Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Materials

Highly Dispersed Metal and Oxide Nanoparticles on Ultra-Polar Carbon as Efficient Cathode Materials for Li-O_2 Batteries

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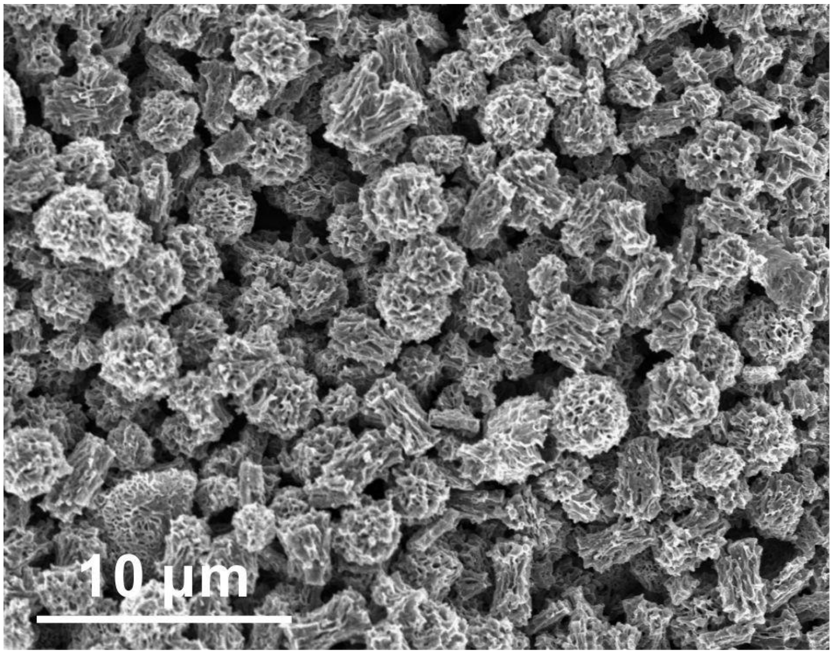

Fig. S1 Top-view SEM image of ultra-polar carbon (UPC). The carbon displays a hierarchically porous morphology.

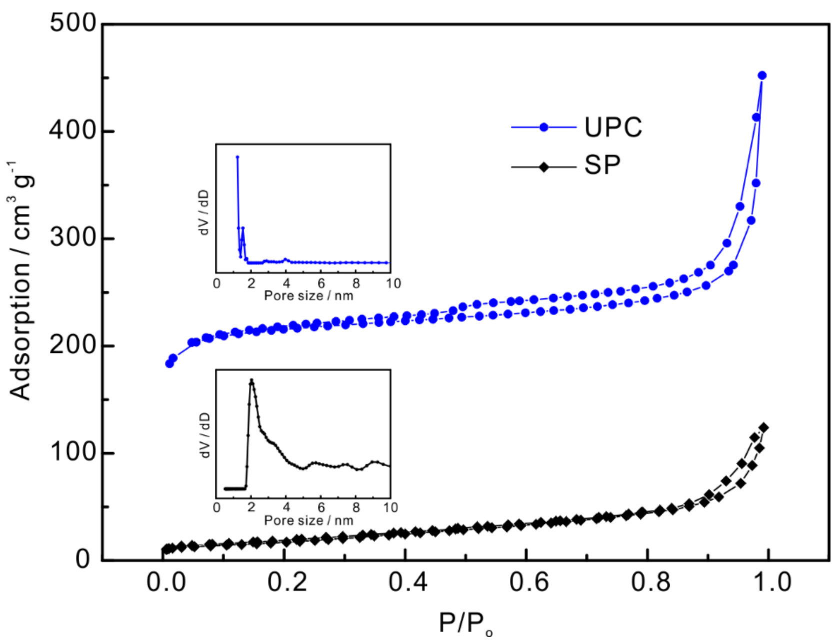

Fig. S2 N_2 adsorption-desorption isotherms and pore size distributions (inset) of UPC and SP.

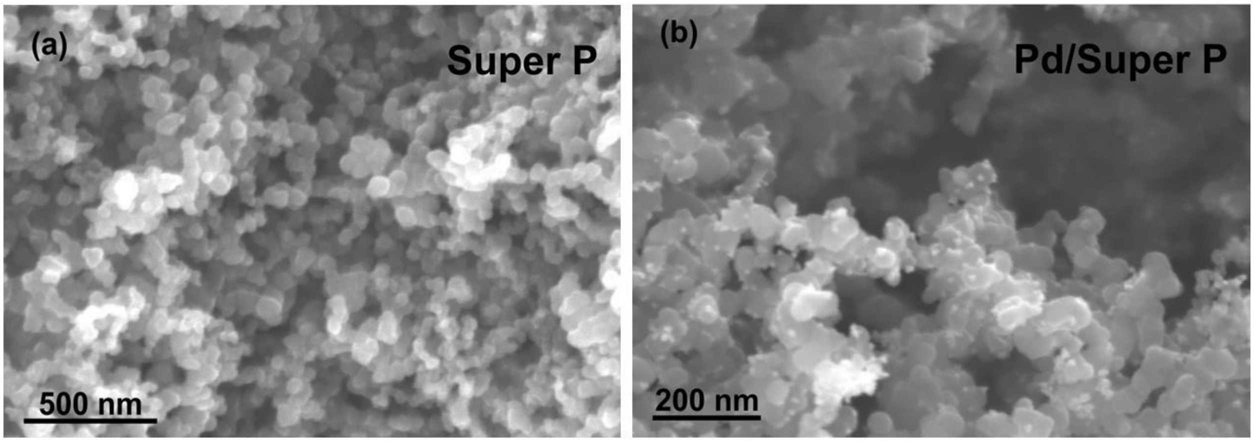

Fig. S3 SEM images of SP and SP supported Pd nanoparticles. Different from Pd/UPC, the Pd nanoparticles on the surface of SP are easy to aggregate during the preparation process.

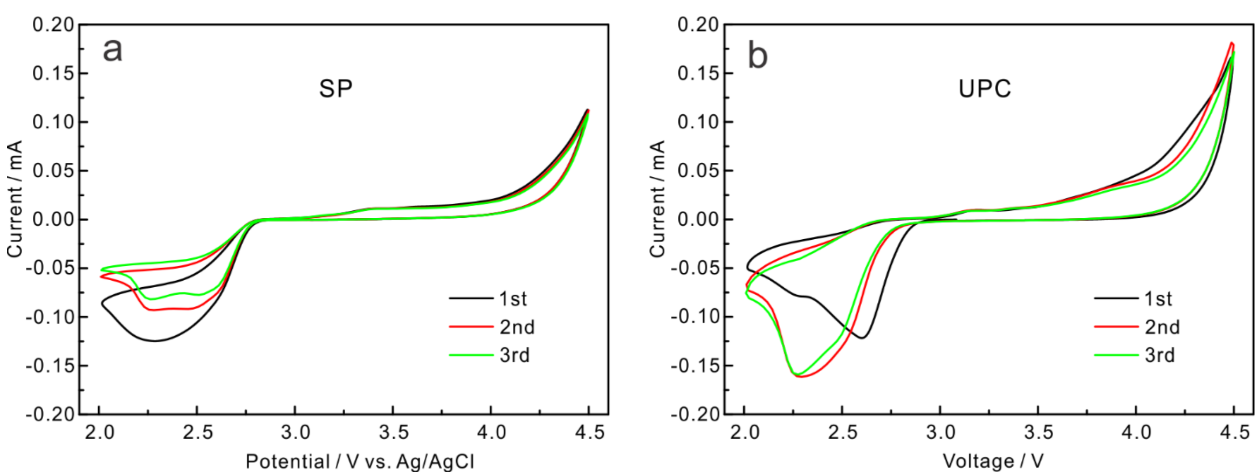

Fig. S4 Cyclic voltammetry of Li-O_2 battery with SP and UPC electrodes at a scan rate of 0.1 mV s^{-1}. The UPC electrode shows higher onset oxygen reduction potential than SP, which is in line with the discharge/charge test results (Fig. 5).

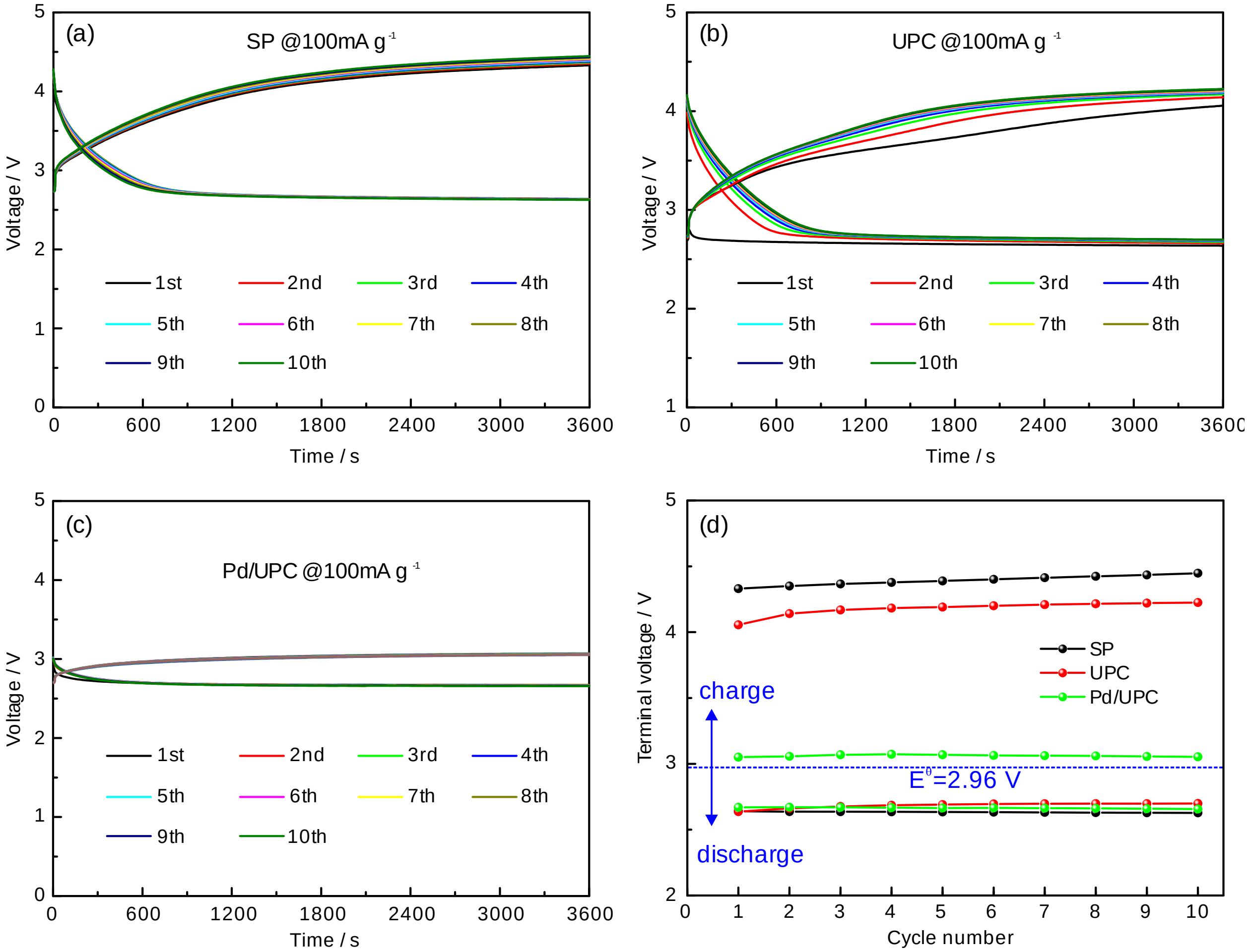

Fig. S5 Discharge-charge profiles of Li-O_2 batteries with SP, UPC and Pd/UPC electrodes at a current density of 100 mA g^{-1}.

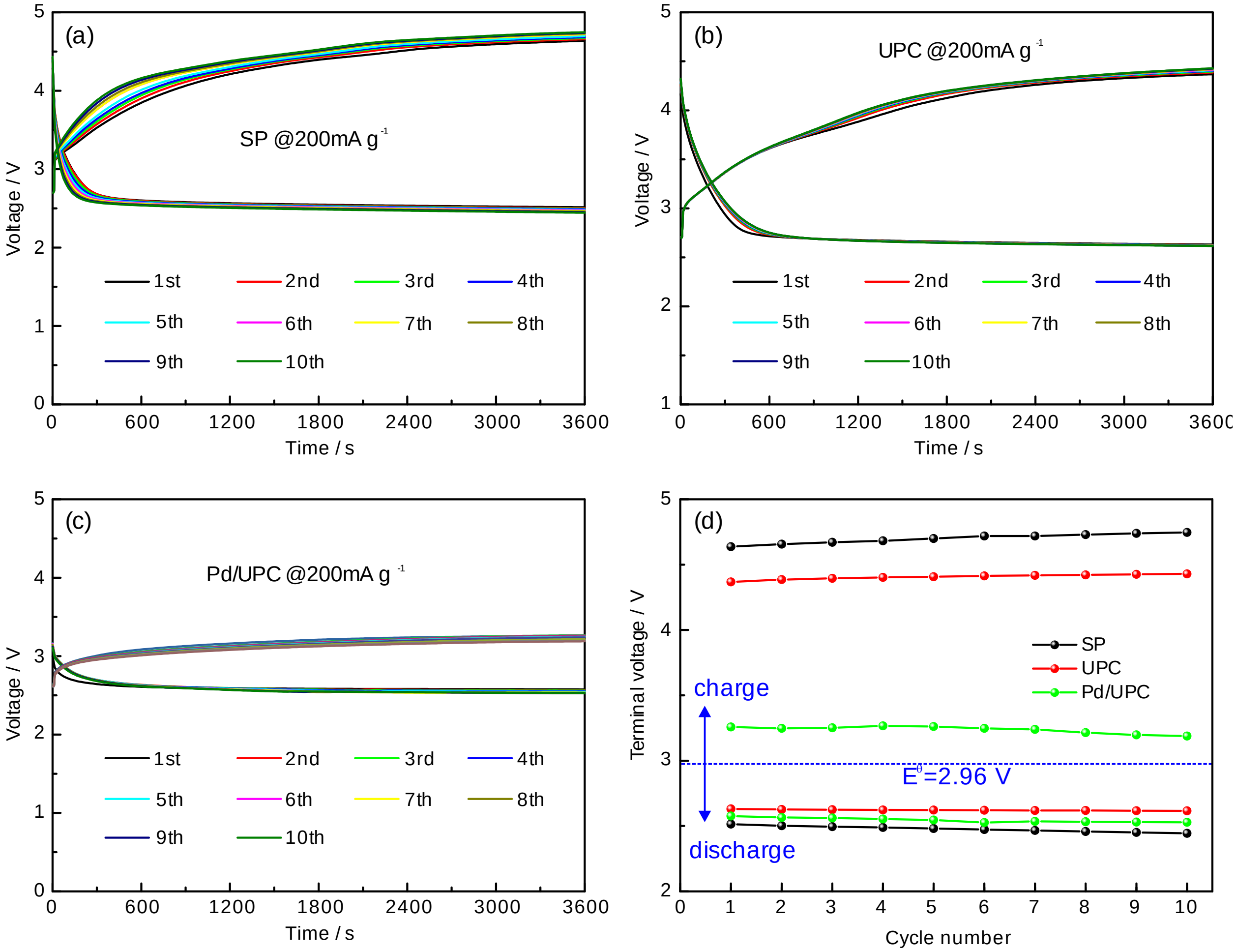

Fig. S6 Discharge-charge profiles of Li-O_2 batteries with SP, UPC and Pd/UPC electrodes at a current density of 200 mA g^{-1}.

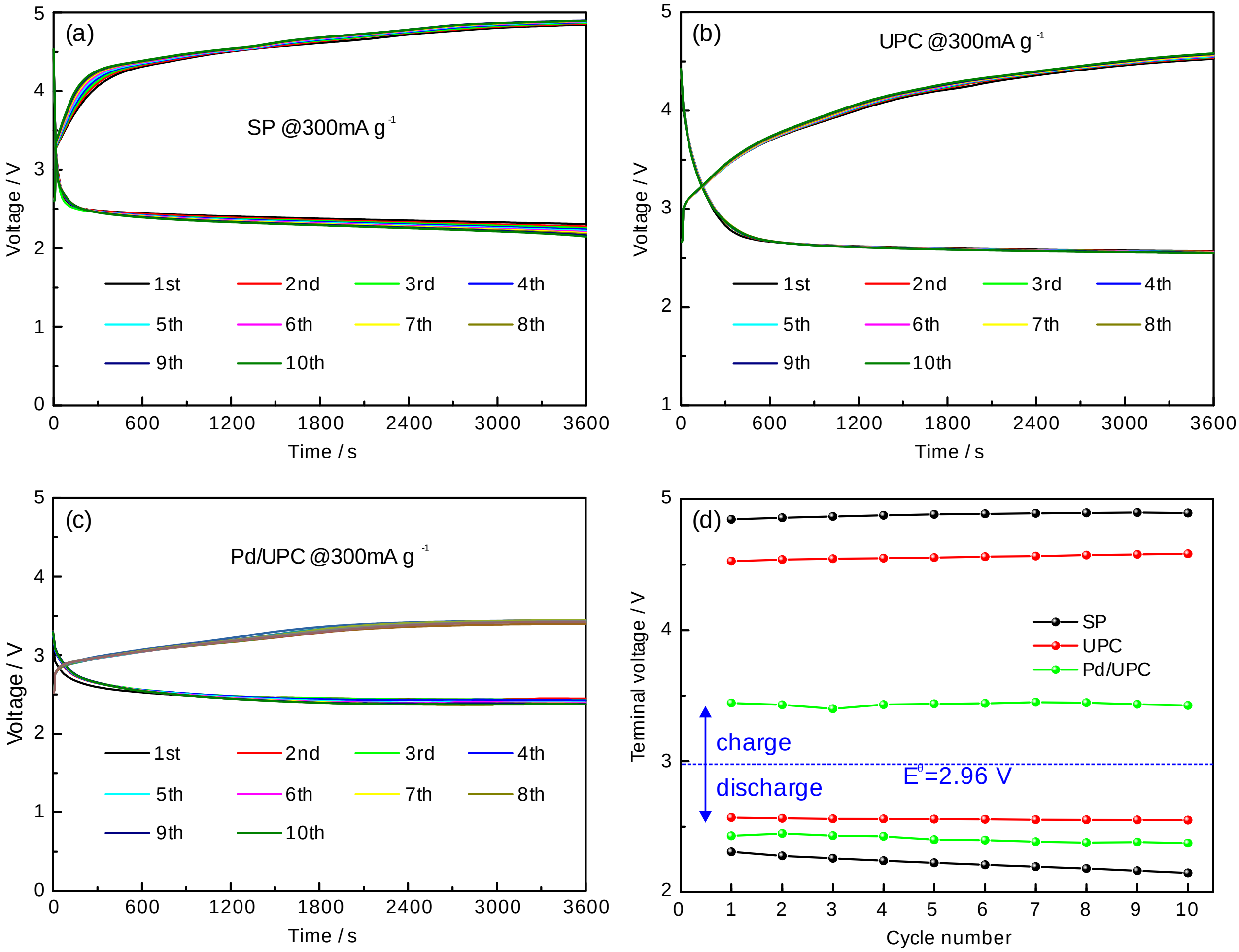

Fig. S7 Discharge-charge profiles of Li-O_2 batteries with SP, UPC and Pd/UPC electrodes at a current density of 300 mA g^{-1}.

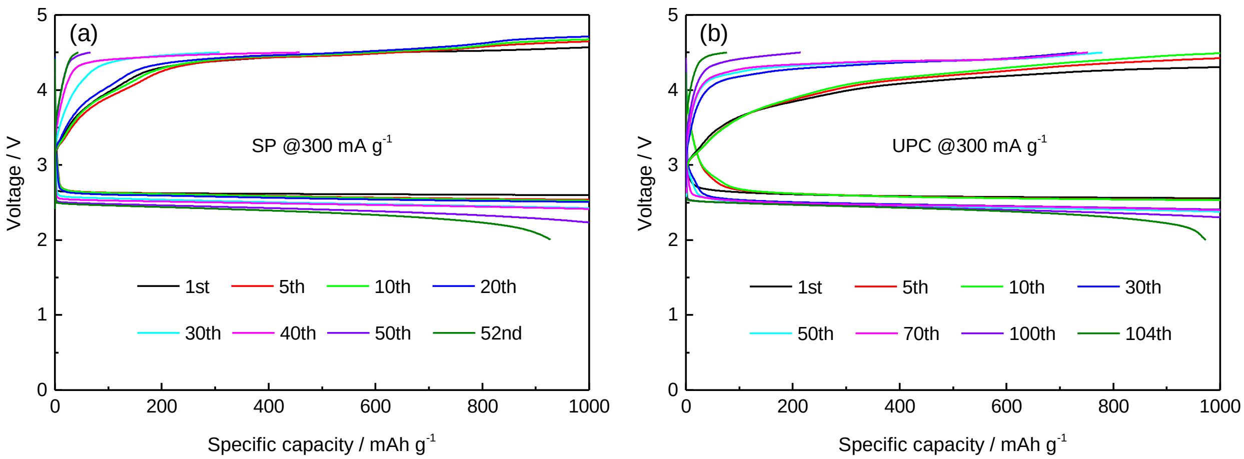

Fig. S8 Discharge-charge profiles of Li-O_2 batteries with SP and UPC electrodes at 300 mA g^{-1} under a specific capacity of 1000 mAh g^{-1}.

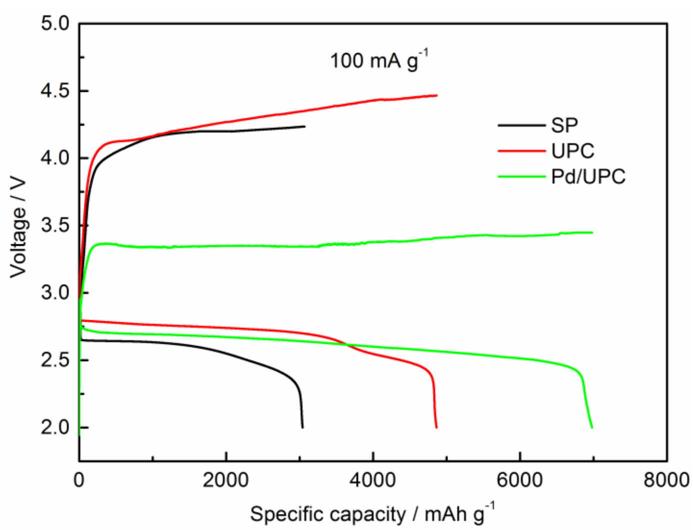

Fig. S9 Discharge-charge profiles of Li-O_2 batteries with SP, UPC and Pd/UPC electrodes at 100 mA g^{-1}.

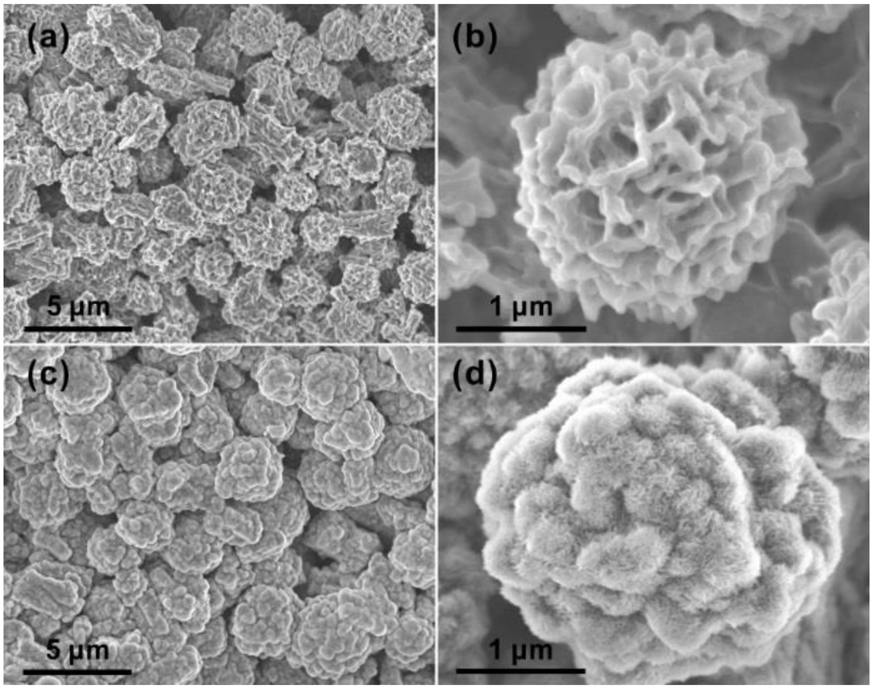

Fig. S10 SEM images of Pd/UPC electrode after the 1st charge (a, b) and 5th discharge (c, d) processes.

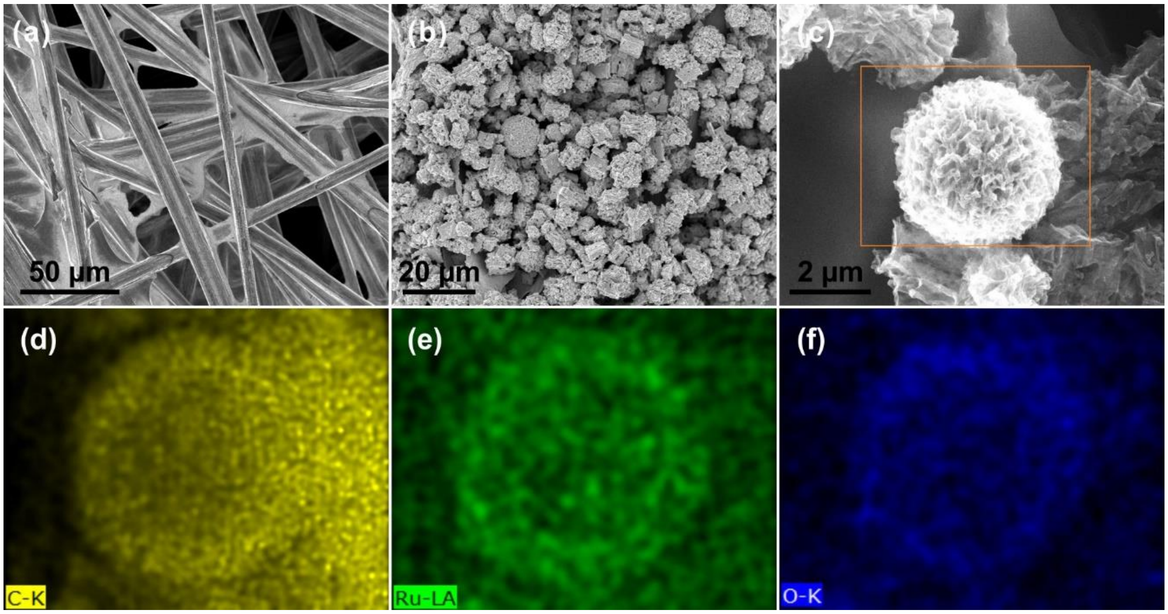

Fig. S11 (a) SEM image of pure carbon paper current collector. (b-f) SEM images of UPC supported RuO_2 fixed on the carbon paper and the corresponding EDS elemental mapping.

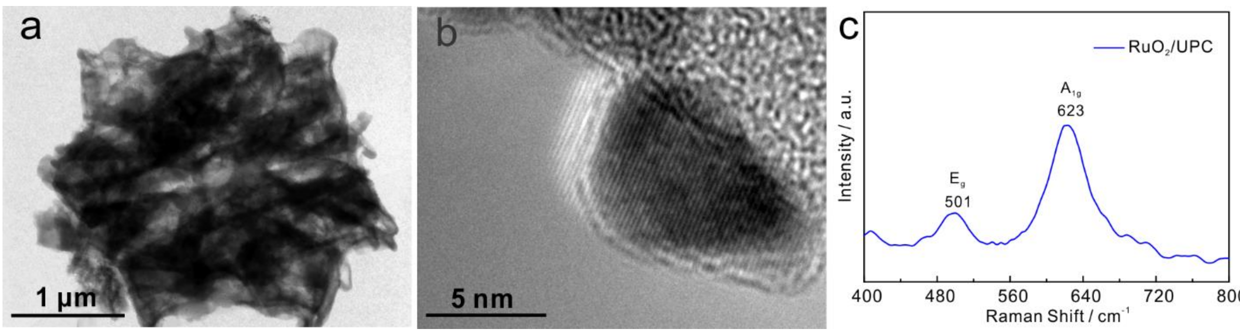

Fig. S12 (a, b) TEM and HR-TEM images of RuO_2/UPC. (c) Raman spectrum of RuO_2/UPC. The lattice space is calculated to be 0.25 nm, corresponding to RuO_2 (101).[1]

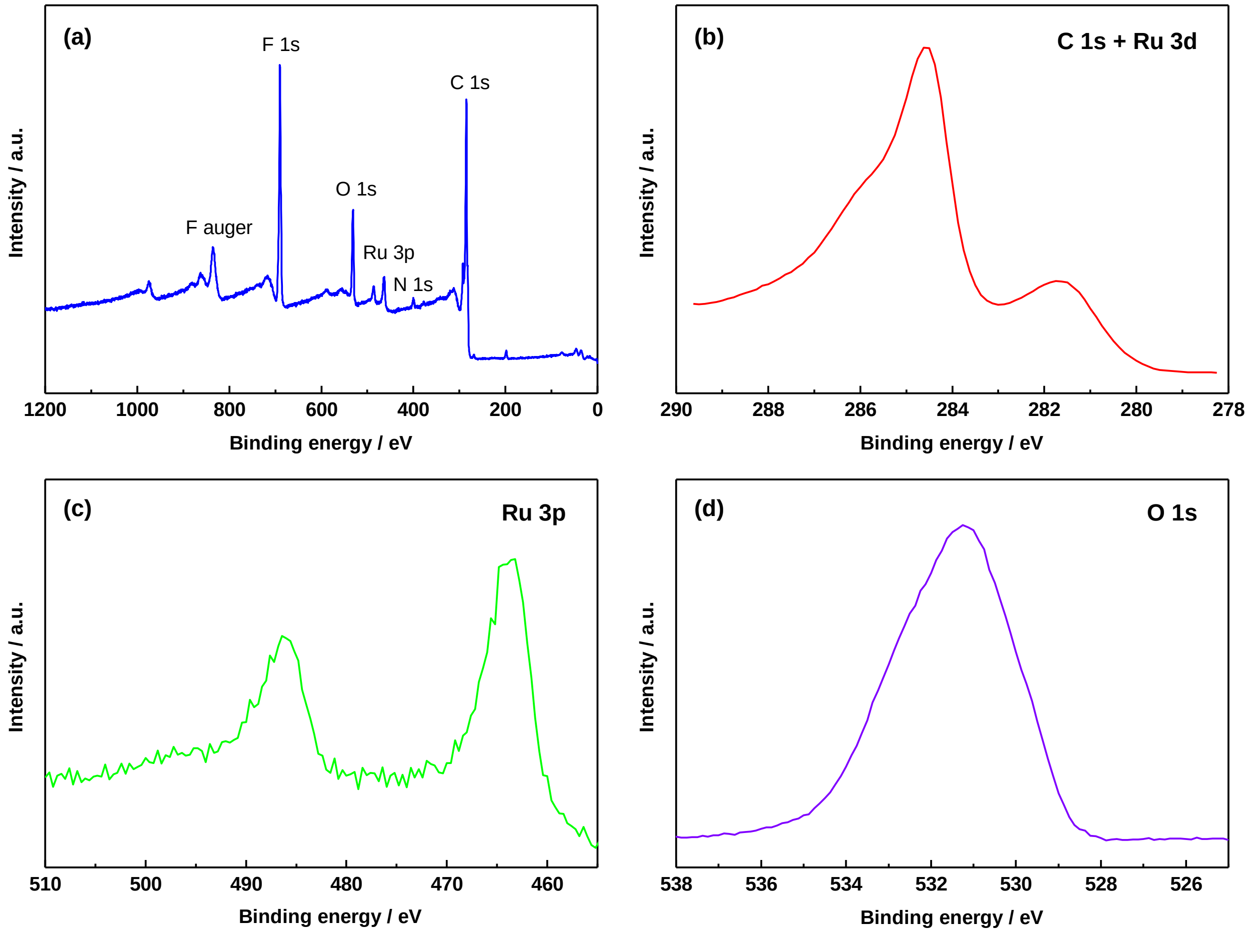

Fig. S13 Wide-scan survey and detailed XPS spectra of RuO_2/UPC. It is difficult to distinguish the C 1s from Ru 3d because they overlap in the region. The binding energy of Ru $3p_{3/2}$ is ~463.9 eV, indicating that the Ru exists in the form of RuO_2 in the composite.[2, 3]

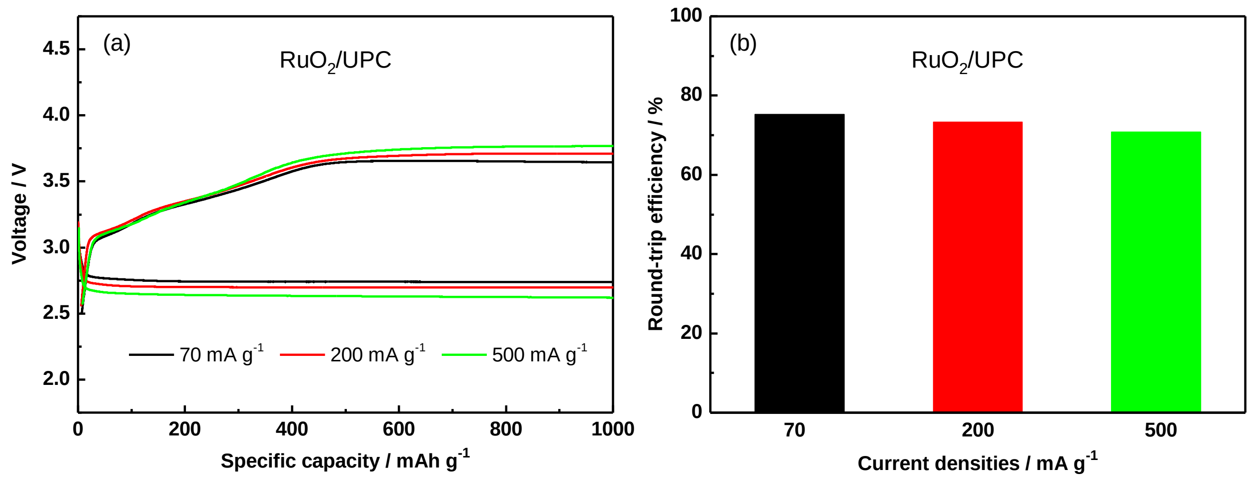

Fig. S14 Discharge-charge curves of Li-O_2 batteries with RuO_2/UPC electrode at current densities of 70, 200 and 500 mA g^{-1} and the corresponding round-trip efficiencies.

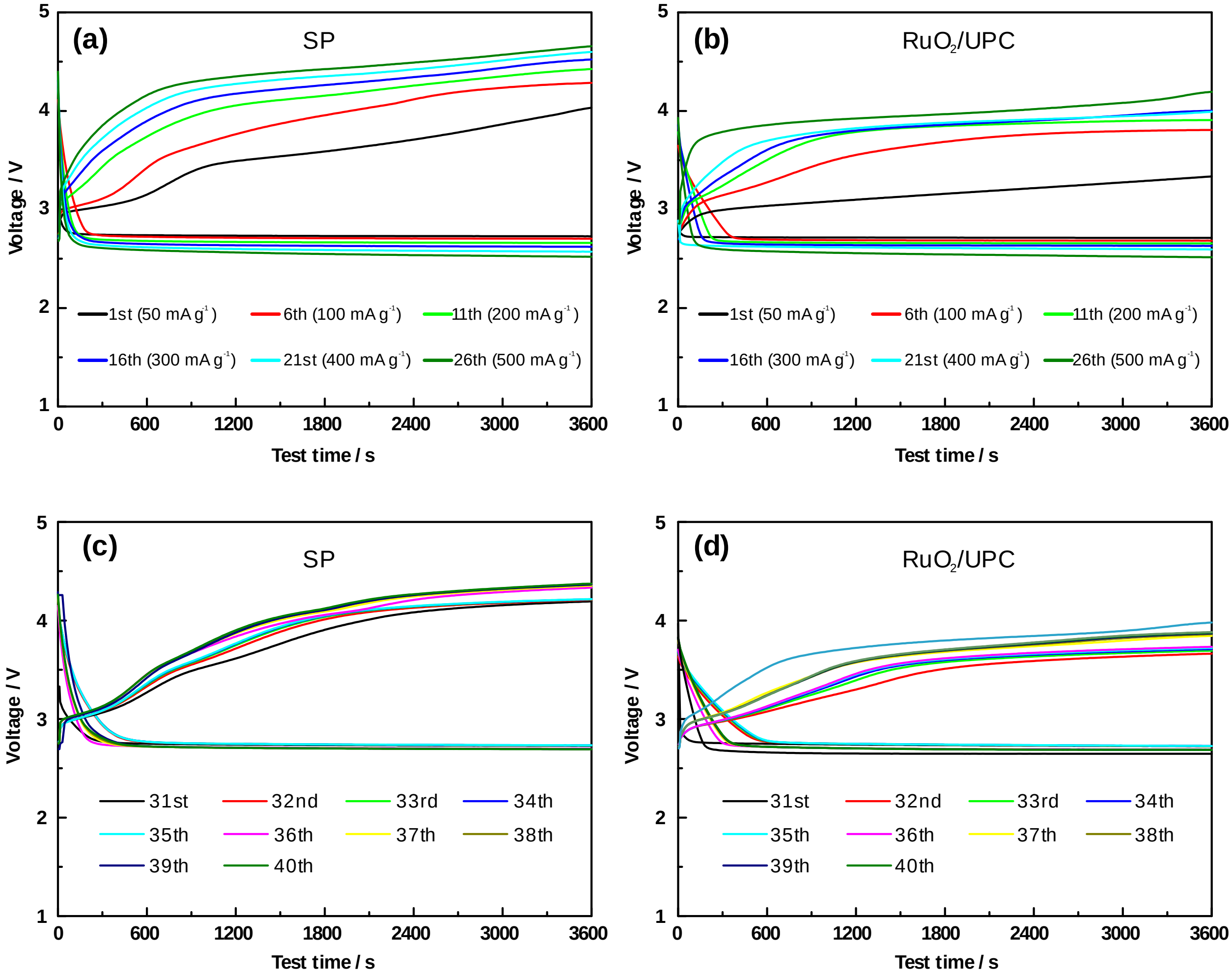

Fig. S15 (a, b) Discharge-charge profiles of Li-O_2 batteries with SP and RuO_2/UPC electrodes being tested from 50 to 500 mA g^{-1} for 5 cycles at each current density. (c, d) Discharge-charge profiles of Li-O_2 batteries with SP and RuO_2/UPC electrodes being tested from 50 to 100 mA g^{-1} for 5 cycles at each current density (From the 31st to the 40th cycle).

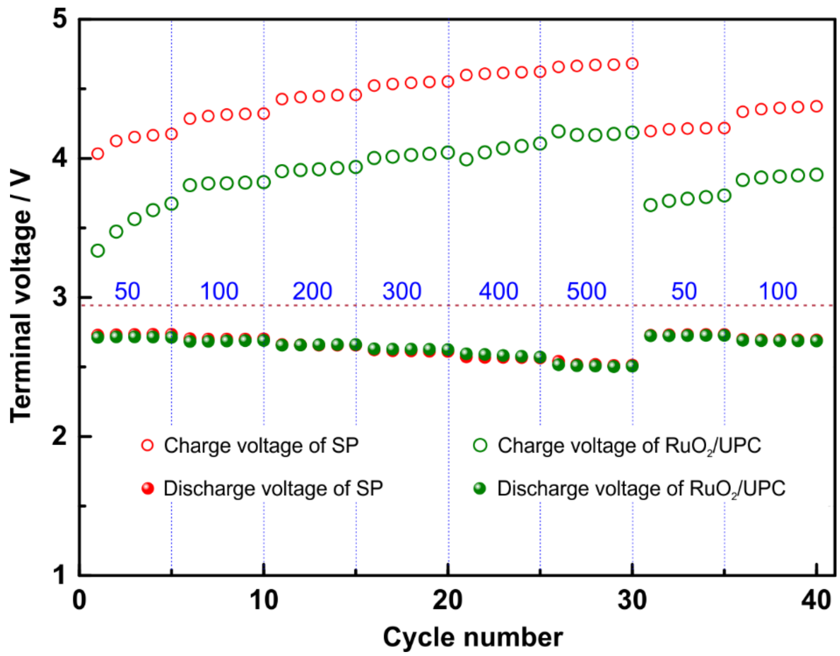

Fig. S16 Terminal voltages profiles of Li-O_2 batteries with SP and RuO_2/UPC electrodes tested sequentially at various current densities.

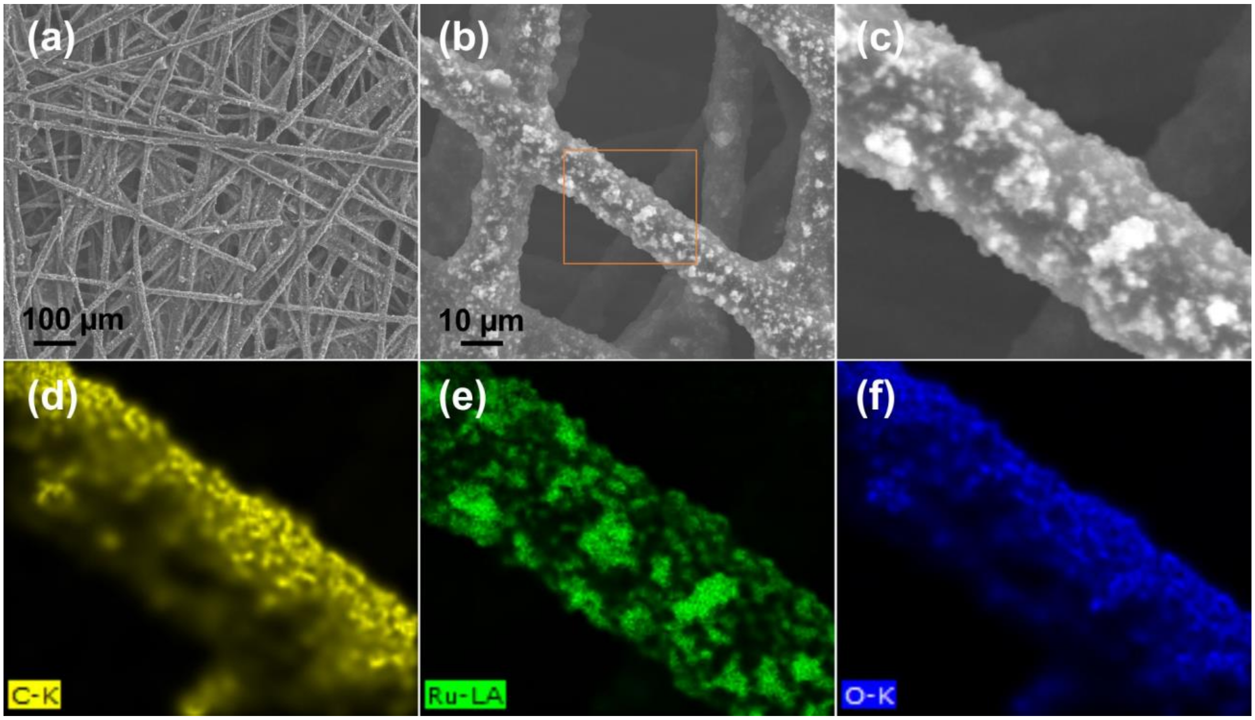

Fig. S17 SEM images of RuO_2/SP fixed on the carbon paper and the corresponding EDS pattern. RuO_2/SP were prepared by the same method as RuO_2/UPC. The spectra shows that the Ru disperse not well on the SP support.

References

[1] C.-C. Hu, K.-H. Chang, M.-C. Lin, Y.-T. Wu, *Nano Lett.*, 2006, **6**, 2690-2695.

[2] X. Guo, P. Liu, J. Han, Y. Ito, A. Hirata, T. Fujita, M. Chen, *Adv. Mater.*, 2015, **27**, 6137-6143.

[3] B. Folkesson, *Acta Chem. Scand.*, 1973, **27**, 287-302.