SUPPORTING INFORMATION

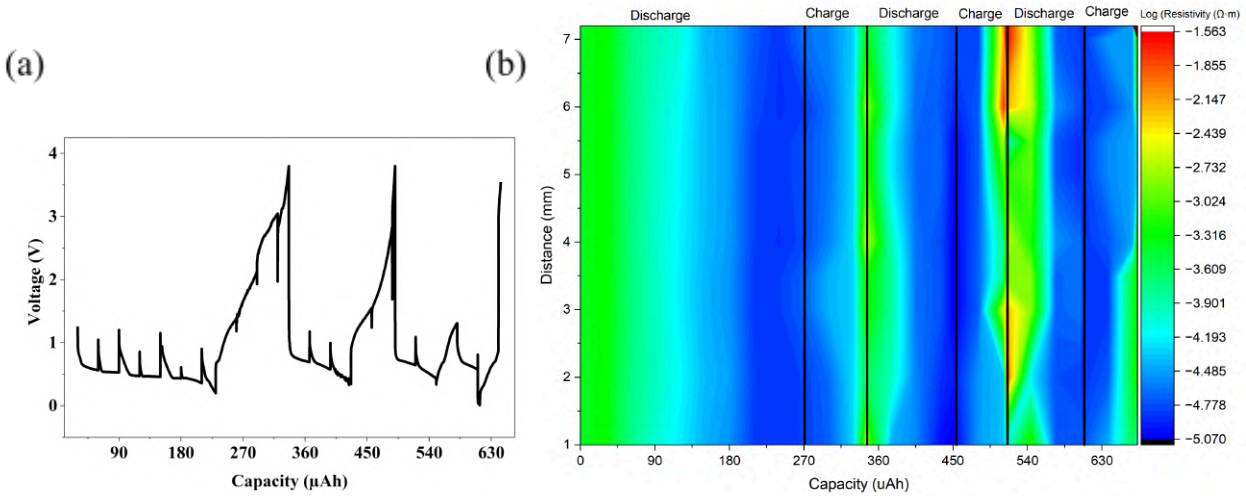

Fig 1. Electrochemical and transport characterization of ZnO thin films. (a) Voltage response of the ZnO sample during the initial three galvanostatic charge-discharge cycles. The measurement was initiated from the pristine (bare) state and conducted at a constant current of 30µA recorded at hourly intervals. (b) Corresponding Two-probe resistivity response visualized via a contour plot, where the color transition from blue to red denotes an increase in resistivity magnitude.

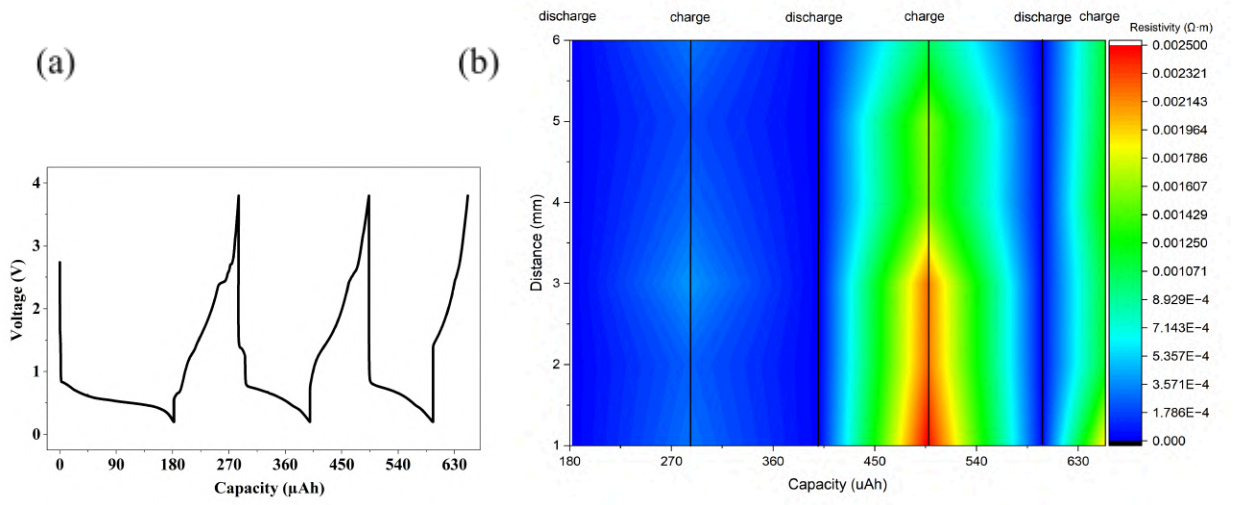

Fig 2. In-situ resistivity characterization of ZnO electrode. (a) Galvanostatic voltage profiles for the first three cycles (I = 30 µA). Resistance data were acquired using a two-probe configuration at the end-of-charge (EOC) and end-of-discharge (EOD) states. (b) 2D contour mapping of the resistivity evolution; the blue-to-red spectrum corresponds to the increase in resistivity magnitude.

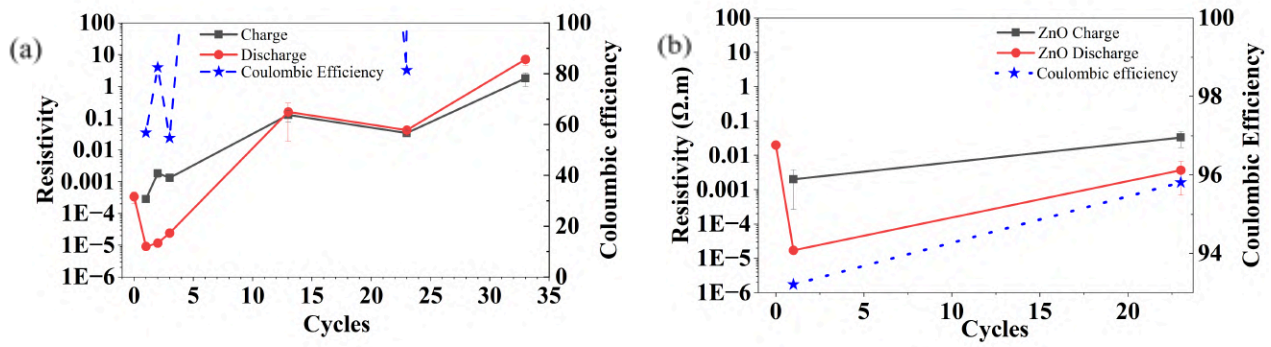

Fig 3. Influence of resistivity trends on electrochemical performance. (a) A sharp, monotonic rise in resistivity is associated with poor CE stability. (b) Controlled management of the resistivity increase leads to higher CE values and improved cycling robustness.