

Supporting information

Decoupling of the anode and cathode ultrasonic responses to the state of charge of a lithium-ion battery

Xueting Liu,^a Zhe Deng,^a Yaqi Liao,^a Jinqiao Du,^b Jie Tian,^b Zijun Liu,^b Yue Shen^{*a}
and Yunhui Huang^{*a}

^a *School of Materials Science and Engineering, Huazhong University of Science and Technology, Wuhan 430000, Hubei, China*

^b *Shenzhen Power Supply, Shenzhen 518000, Guangdong, China*

*Corresponding authors.

E-mail address: shenyue1213@hust.edu.cn(Y. Shen), huangyh@hust.edu.cn(Y. Huang)

Table S1 Properties of various materials

Materials	Thickness (μm)	Velocity of sound (m/s)
Acrylic plate	3500	2730
Nylon	80	2600
Al foil	40	6300
Polypropylene	25	2475
Al current collector	14	6300
LFP (dense)	70	7360
Cu current collector	8	4400
Gr (dense)	50	1470
Electrolyte	675	1850

$$t = \sum_v^l \frac{l}{v} \#(1)$$

t is the time spent crossing the material. l is the thickness of the materials. V is the sound speed of the materials. The sound speeds of the electrode materials (Gr and LFP) in Table S1 are the value of dense materials where the porosity is 0. The electrodes in real cells are porous materials, so the actual ToF of the ultrasound reflected from the Gr | electrolyte interface should be longer than the calculated ToF. Considering the thickness of the electrodes are very thin ($40 \sim 74 \mu\text{m}$), the reflected wave should appear at the region slightly right of the green dashed line in Fig. S2.

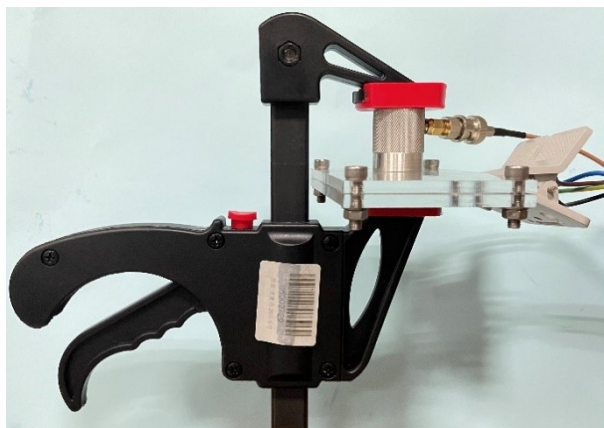


Fig. S1 Ultrasonic testing set up.

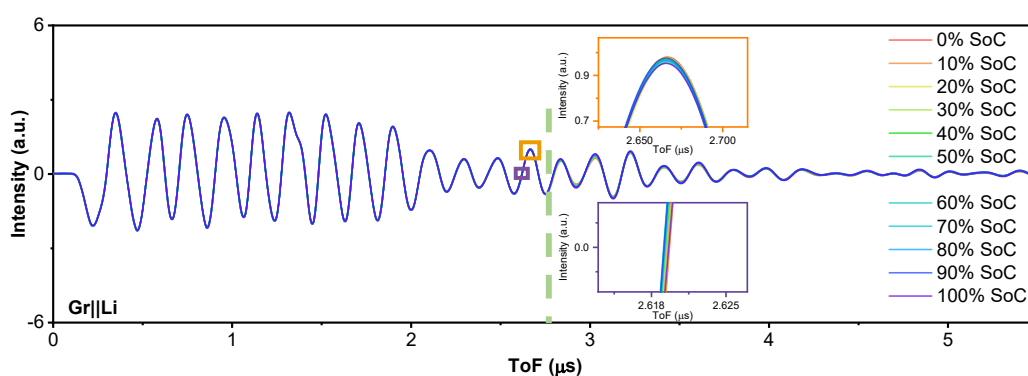


Fig. S2 The reflected ultrasonic waveforms from a Gr||Li half-cell at different SoCs.

The inset is a magnified view of the waveforms in the region of 2.618~2.625 μs and a magnified view of the peak of the wave at around 2.67 μs .

Tiny changes of the ultrasonic ToF and intensity were observed before the dashed line. The ΔToF is about 1 ns, which is less than the ΔToF observed after the dashed line. Meanwhile, the change in intensity is much smaller than that measured after the green dashed line, which is only 3%.

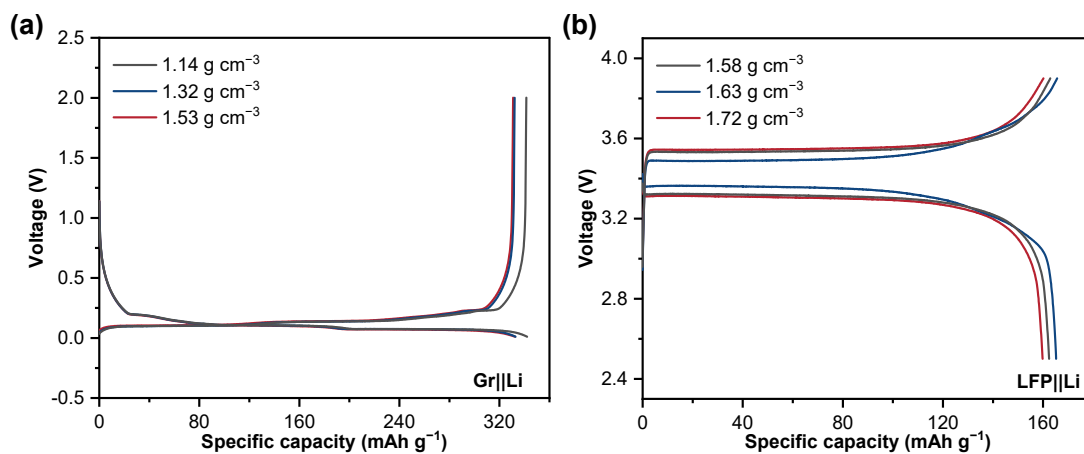


Fig. S3 The charge-discharge curves of the (a) Gr||Li half-cells and (b) LFP||Li half-cells with different electrode compact densities.

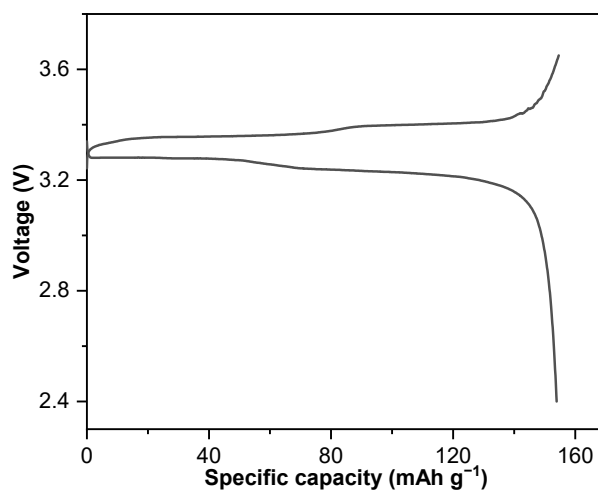


Fig. S4 The charge-discharge curves of the multi-layered LFP||Gr pouch-type cell.