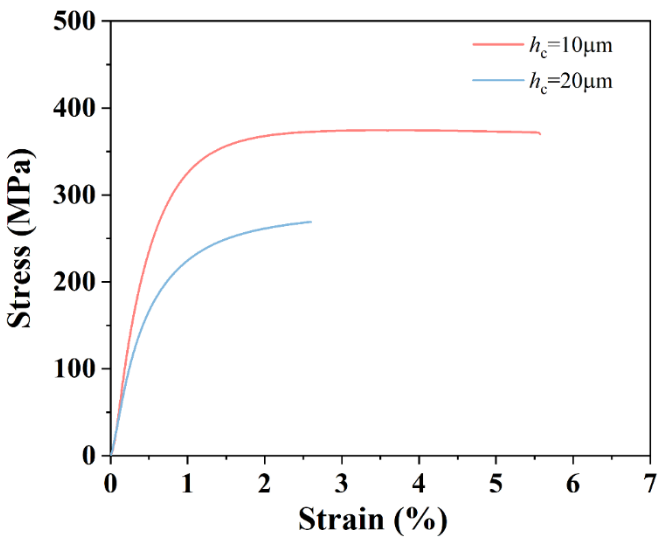

Figure S1. Stress-Strain Curve of the Current Collector Material

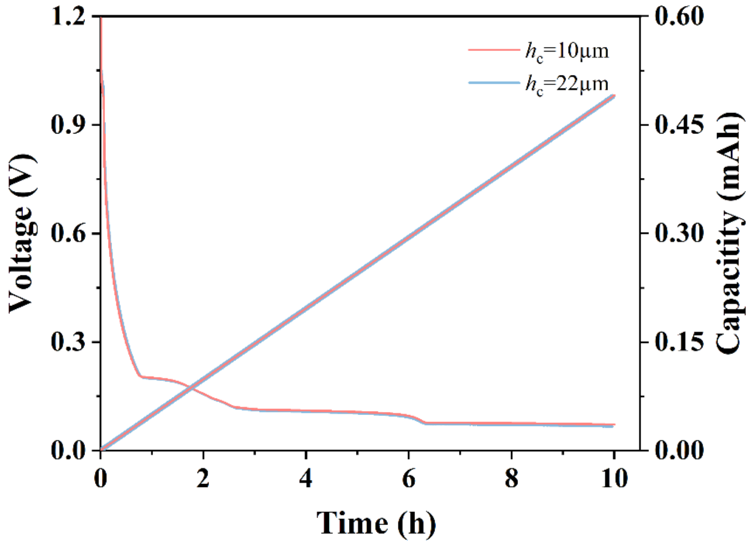

Figure S2. Voltage-Capacity Curve During Cycling