

**Investigating the Increased-Capacity Mechanism of Porous Carbon Materials in
Lithium-Ion Batteries**

Kai Zhou^{1,2}, Shuwei Wang^{1,2}, Shichao Zhang¹, Feiyu Kang^{1,2}, Baohua Li^{1,*}

1. ShenZhen Key Laboratory of Power Battery Safety and Shenzhen Geim Graphene Center, Graduate School at Shenzhen, Tsinghua University, Shenzhen, 518055, China

2. School of Materials Science and Engineering, Tsinghua University, Beijing 100084, P. R. China.

Email: libh@mail.sz.tsinghua.edu.cn

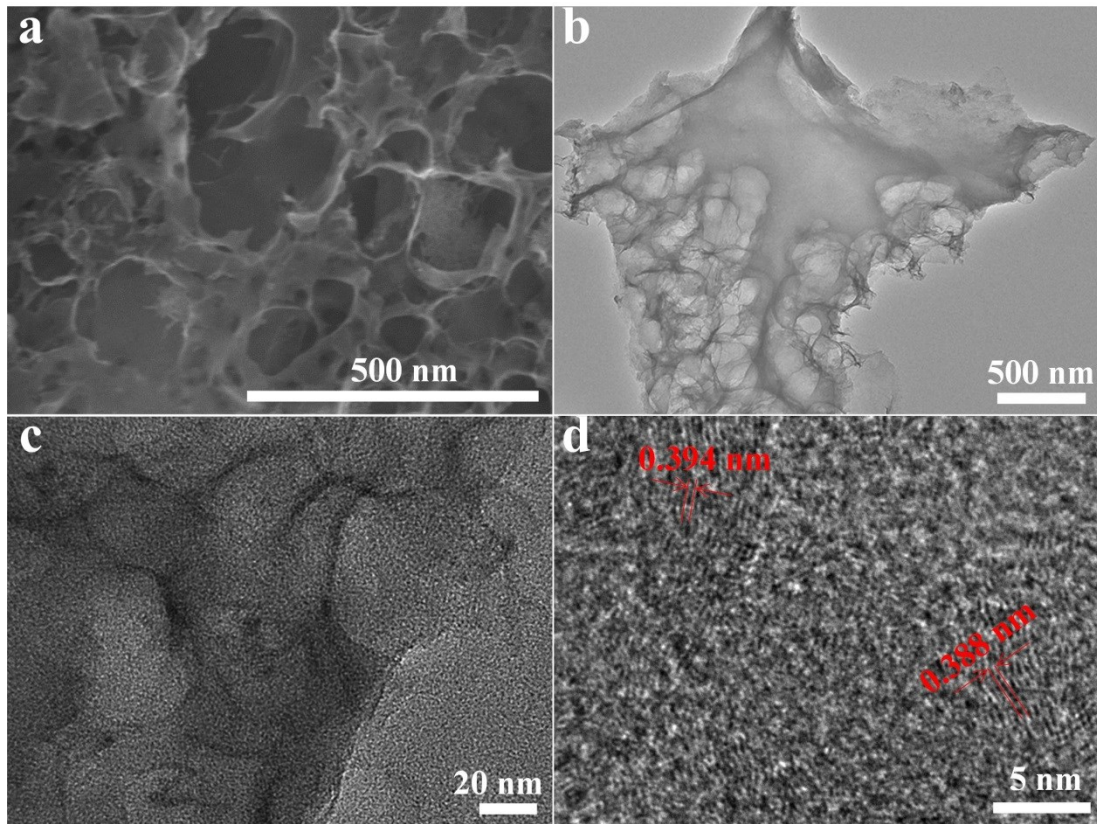


Figure S1. Morphology characterization of the Ni-C materials. (a) SEM image of porous carbon. (b-d) TEM images of the porous carbon.

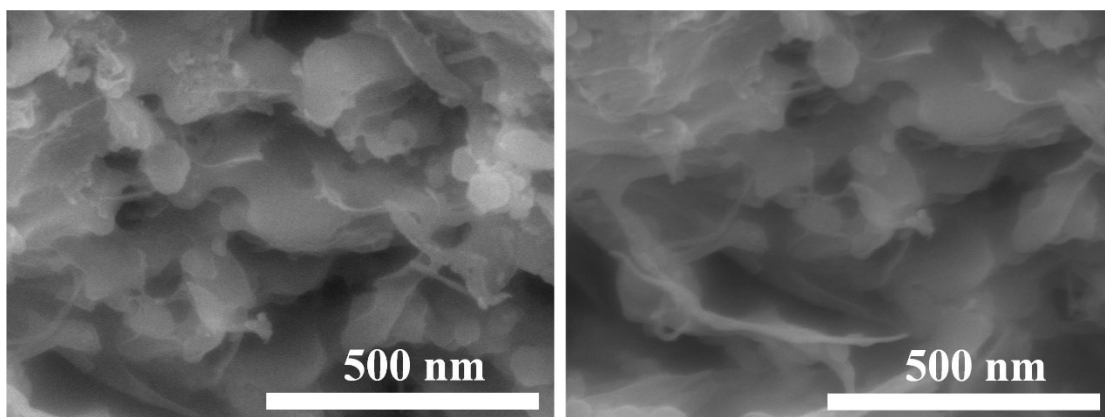


Figure S2. Morphology characterization of the Ni—free-C materials characterized by SEM.

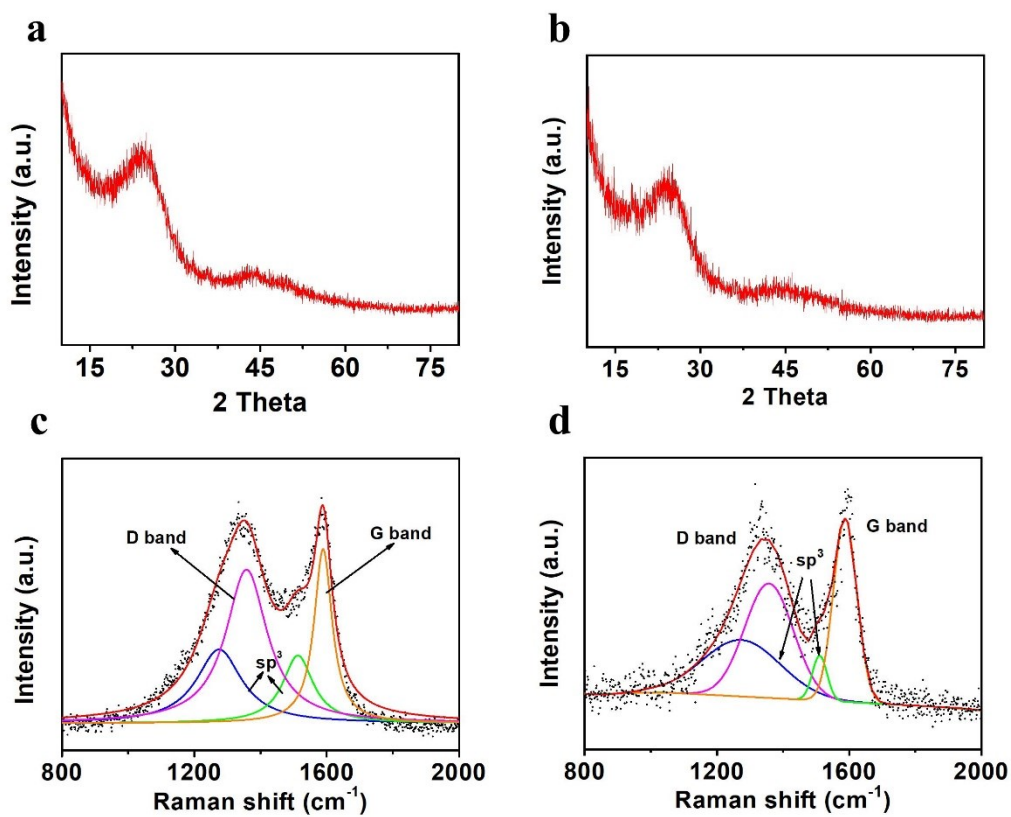


Figure S3. Structural characterization of the samples. (a) XRD pattern of (a) Ni-C and (b) Ni-free-C. Raman spectrum of the (c) Ni-C and (d) Ni-free-C.

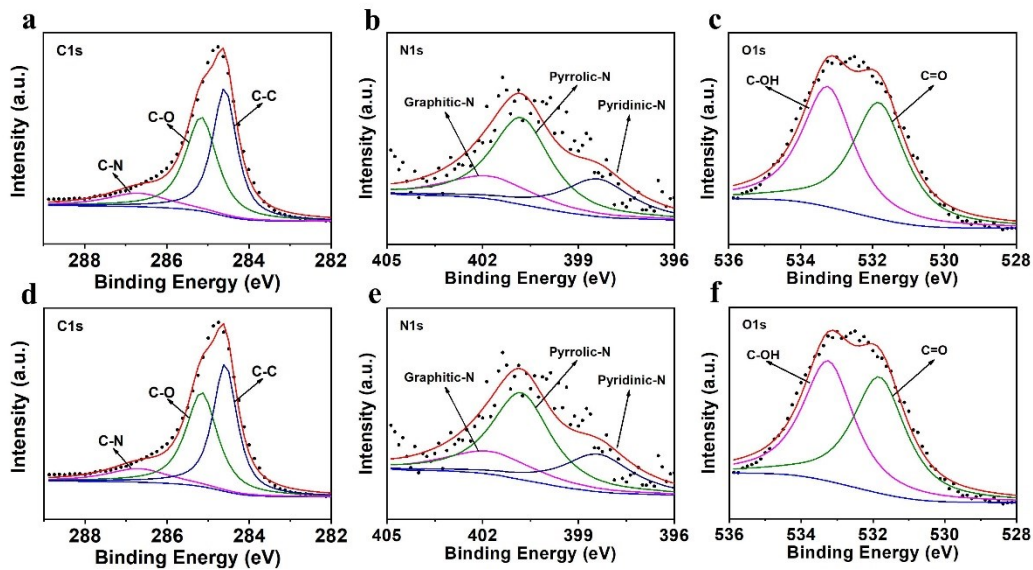


Figure S4. X-ray photoelectron spectroscopic (XPS) high-resolution (a) C1s, (b) N1s, and (c) O1s spectra of Ni-C. XPS high-resolution (a) C1s, (b) N1s, and (c) O1s spectra of Ni-free-C.

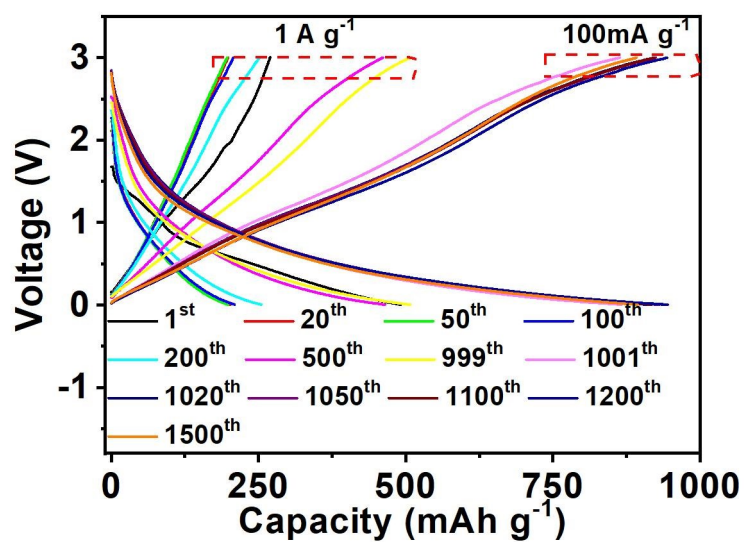


Figure S5. The charge-discharge profiles of the long-term cycling performance with first 1000 cycles at 1 A g^{-1} and followed 500 cycles at 100 mA g^{-1} .

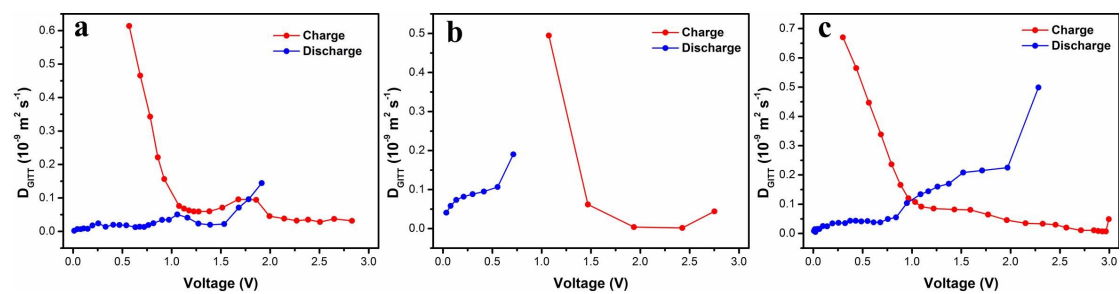


Figure S6. The cycled or rested cells Li ion diffusion kinetic calculated by GITT. The coefficient versus state of charge and discharge of (a) the rested cells, (b) the cells cycled at 100 mA g^{-1} , and (c) the cells cycled at 1 A g^{-1} .

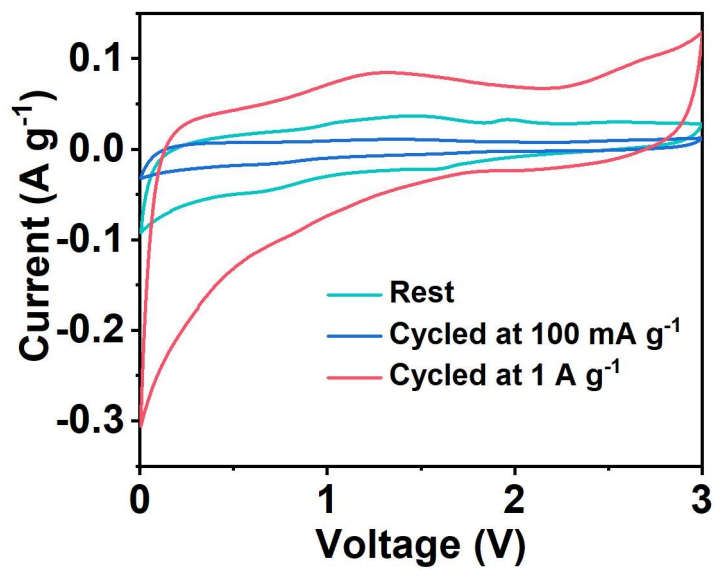


Figure S7. Analytical comparison of electrochemical mechanism of cells cycled or rested with 936 h. Cyclic voltammogram curves at a scan rate of 0.1 mV s⁻¹.

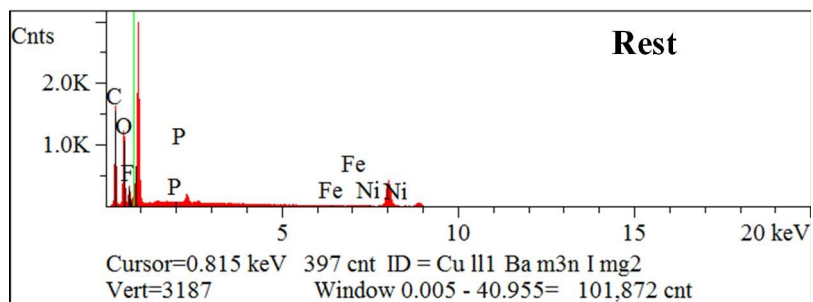


Figure S8. The elemental energy dispersive spectrum of the rested carbon electrodes for 936 h.

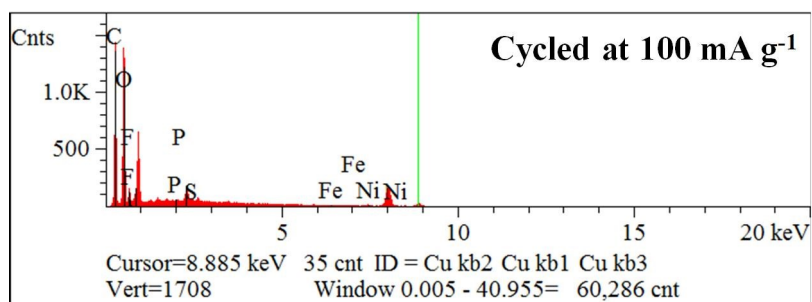


Figure S9. The elemental energy dispersive spectrum of the carbon electrodes after cycled at 100 mA g⁻¹ for 936 h.

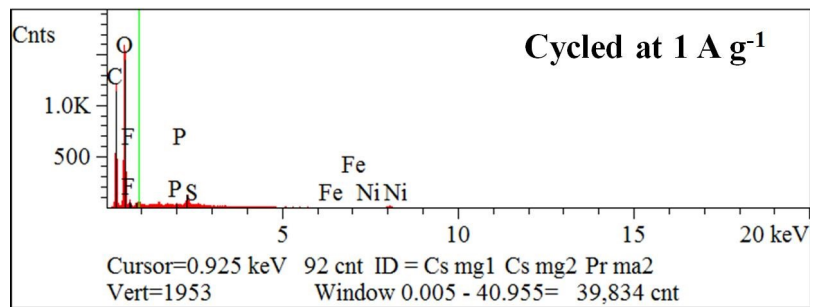


Figure S10. The elemental energy dispersive spectrum of the carbon electrodes after cycled at 1 A g⁻¹ for 936 h.

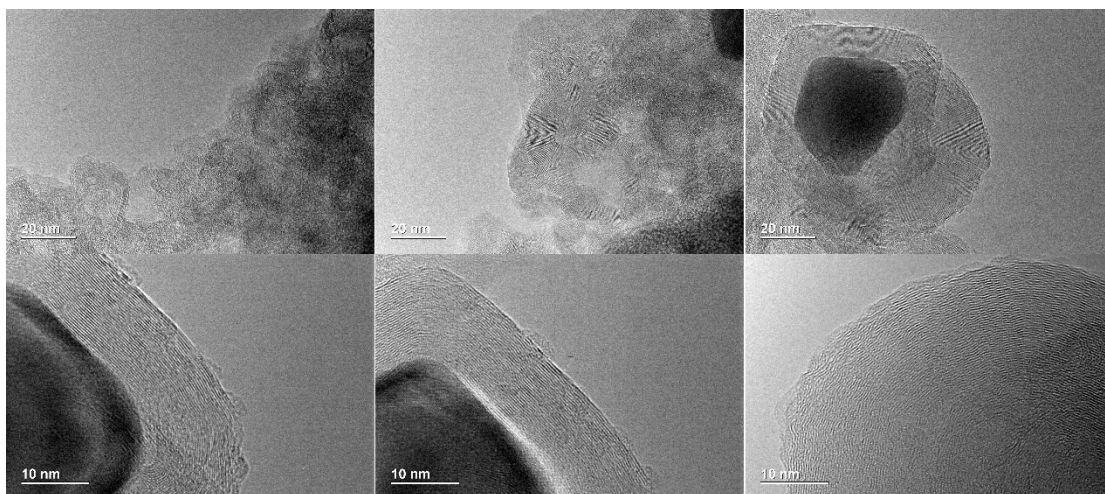


Figure S11. High-resolution TEM images of the porous carbon materials after cycled at 1 A g^{-1} for 936 h, acquired from the other areas.

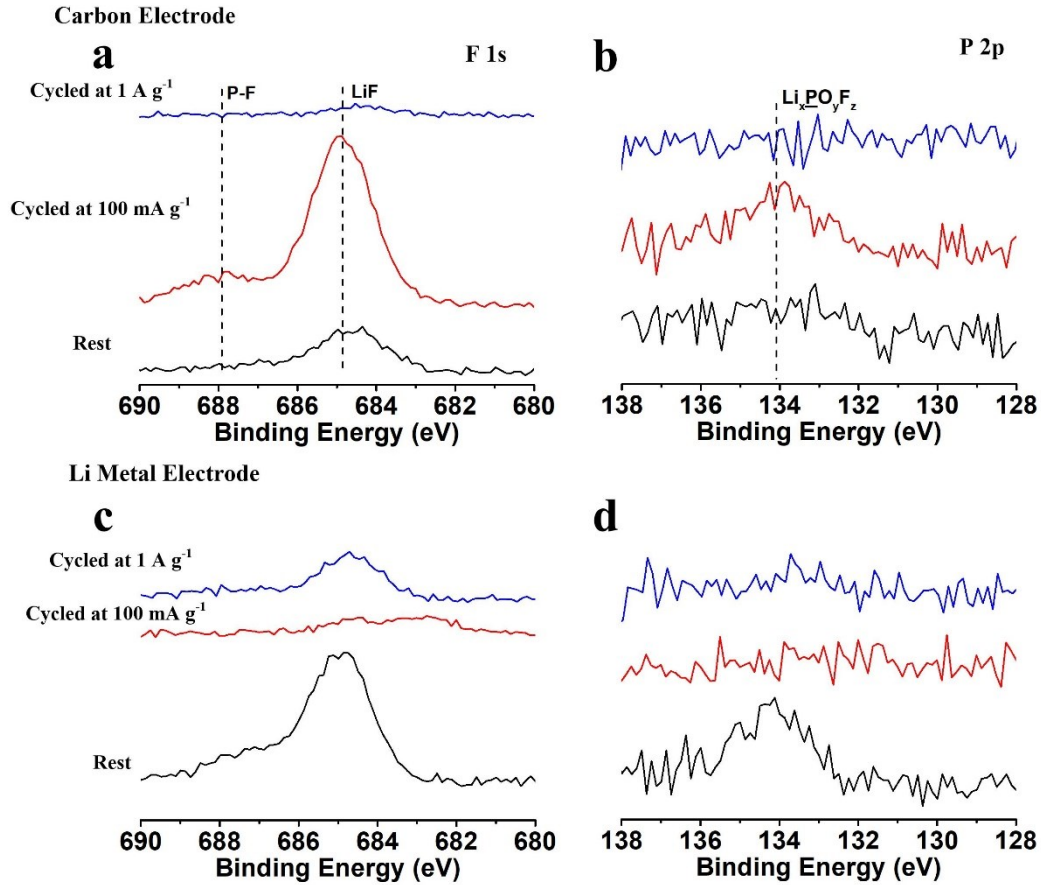


Figure S12. Characterization of components of SEI covered on the surface of cycled carbon and Li metal electrodes. XPS (a) F 1s and (b) P 2p spectra of carbon electrodes from (a) the rested cells, (b) the cells cycled at 100 mA g^{-1} , and (c) the cells cycled at 1 A g^{-1} for 936 h. (c) F 1s and (d) P 2p spectra of Li metal electrodes for three groups of batteries after cycled or rested.

Table. S1 The elemental quantitative analysis of the carbon electrodes after cycled or rested from SEM-EDS measurement.

Sample	C (%)	O (%)	F (%)	P (%)	Other (%)
Rest	39.575	46.134	12.984	0.140	1.054
Cycled at 100 mA g ⁻¹	38.056	53.710	7.227	0.270	0.679
Cycled at 1 A g ⁻¹	33.685	62.522	3.200	0.151	0.435