Supporting Information

Integrated arrays of micro resistance temperature detectors for monitoring of the short-circuit point in lithium metal batteries

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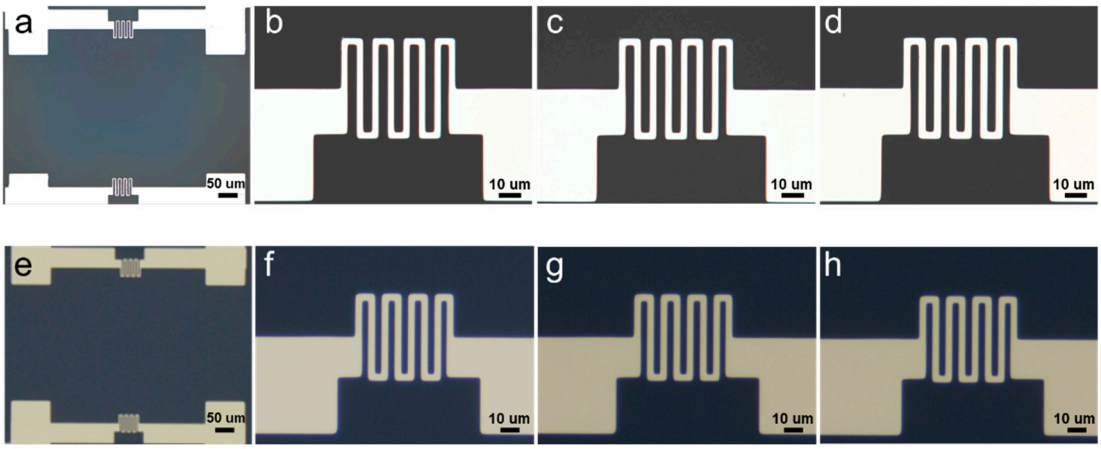
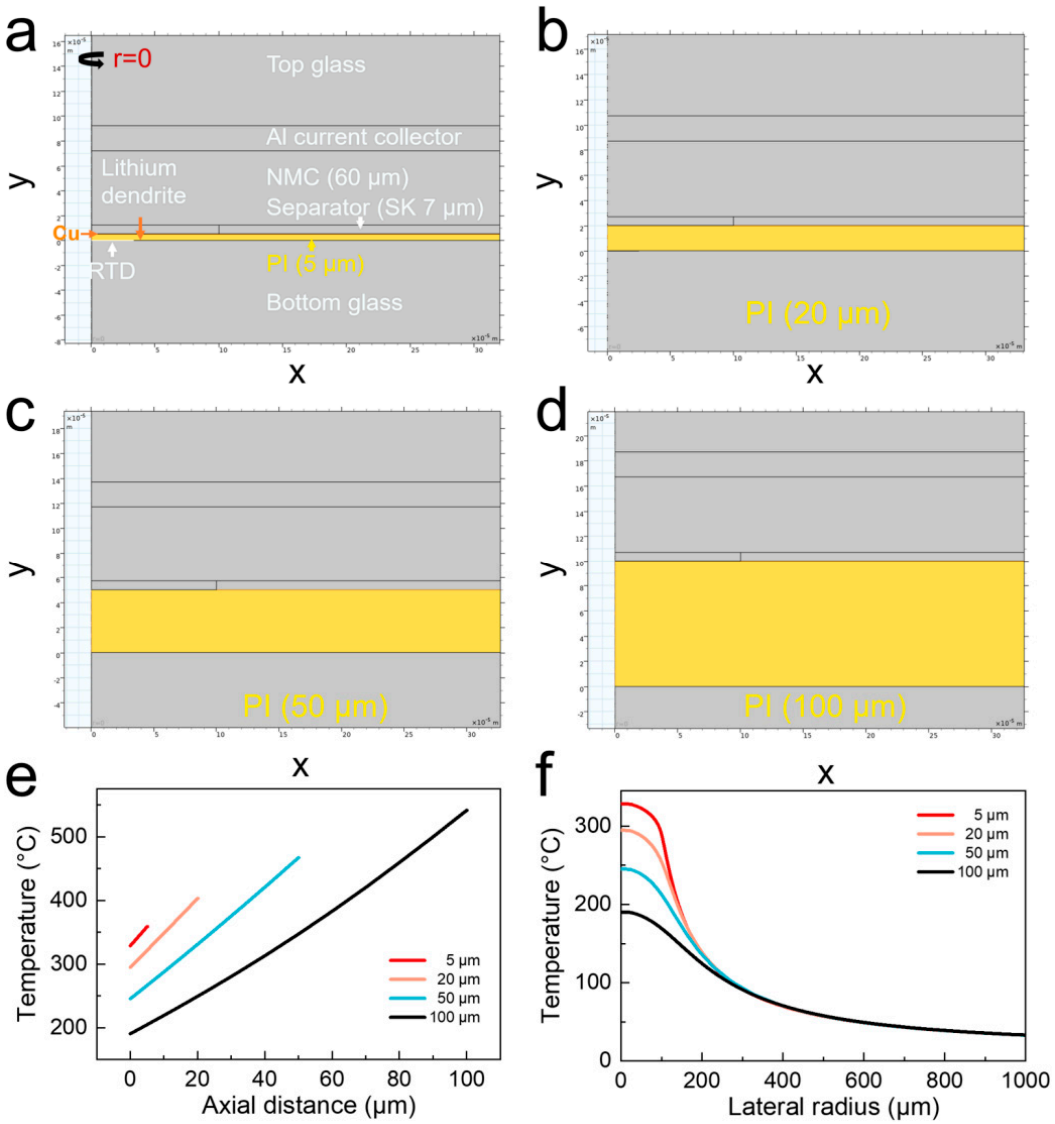
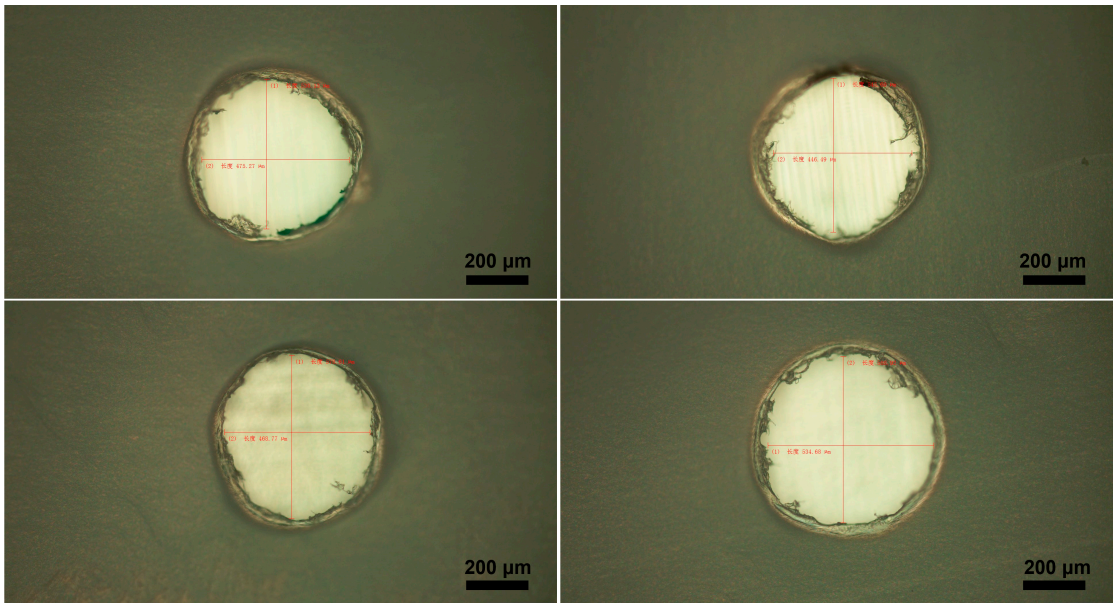


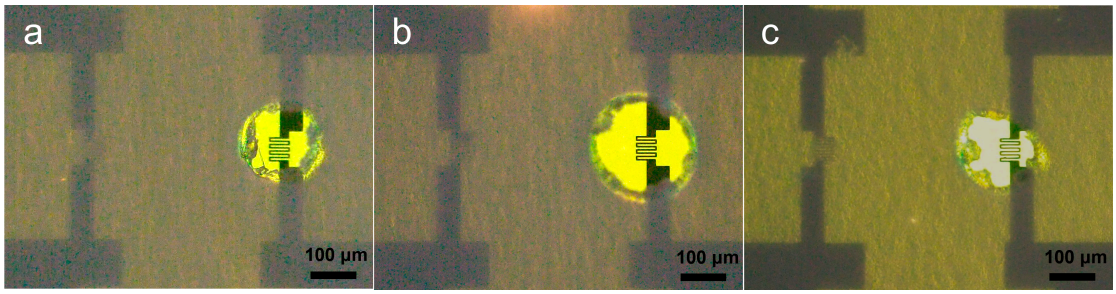
Supplementary Figure S1. Au and Pt micro-RTDs are fabricated by photolithography. (a-d) Au micro-RTDs, (e-h) Pt micro-RTDs.



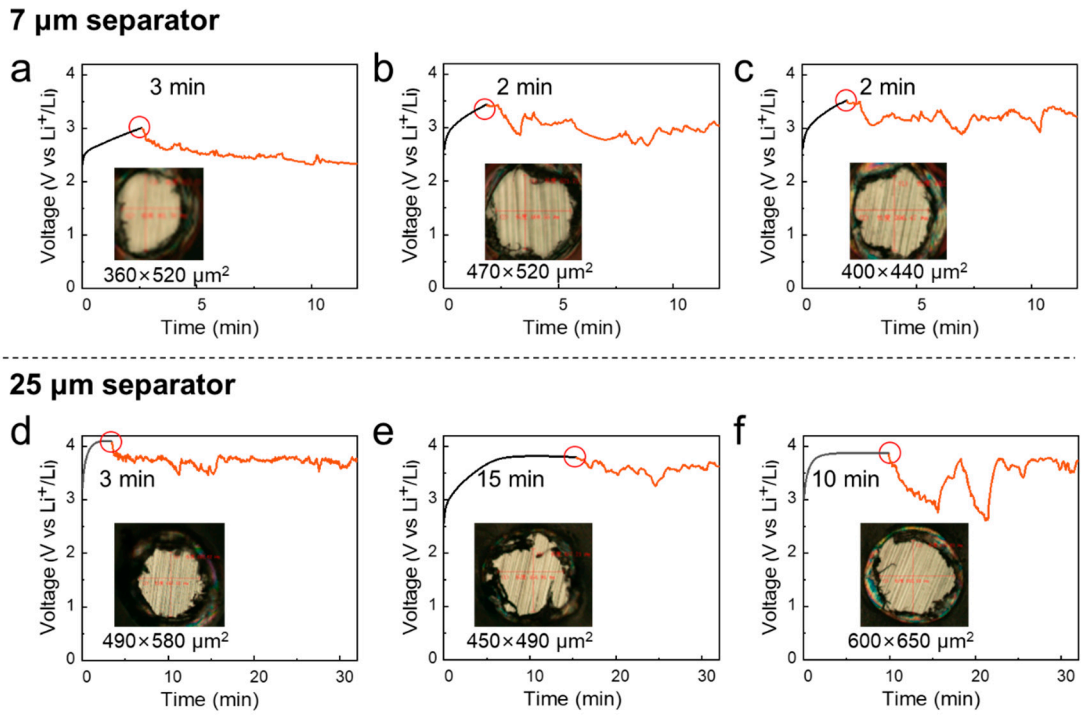
Supplementary Figure S2. Four simulated models with the different PI thickness of 5, 20, 50, and 100 μm. (a-d) Four simulated models were established with different PI thickness of 5, 20, 50, and 100 μm to investigate the effect of the PI thickness on temperature. (e) Temperature distribution in the vertical direction from the micro-RTD surface (at the bottom of the PI film) to the Cu surface (at the top of the PI film) with the heat source at maximum power (225 mW). The difference in temperature on both sides of the PI increases with the thickness, from ~30 °C (5 μm PI) to ~350 °C (100 μm PI). (f) Radial temperature distribution along the micro-RTD surface. On one hand, the increase of the thickness can reduce heat dissipation, thus leading to the temperature rising of the short-circuit center; on the other hand, the increase of the thickness distorts the temperature measured by micro-RTDs and reduces the temperature detection accuracy. Therefore, this ultra-thin polyimide was used.



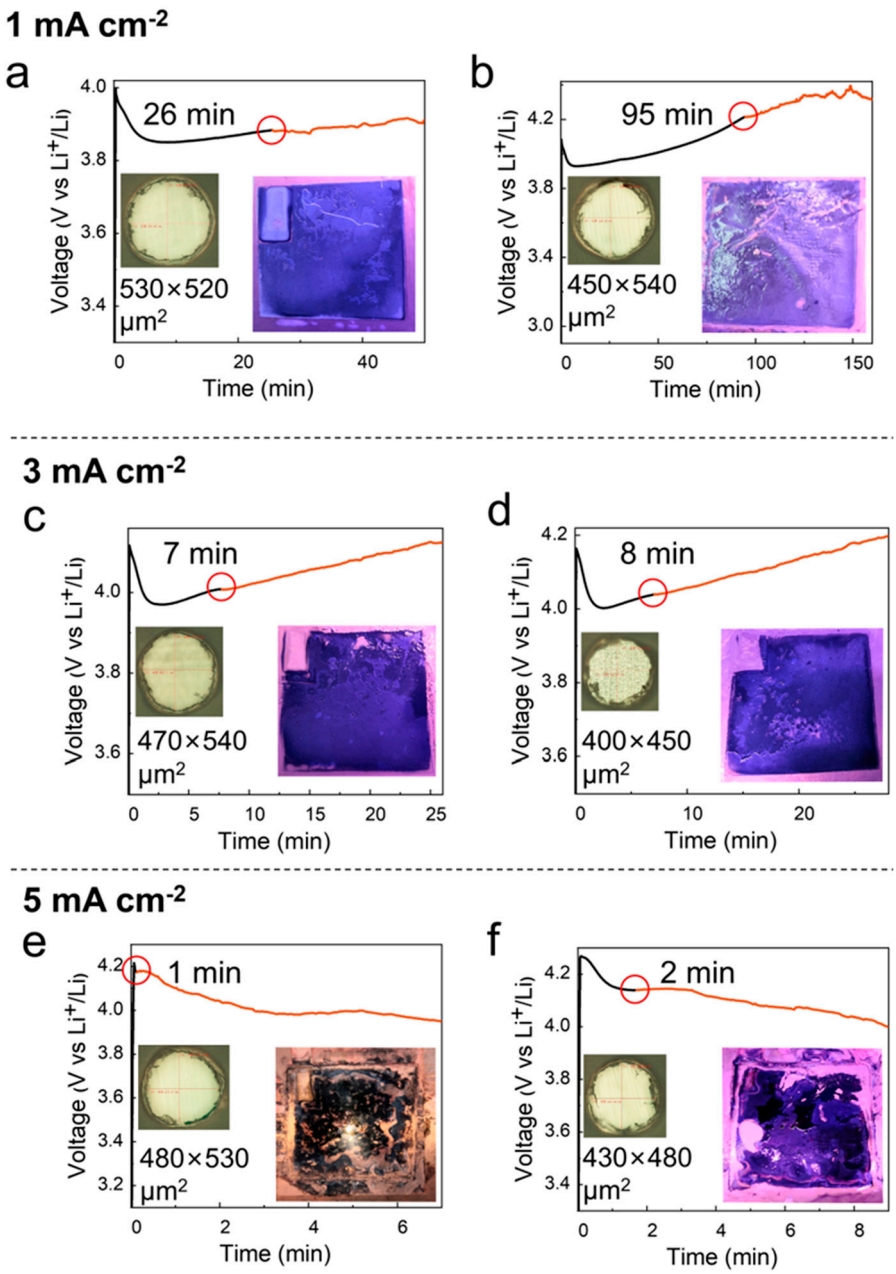
Supplementary Figure S3. Optical pictures of separators with micropores for inducing lithium dendrite short circuits.



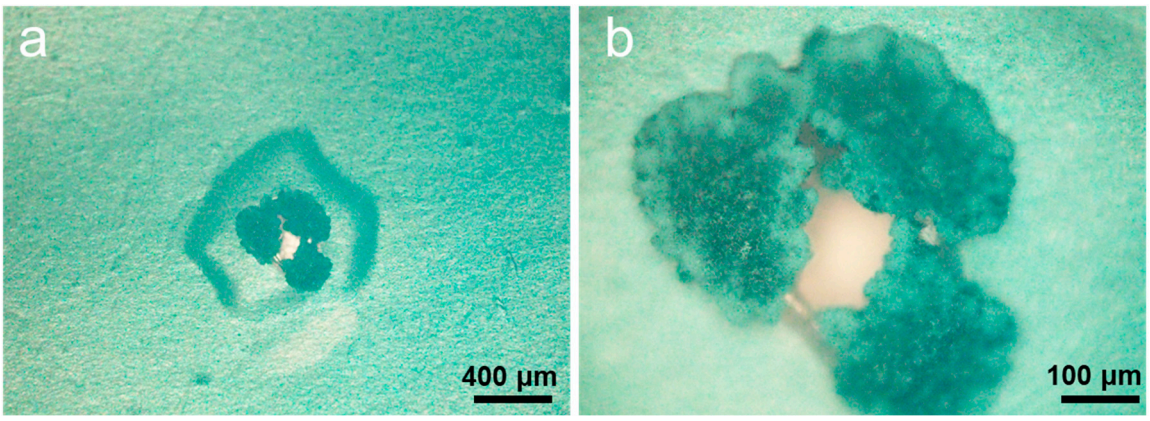
Supplementary Figure S4. Optical images of the aligned circular micropores in separator with the micro-RTD.



Supplementary Figure S5. Coin cell charging curve which used 7 μm or 25 μm thickness separator with a similar size micropore. The starting points of significant fluctuations in the voltage curve are highlighted in red in the diagram. (a-c) Coin cells with a 7 μm separator, (d-f) coin cells with a 25 μm separator.



Supplementary Figure S6. Pouch cells charging curve which used a 7 μm thickness separator with a similar size micropore at a different charging current density of 1, 3, and 5 mA cm^{-2} respectively. (a,b) Pouch cell operating at a current density of 1 mA cm^{-2}, (c,d) pouch cell operating at a current density of 3 mA cm^{-2} , (e,f) pouch cell operating at a current density of 5 mA cm^{-2}. As the current increases, the short-circuit time of the battery becomes shorter.



Supplementary Figure S7. Optical microscopy images of the negative electrode after charging.