Supplementary Information

Enhanced Electrochemical Capabilities of Lithium Ion Batteries by Structurally Ideal Anodic Aluminum Oxide Separator

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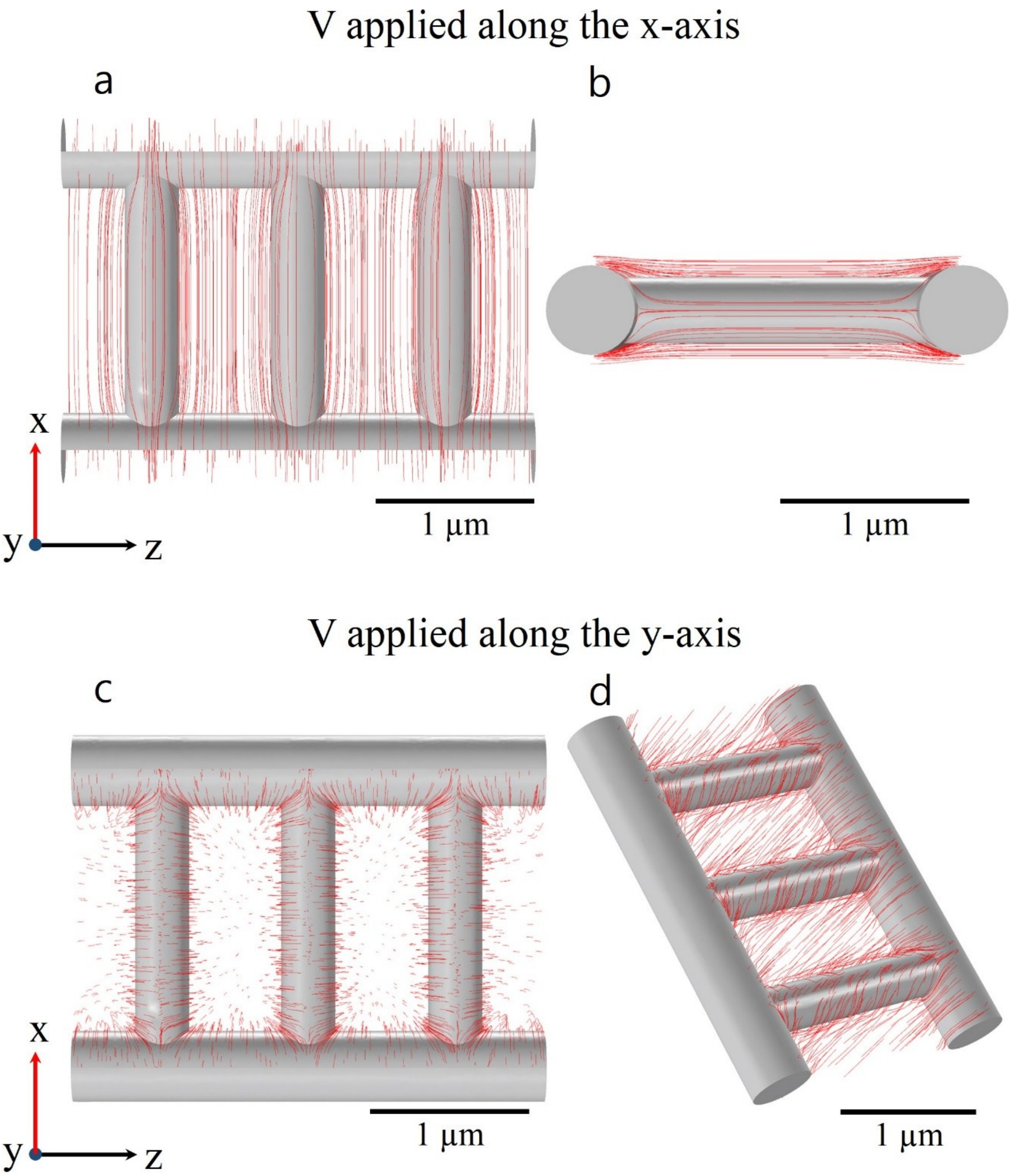

Figure S1. Modelling of current density distribution in the porous poly propylene separator (Celgard 2500) with liquid electrolyte (1M $LiPF_6$ in ethylene carbonate/dimethyl carbonate with the weight ratio of 1/1), simulated by finite element method (FEM, COMSOL multiphysics). The red lines denotes the current pathways, when the voltage is applied along each axis, e.g., x-axis (a and b), y-axis (c and d), respectively.

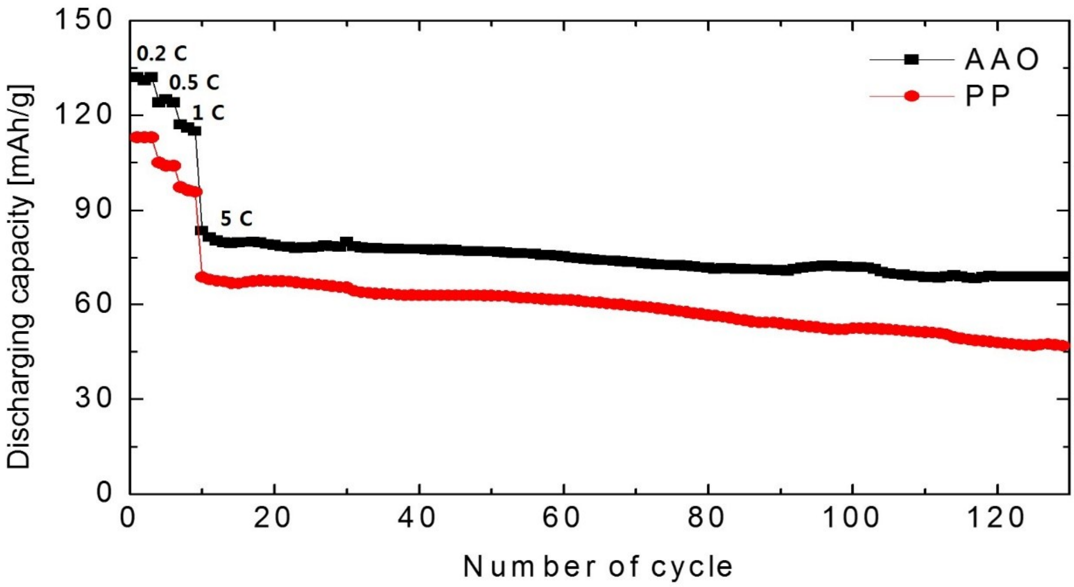

Figure S2. Discharging capacity variation of the AAO and PP separator employed half-cell with lithium iron phosphate ($LiFePO_4$, LFP)/Li metal. The current density rate varies from 0.2 C to 5C. The initial capacity of the AAO and PP cells are 132 mAh g^{-1} and 113 mAh g^{-1} at 0.2 C, respectively. At 5 C, the discharging capacity of AAO cell fades from 83.41 mAh g^{-1} to 68.94 mAh g^{-1}. The PP composed cell, meanwhile, shows large decrease in capacity from 68.72 mAh g^{-1} to 46.87 mAh g^{-1}.

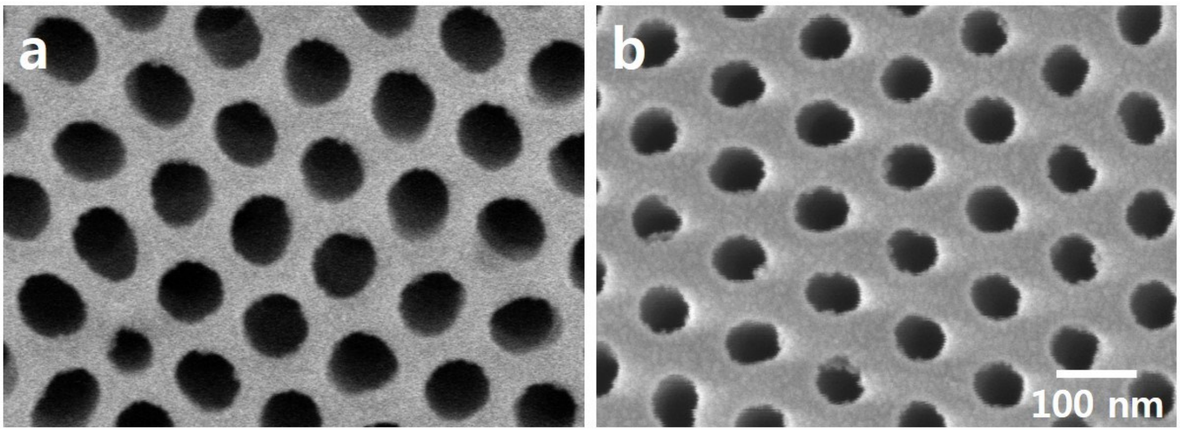

Figure S3. SEM images of AAO separator after 130 cycled at current density of 5 C. (a) Front side and (b) reverse side of AAO separator.

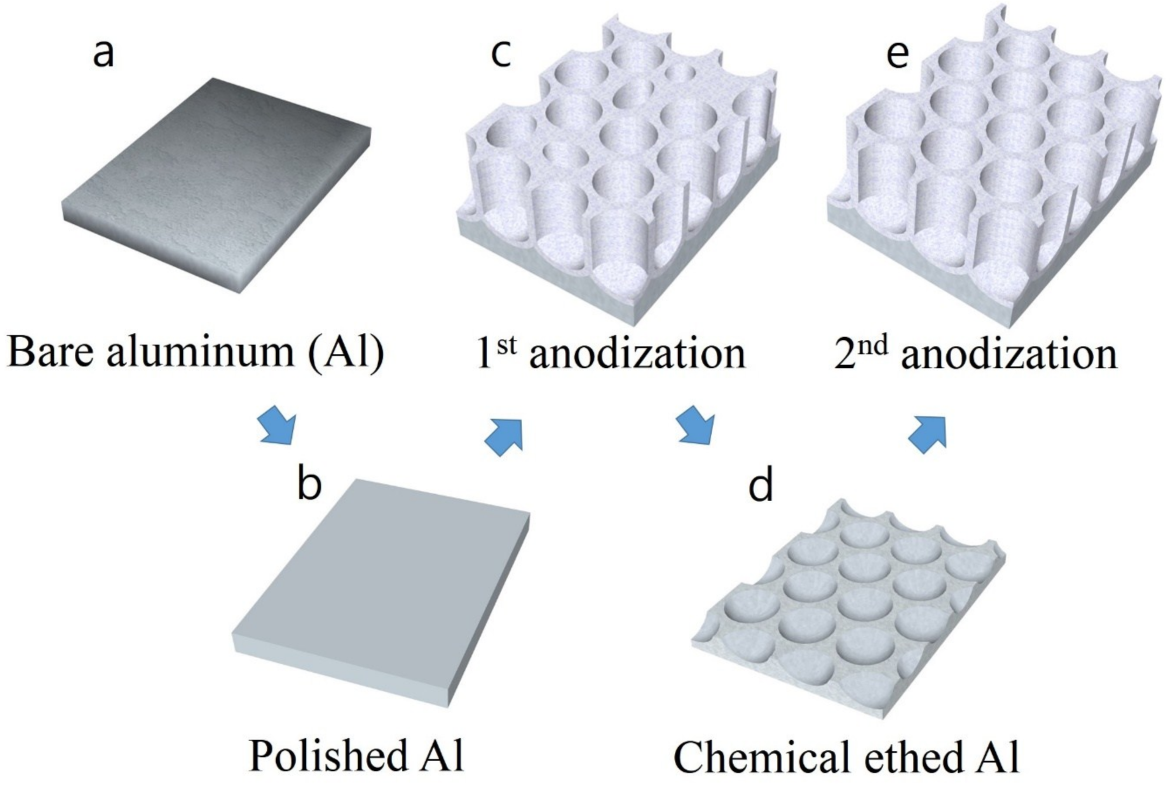

Figure S4. Schematic diagram of anodic aluminum oxide preparation steps. (a) Bare aluminum (Al, purity of 99.999%, Good Fellow) specimen, (b) after electropolished aluminum substrate, (c) non-uniform pore array of the AAO layer was formed after 1st anodization step, (d) chemically etched aluminum substrate (immersed in 0.3 M chromium oxide solution), and (e) hexagonal pore array of the AAO layer after 2nd anodization process.

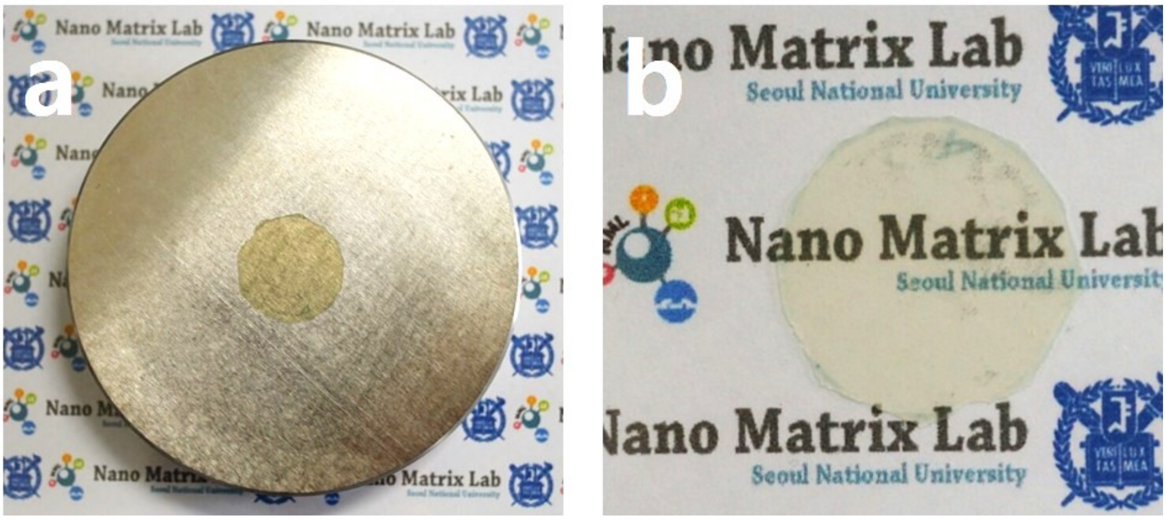

Figure S5. Measurement of AAO separator mechanical strength using hydraulic pump press machine. (a) Before pressure test of AAO membrane image and (b) after test under 20 MPa pressure (12 tonne-force). Prepare AAO separator can endure over 41.70 kPa, this result indicates that AAO separator is possibly used in stacked-battery for huge energy storage system.