Supporting Information

3D Printing of Freestanding "O₂ Breathable" Air Electrodes for High-Capacity and Long-Life Na-O₂ Batteries

Xiaoting Lin, Jiwei Wang, Xuejie Gao, Sizhe Wang, Qian Sun, Jing Luo, Changtai Zhao, Yang Zhao, Xiaofei Yang, Changhong Wang, Ruying Li, Xueliang Sun*

Department of Mechanical and Materials Engineering University of Western Ontario London, Ontario N6A 5B9, Canada E-mail: xsung@uwo.ca

Corresponding Author

*E-mail: <u>xsung@uwo.ca</u>

Keywords: 3D printing, O2 breathable, NaO2, air electrode, Na-O2 batteries



Figure S1. Schematic illustration of a Na-O₂ battery with carbon paper protected Na anode.



Figure S2. The Raman spectra of 3D printed GO and rGO electrodes.



Figure S₃. (a) Normalized wide-scan survey XPS spectra for GO and rGO. (b-e) C 1s and

O 1s spectra of GO and rGO.



Figure S4. Current-voltage (I-V) curves of GO and rGO.



Figure S5. Nitrogen adsorption/desorption isotherm of the (a) 3DP-NP, (b) 3DP-SP, and (c) 3DP-LP cathode; Pore size distribution plot of the (d) 3DP-NP, (e) 3DP-SP, and (f) 3DP-LP cathodes.



Figure S6. The optical images of the printed electrode before freeze-drying and thermal reduction.



Figure S7. The high magnification SEM image of 3DP-SP electrode with highly interconnected rGO sheets.



Figure S8. The (a) SEM and (b) TEM images of the rGO.



Figure S9. The cross-sectional SEM images of the 3DP-SP electrode at different magnifications.



Figure S10. The discharge/charge profiles of the 3DP-NP, 3DP-SP and 3DP-LP air electrodes with a cutoff capacity of 1500 mAh g^{-1} at 1A g^{-1} .



Figure S11. The SEM image of bulk Na side of carbon paper interlayer after the Na- O_2 cell is fully charged at 0.2 A g⁻¹.



Figure S12. The Cross-sectional SEM images of fully discharge $_3$ DP-NP air electrode at 200 mA g⁻¹, and the discharge capacity is $_{4613}$ mAh g⁻¹.



Figure S13. The cross-sectional SEM images of discharged 3DP-SP air electrode with the discharge capacity of 4613 mAh g^{-1} at 200 mA g^{-1} .



Figure S14. The cross-sectional SEM image of discharged 3DP-LP air electrode with the discharge capacity of 4613 mAh g^{-1} at 200 mA g^{-1} .



Figure S15. The discharge/charge profiles of 3DP-LP air electrodes at different cycles.



Figure S16. The cycling performance of Na-O₂ cell with 3DP-SP electrode at 1000 mA g^{-1} with a limited discharge capacity of 500 mAh g^{-1} .



Figure S17. The morphology of the recharged 3DP-SP cathode at 500 mA g^{-1} with a capacity of 500 mAh g^{-1} .



Figure S18. The SEM image of discharge 3DP-SP air electrode after 100 cycles.