JOUL, Volume *4*

Supplemental Information

Ultrasonic Scanning to Observe Wetting and "Unwetting" in Li-Ion Pouch Cells

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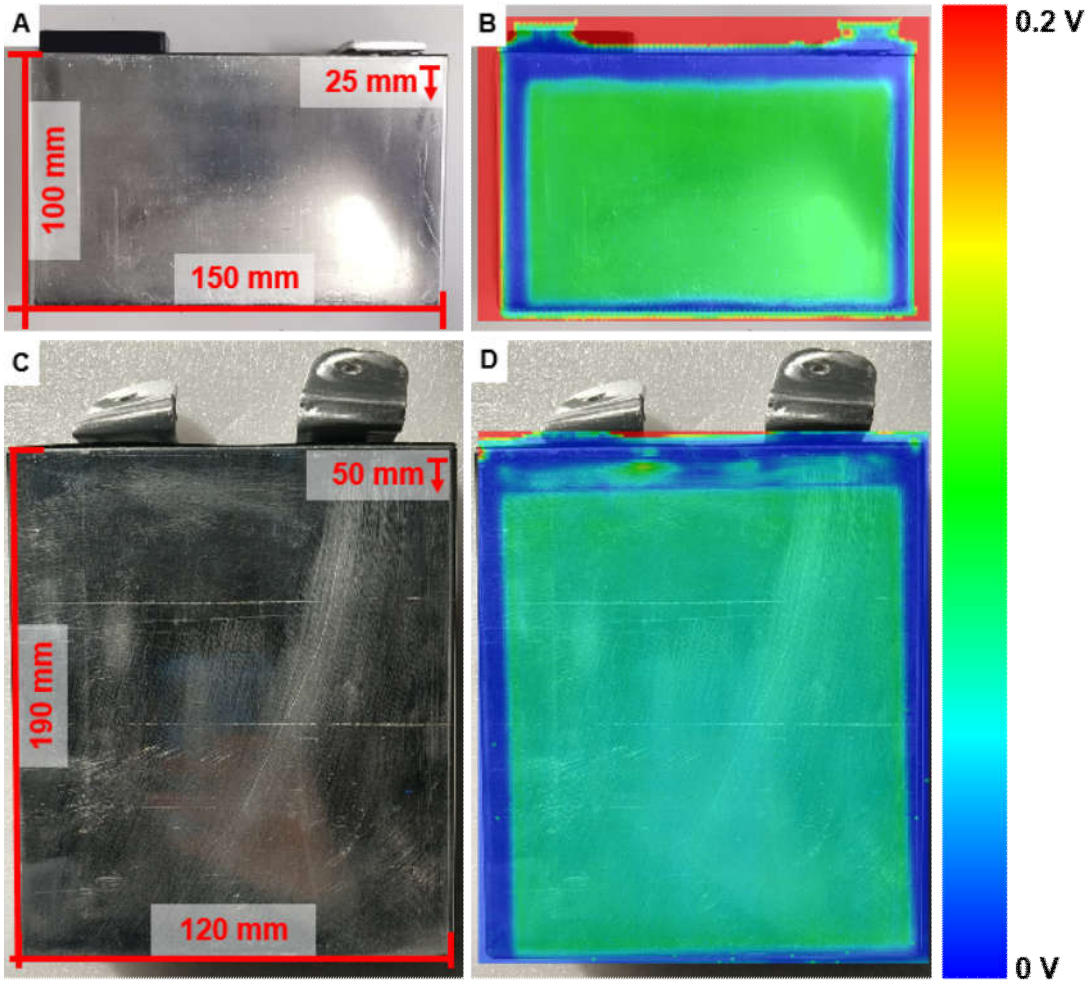

Figure S1 Photographs of two prismatic cells (A)(C) and their ultrasonic images overlapped with corresponding photographs(B)(D). This figure demonstrates the good penetrability of ultrasound beam.

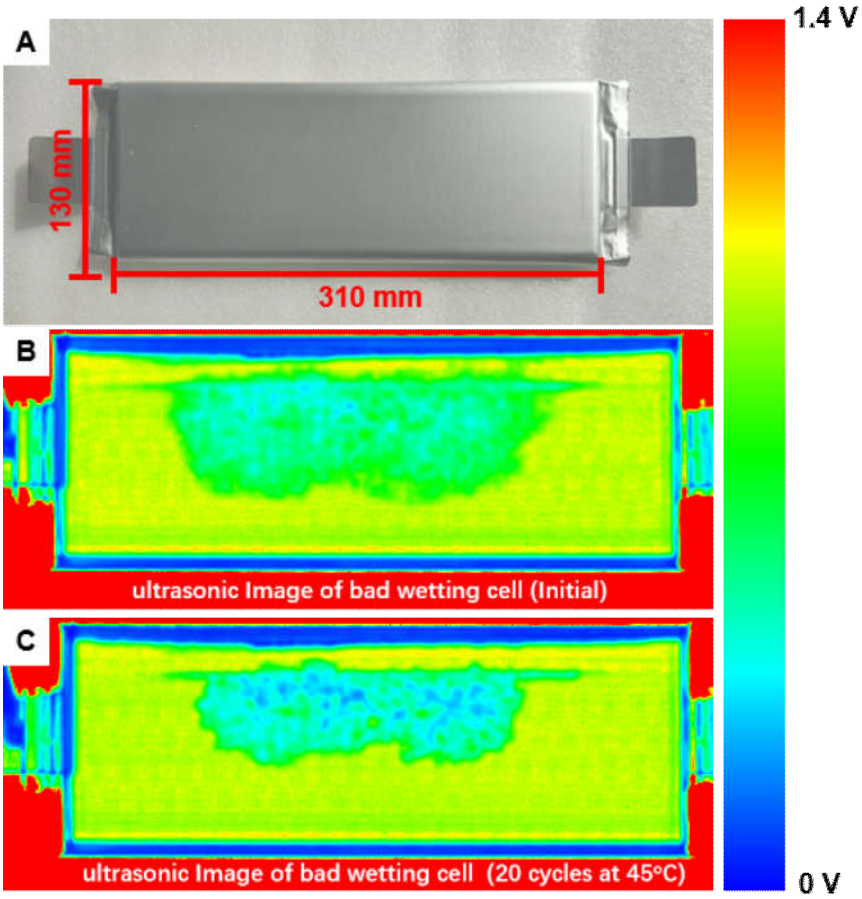

Figure S2 (A) Photo of a large commercial pouch cell; (B and C) its ultrasonic images before (B) and after (C) 20 cycles at 45°C. It can be seen that the distribution of electrolyte was not uniform at the initial state, and such non-uniformity in the central area worsened after cycling. This result indicates that non-uniformity of electrolyte distribution can become worse during cycling, and is a possible reason for battery failure.

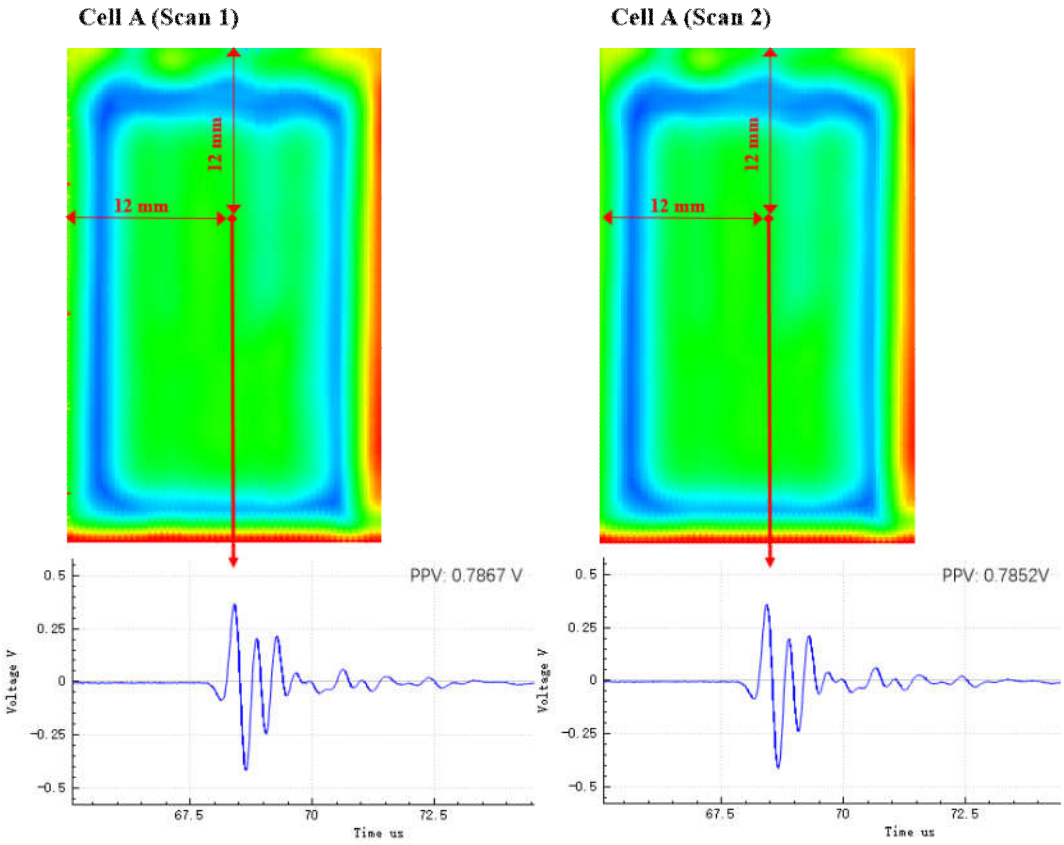

Figure S3 Ultrasonic images of Cell A obtained from two different scans with the same scanning parameters. Their ultrasonic waveform from the same positions are marked by red arrows. This figure demonstrates excellent repeatability of the machine. For the same sample, the peak to peak value variation is less than 2‰ from scan to scan.

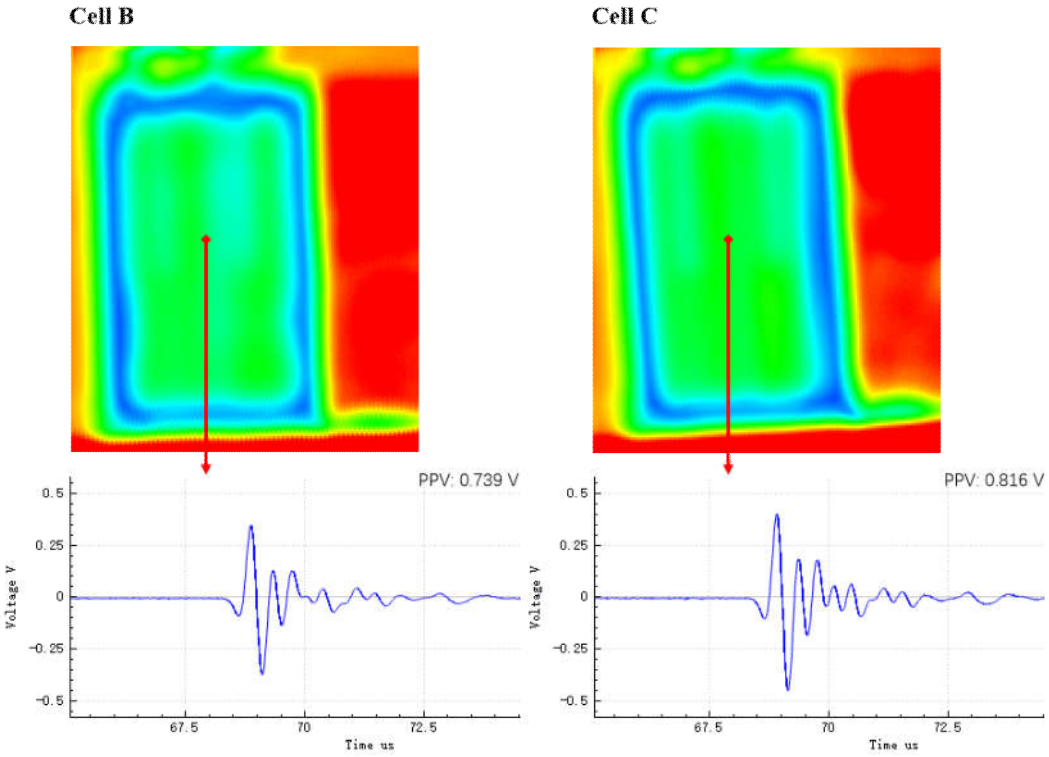

Figure S4 Ultrasonic images of two different cells from the same batch. Their ultrasonic waveforms are shown from the position marked by red arrows. Cell B and Cell C are two different cells with the same electrolyte and manufacturing steps. Ultrasound images show that they are both well wetted. The ultrasonic waveforms from the position marked by red arrow show that there is a 10 % variation of peak to peak value between two cells.

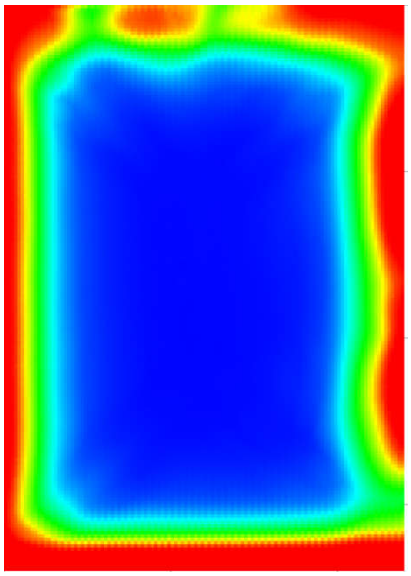

Figure S5 ultrasonic image of an NMC 532/AG commercial dry cell. When cells are dry there is little ultrasonic transmission through the jelly roll.

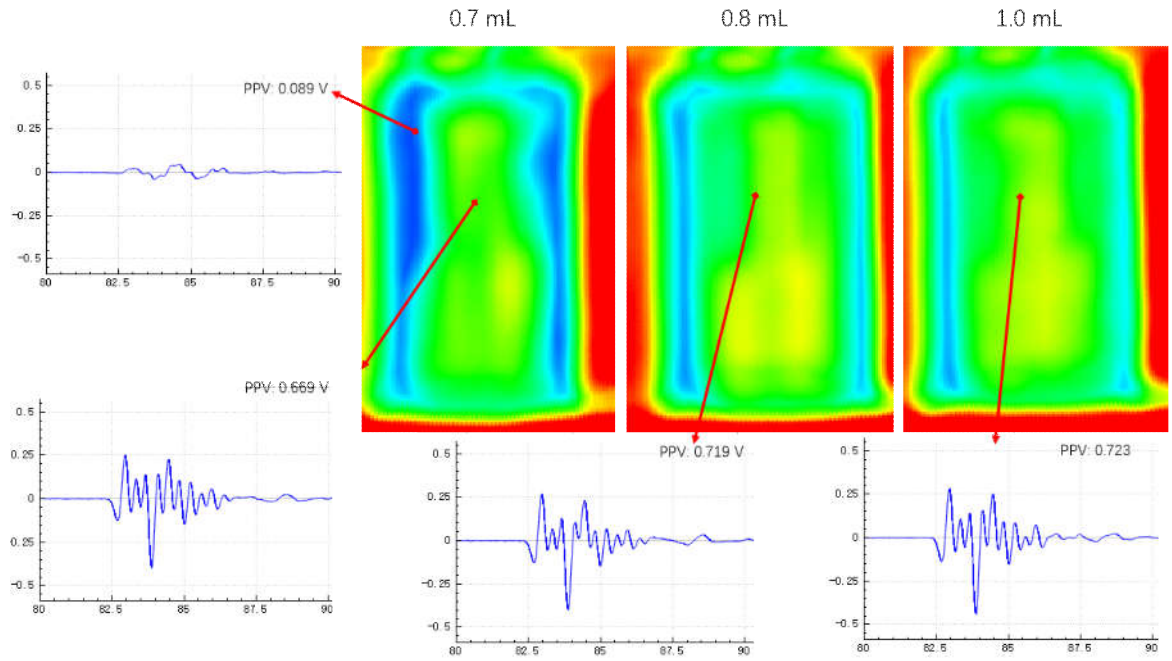

Figure S6 Ultrasonic images of NMC 532/AG cells with 0.7 mL, 0.8 mL and 1.0 mL electrolyte after wetting for 24 hours, as well as the corresponding ultrasonic waveforms at positions marked with red arrows. The peak to peak value of the ultrasonic wave at the well wetted area is more than 6 times higher than the insufficiently wetted area. Moreover, when the electrolyte is over 0.8 mL, adding more electrolyte does not further enhance the ultrasound transmission signal and the ultrasonic image always exhibits a uniform color. According to this result, 0.8 mL electrolyte is sufficient for wetting the cells we tested.

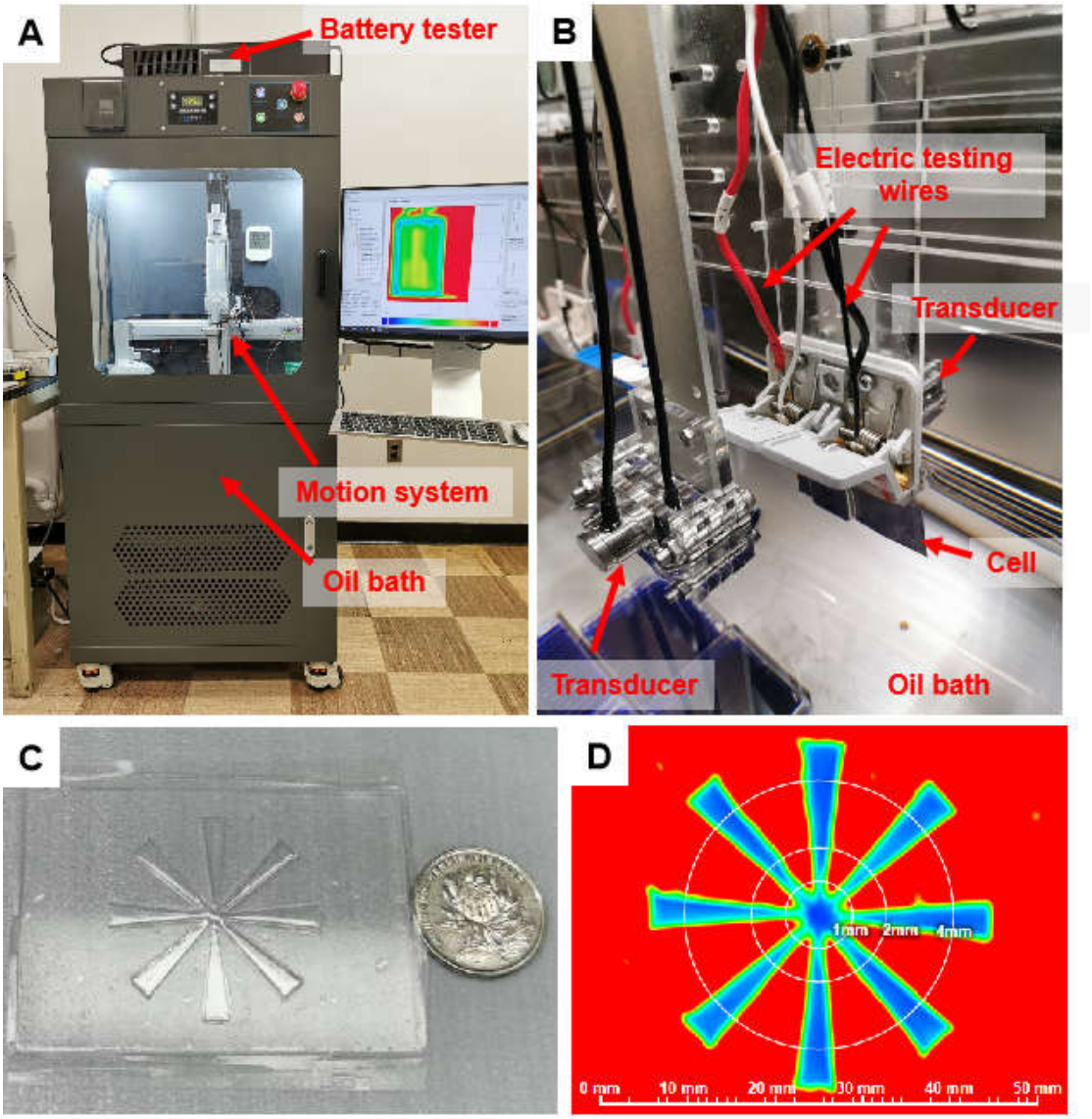

Figure S7 (A) Photograph of the UBSC-LD50 ultrasonic scanning instrument installed at Dalhousie University. It has a temperature-controlled silicone oil bath, which can provide a stable testing temperature from -20 to 60 ^{o}C. It is integrated with a battery tester (Neware Co. Ltd., Shenzhen, China), and thus is capable to do ultrasonic scanning during charge/discharge; (B) The ultrasonic transducers and the tested cell. (C) Photograph of a standard sample for resolution testing; (D) Resolution test result of the ultrasonic scanning machine. The dashed-line circles indicate the corresponding gap widths of the standard sample.