

Supporting Information

Anchoring an Artificial Protective Layer to Stabilize Potassium Metal Anode in Rechargeable K–O₂ Batteries

*Neng Xiao, Jingfeng Zheng, Gerald Gourdin, Luke Schkeryantz, and Yiyi Wu**

Department of Chemistry and Biochemistry, The Ohio State University, 100 West 18th Avenue, Ohio 43210, United States

E-mail: wu@chemistry.ohio-state.edu

Supporting Information

Anchoring an Artificial Protective Layer to Stabilize Potassium Metal Anode in Rechargeable K–O₂ Batteries

Supplementary Figures



Figure S1. (a) Raw K metal cubes dipped into pure TEGDME, 0.2 M SbF₃-TEGDME, and 0.2 M SbCl₃-TEGDME. The reaction between K and SbCl₃ continued until all K was consumed, while the reaction with SbF₃ is terminated on the surface. (b) Raw K metal cubes aged in pure TEGDME (left) and 0.2M SbF₃-TEGDME (right) up to a month. SbF₃ formed an artificial protective layer on the K metal surface to prevent the continuous decomposition of TEGDME (decomposition resulted in yellow solution).

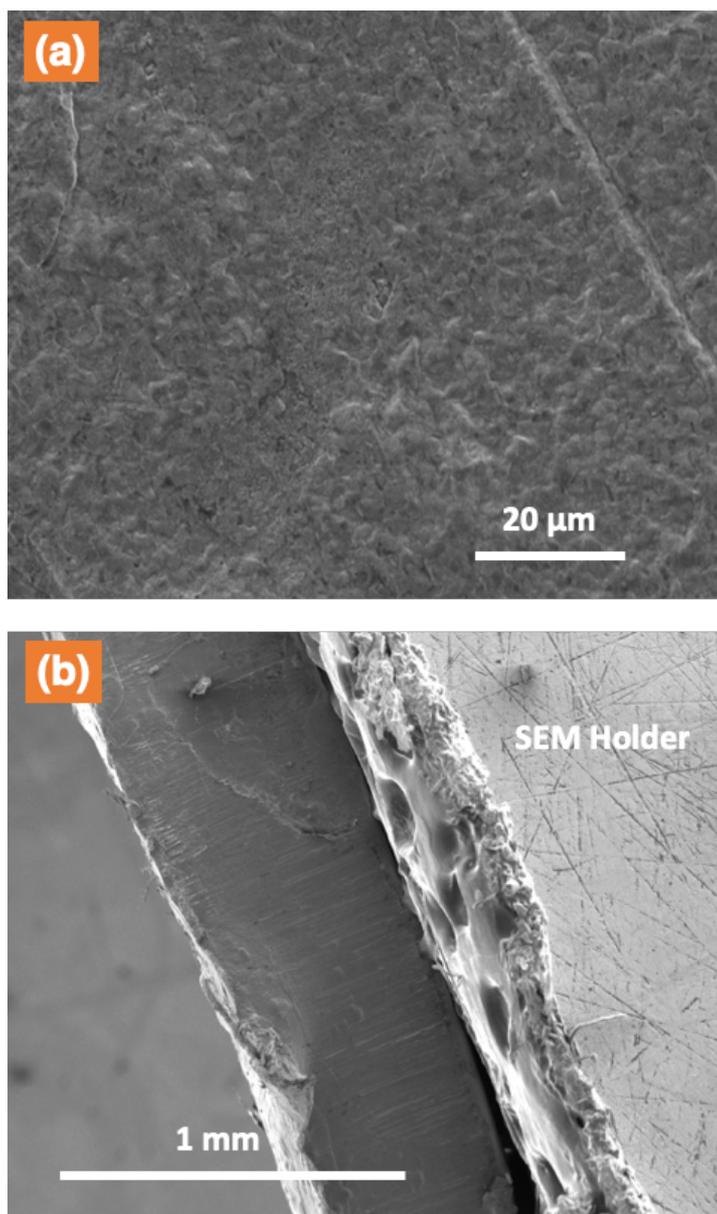


Figure S2. SEM imaging on (a) surface and (b) cross-section of a pristine K metal anode fabricated with proposed procedure.

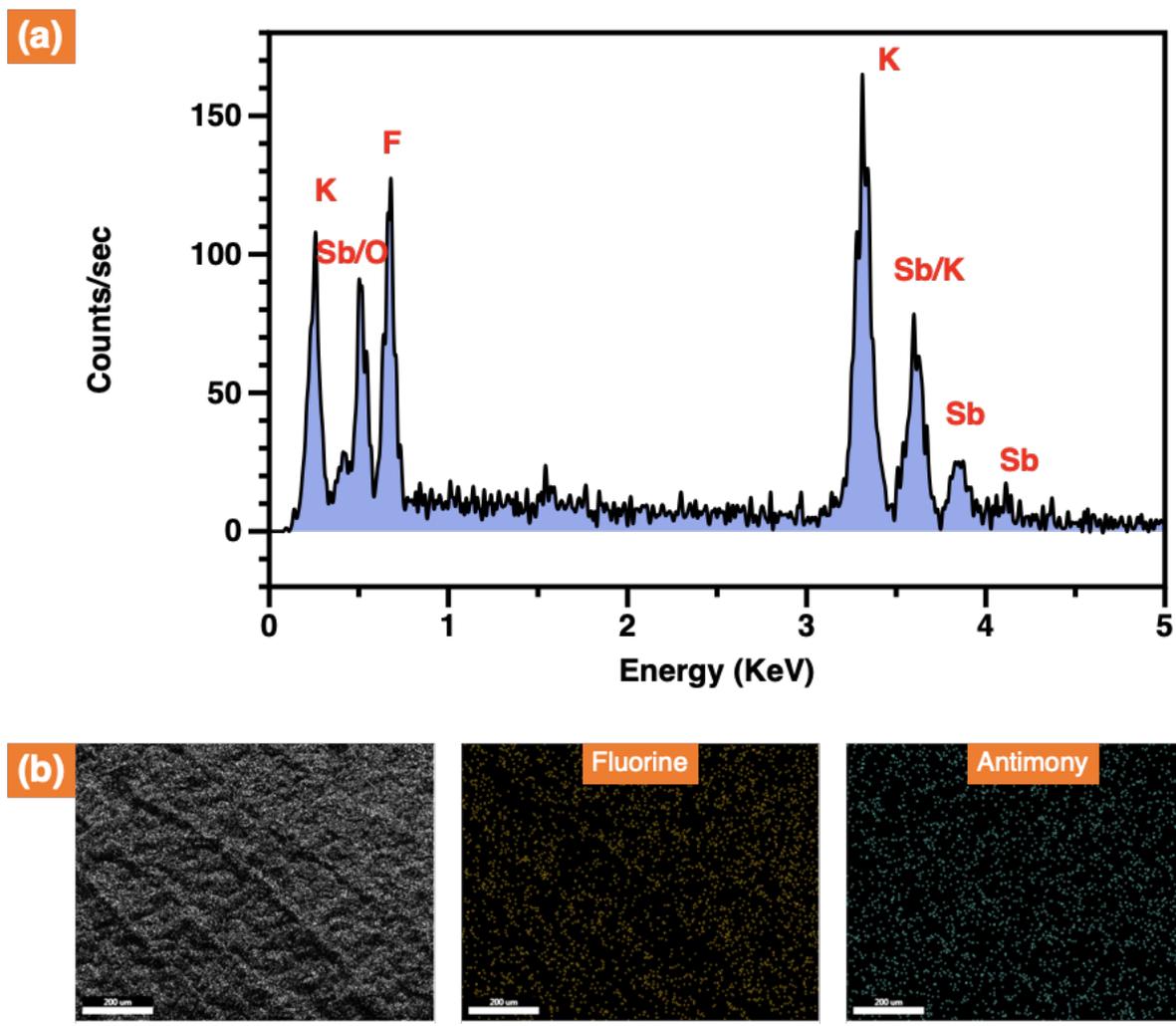


Figure S3. (a) EDS spectrum and (b) F and Sb mapping of the artificial protective layer.

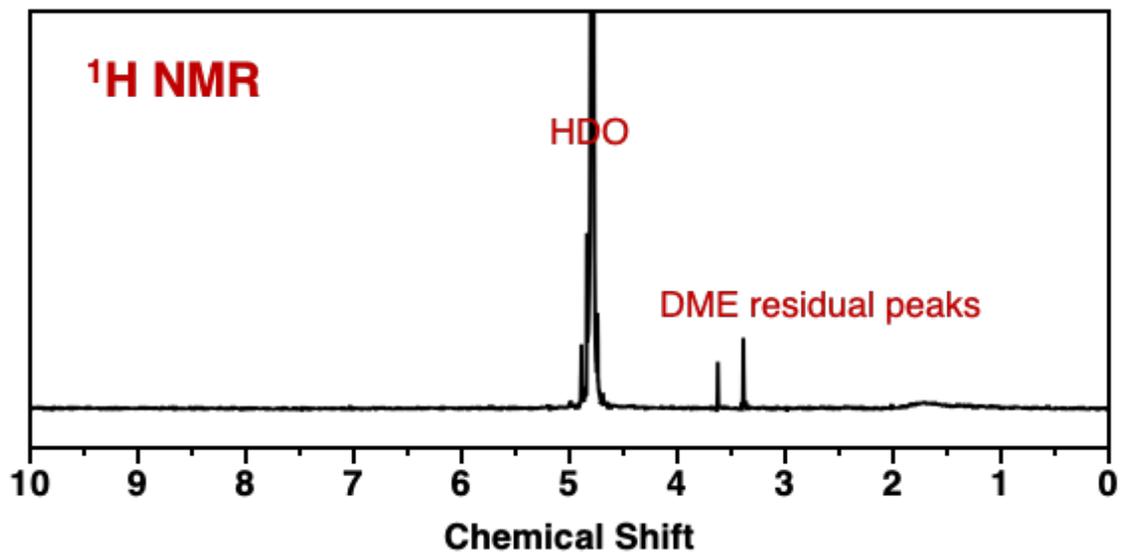


Figure S4. ^1H NMR on the surface layer of SbF_3 -treated K metal anode (D_2O , 400 MHz).

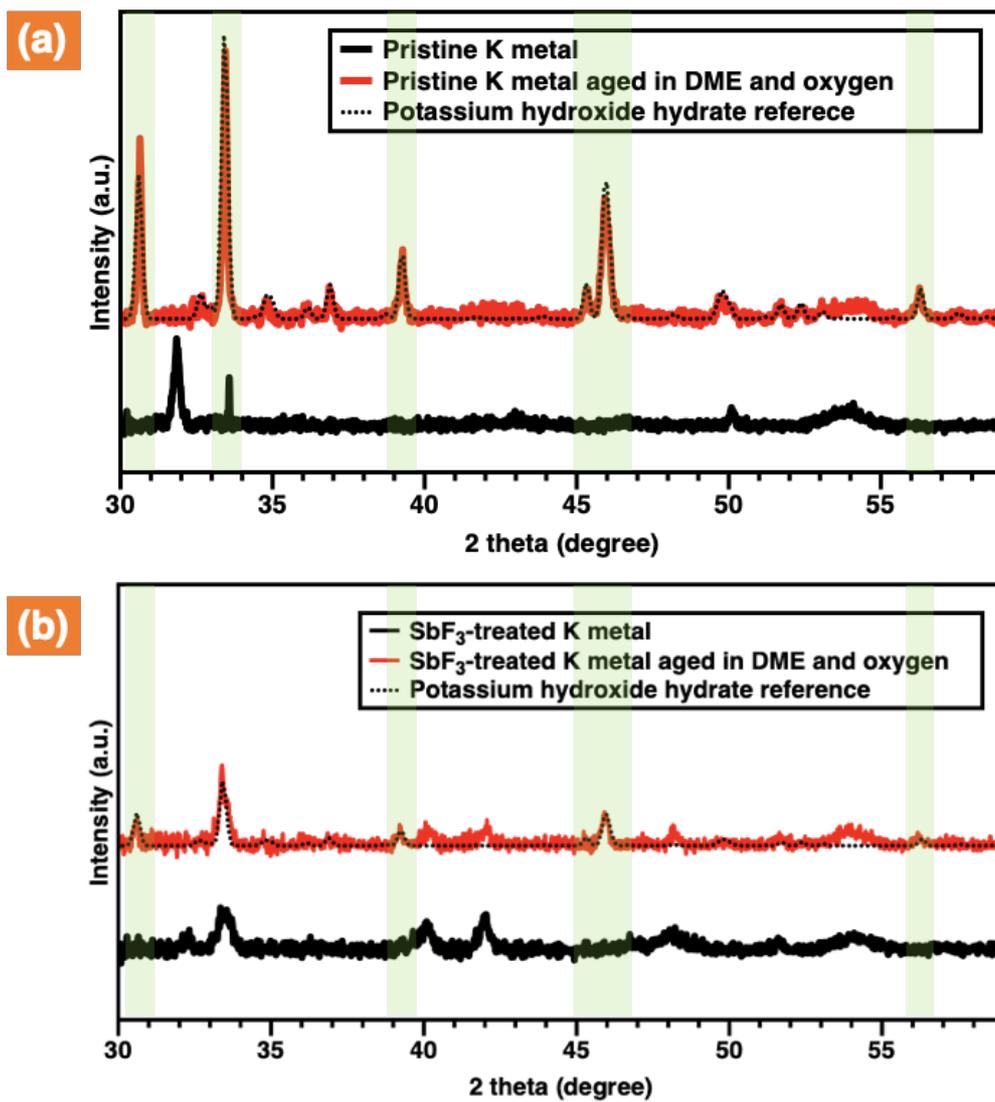


Figure S5. XRD on the (a) pristine K metal anode and (b) SbF₃-treated K metal anode before and after aging for two weeks in the DME solvent saturated with pure O₂.

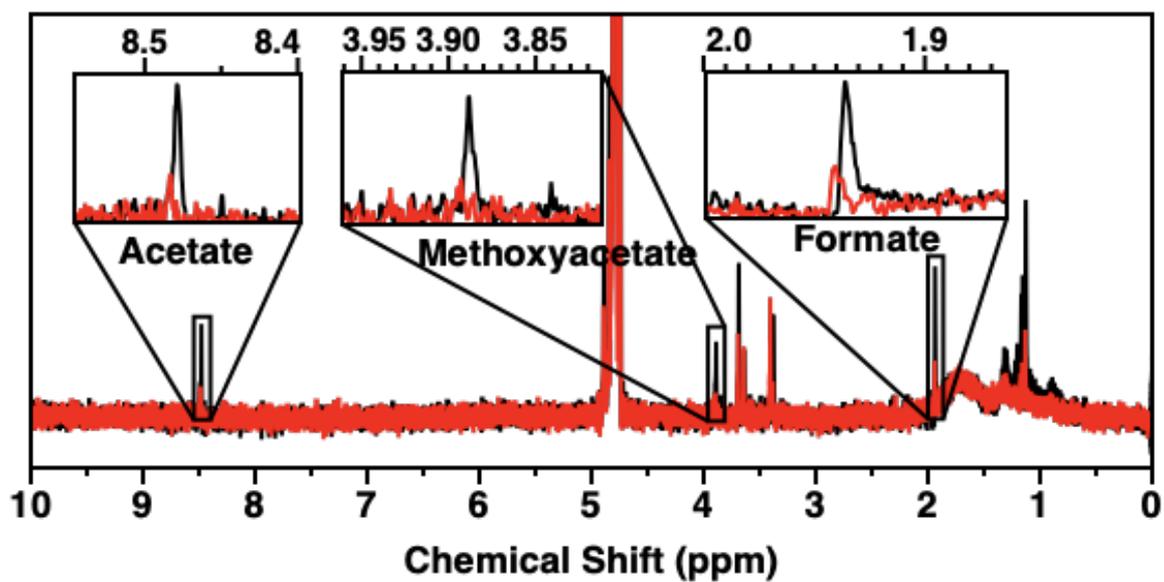


Figure S6. NMR on the dissolved surface layer from pristine K metal anode (black) and SbF_3 -treated K metal anode (red) after aging for two weeks in the DME solvent saturated with pure O_2 .

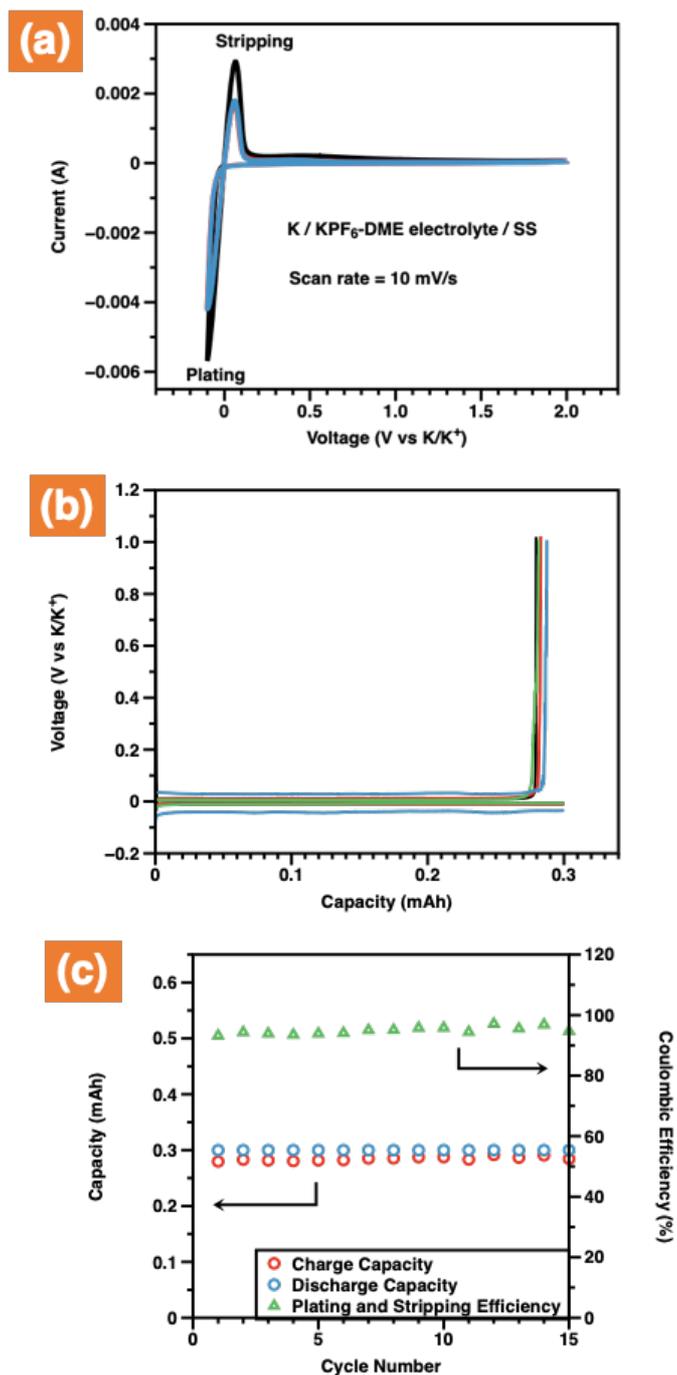


Figure S7. (a) Cyclic voltammetry and (b-c) galvanostatic cycling of K plating and stripping in a KPF_6 -DME electrolyte with the standard K metal foil fabricated in the way reported in this work. Efficiency has been increased in the initial 15 cycles compared with the raw K anode reported before.

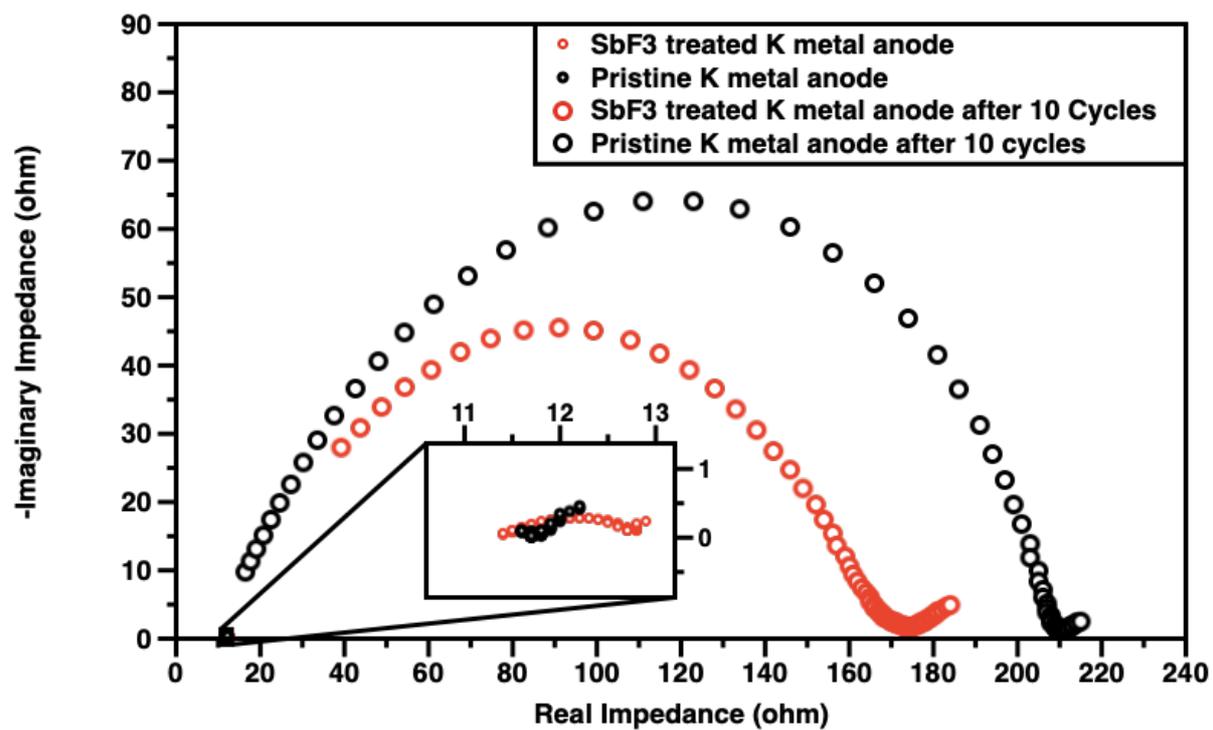


Figure S8. Electrochemical impedance spectra analysis on the SbF₃-treated K metal anode.

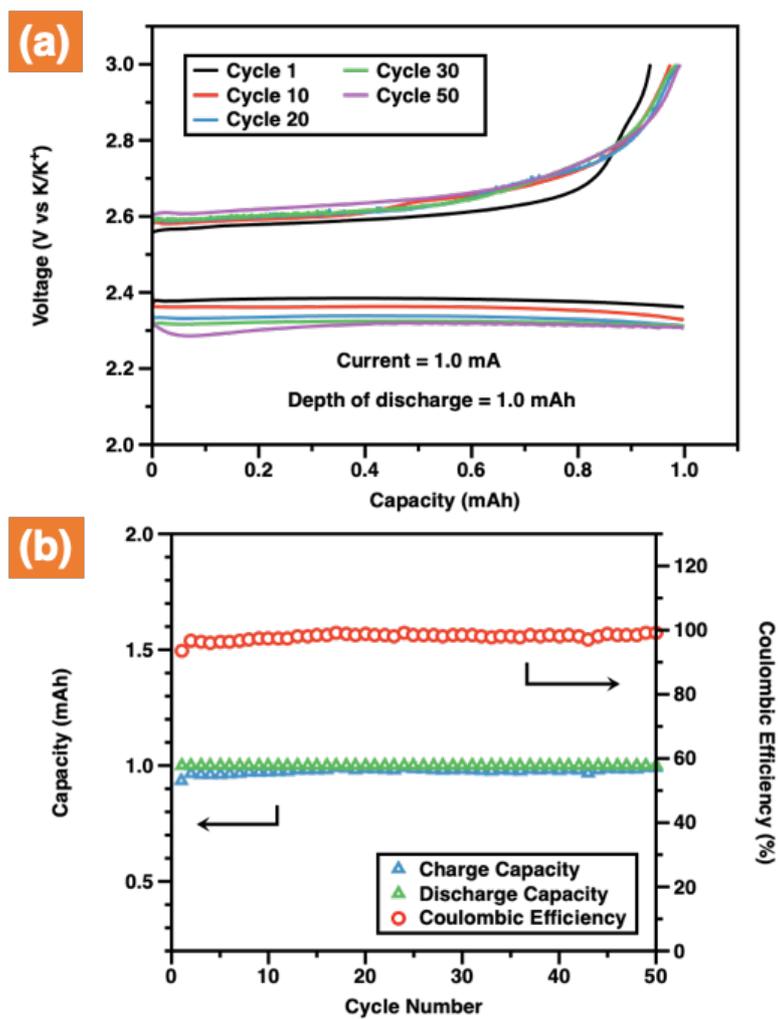


Figure S9. (a) Voltage profile and (b) cycling of K-O₂ battery with SbF₃-treated K metal anode at a high rate (discharge capacity = 1 mAh, current = 1 mA).

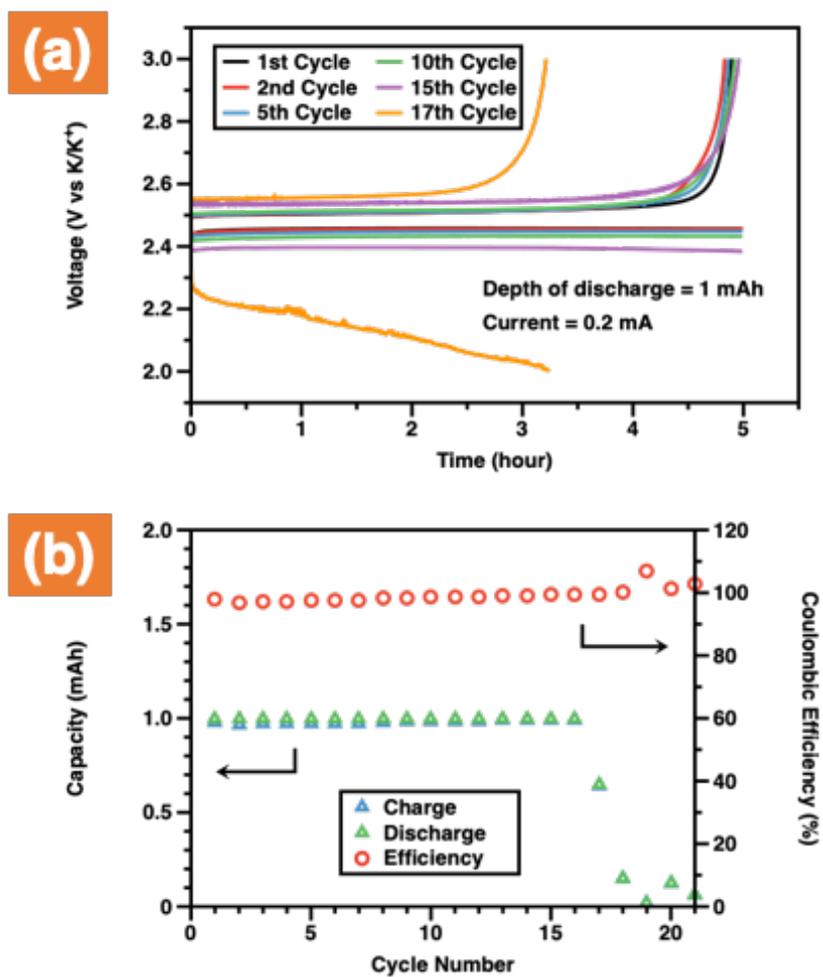


Figure S10. (a) Voltage profiles and (b) cycling performance of K-O₂ battery with pristine K metal anode.

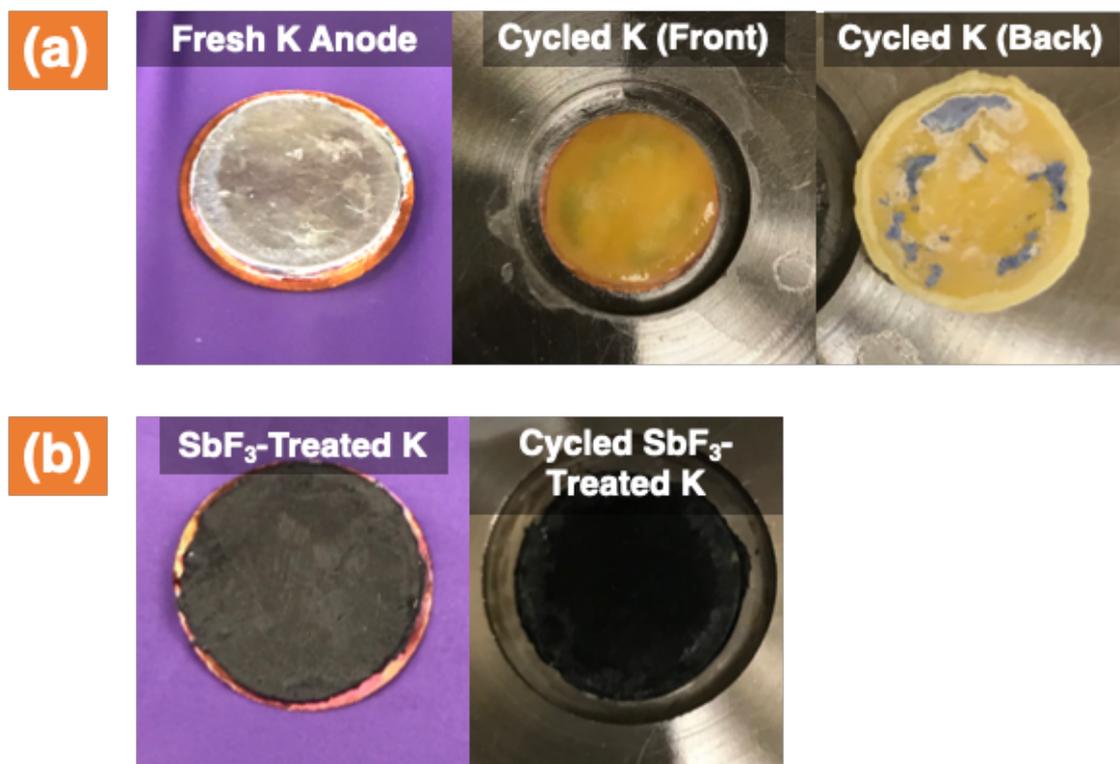


Figure S11. Photos of (a) corroded K metal anode after 20 cycles in K–O₂ battery with no artificial protective layer and (b) K anode with SbF₃ treatment after 20 cycles.

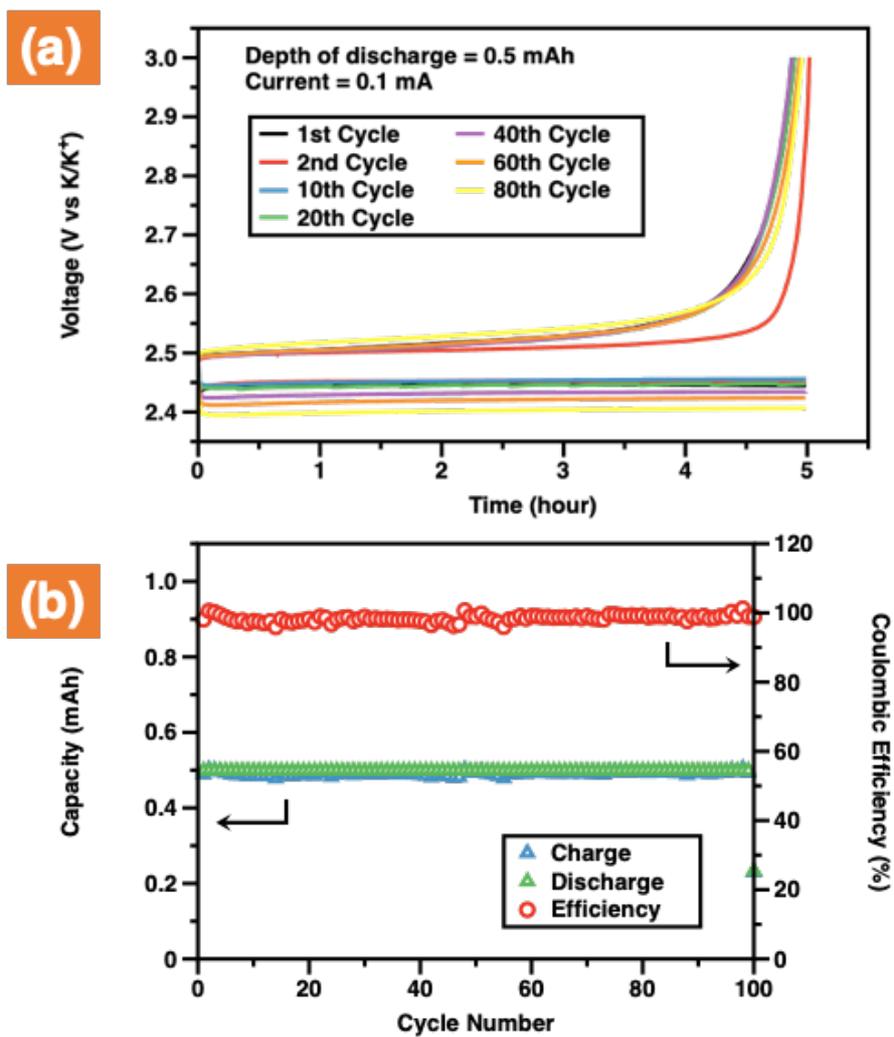


Figure S12. (a-b) Cycling of K-O₂ battery with artificial protective layer at lower rate and depth of discharge for 1000 hours (discharge capacity = 0.5 mAh, current = 0.1 mA).

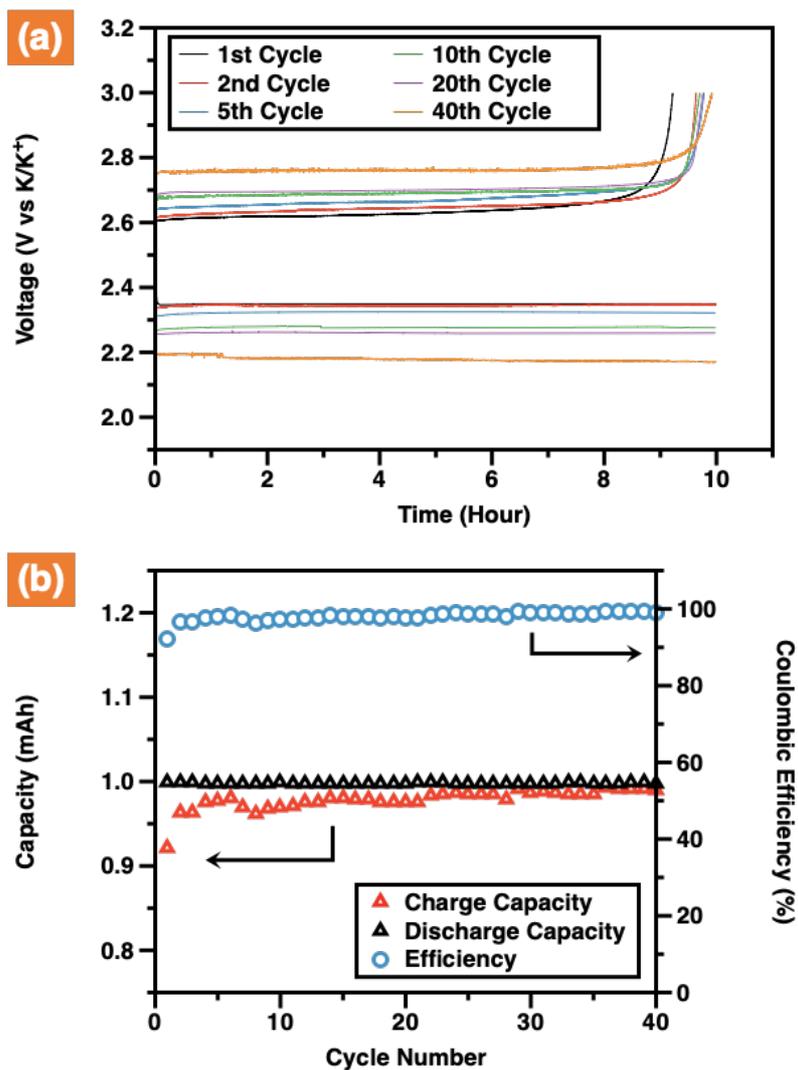


Figure S13. (a-b) Cycling of K-O₂ battery with both SbF₃ treatment and Nafion membrane (over 800 hours). The Nafion membrane increased both the cost and cell overpotential significantly even at a lower rate (0.1 mA).