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

Supplementary Materials

Bifunctional Au-Pd Decorated MnO_x Nanomembranes as Cathode Materials for Li-O_2 batteries

Xueyi Lu,*[ab] Long Zhang,[cd] Xiaolei Sun,[a] Wenping Si,[a] Chenglin Yan,[e] and Oliver G. Schmidt[ab]

a Institute for Integrative Nanosciences, IFW Dresden, Helmholtz Straße 20, Dresden 01069, Germany

b Materials Systems for Nanoelectronics, Technische Universtät Chemnitz, Reichenhainer Straße 70, Chemnitz 09107, Germany

c Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences, Shenyang 110016, China

d Institute for Complex Materials, IFW Dresden, Helmholtz Straße 20, Dresden 01069, Germany

e College of Physics, Optoelectronics and Energy & Collaborative Innovation Center of Suzhou Nano Science and Technology, Soochow University, Suzhou 215006, China

*Corresponding author: Email: x.lu@ifw-dresden.de

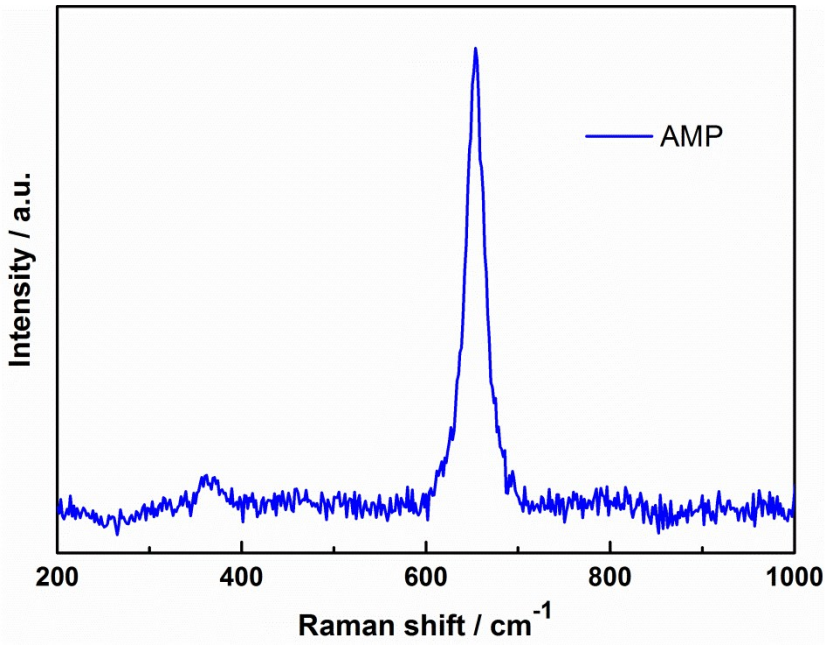

Figure S1. Raman spectrum of Au and Pd decorated MnO_x nanomembranes. The intense peak located at ~654 and ~362 cm^{-1} are the characteristics of manganese oxides, including possible MnO and MnO_2.[1-3]

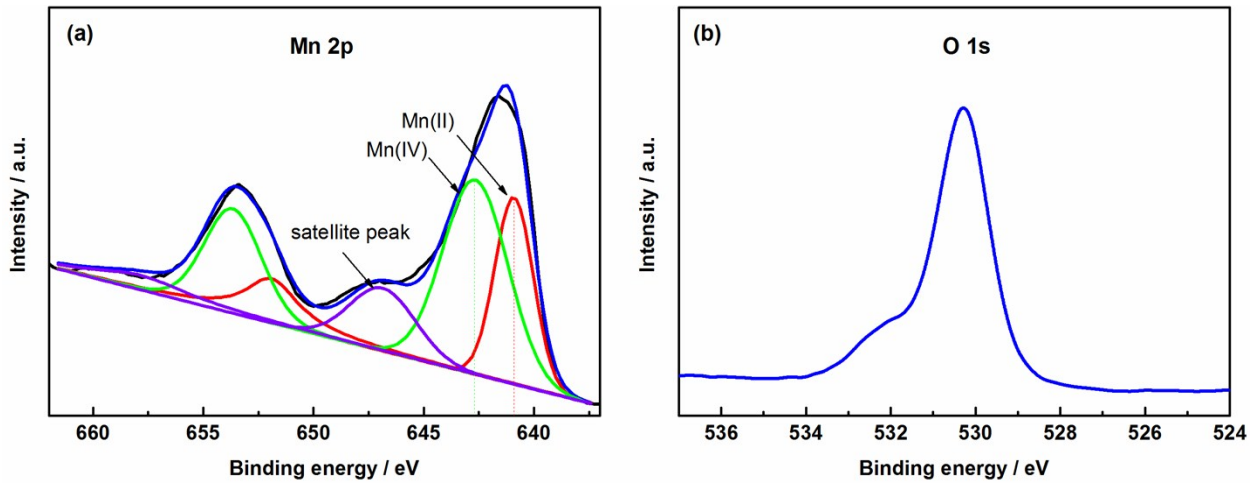

Figure S2. Detailed XPS spectra of Mn 2p and O 1s of pure MnO_x nanomembranes. The Mn 2p spectra of MnO_x is similar to AMP while the binding energies of Mn (II) and Mn (IV) are ~1.0 eV lower than that of AMP, which indicates that there exists synergy between metals and MnO_x in the AMP.

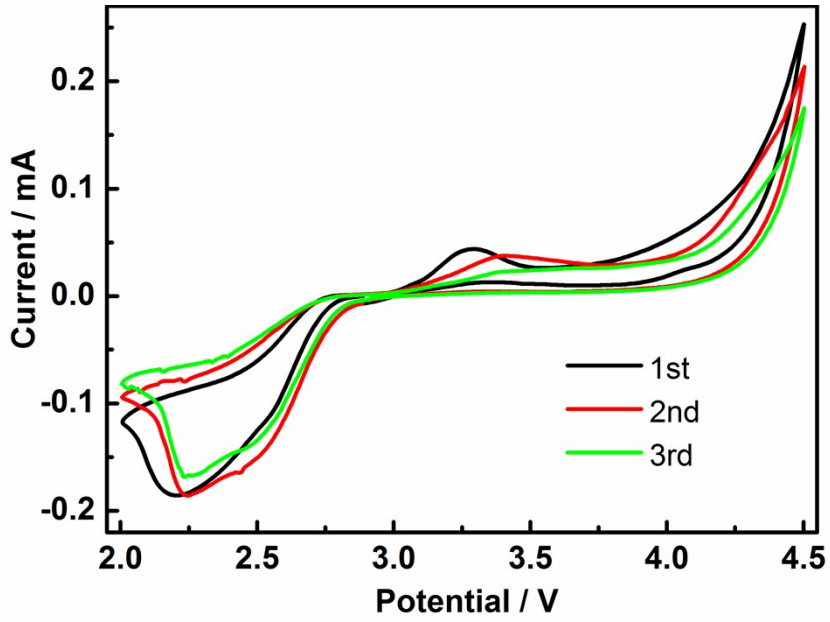

Figure S3. Cyclic voltammetry of Li-O_2 battery with AMP electrode at a scan rate of 0.1 mV s^{-1}.

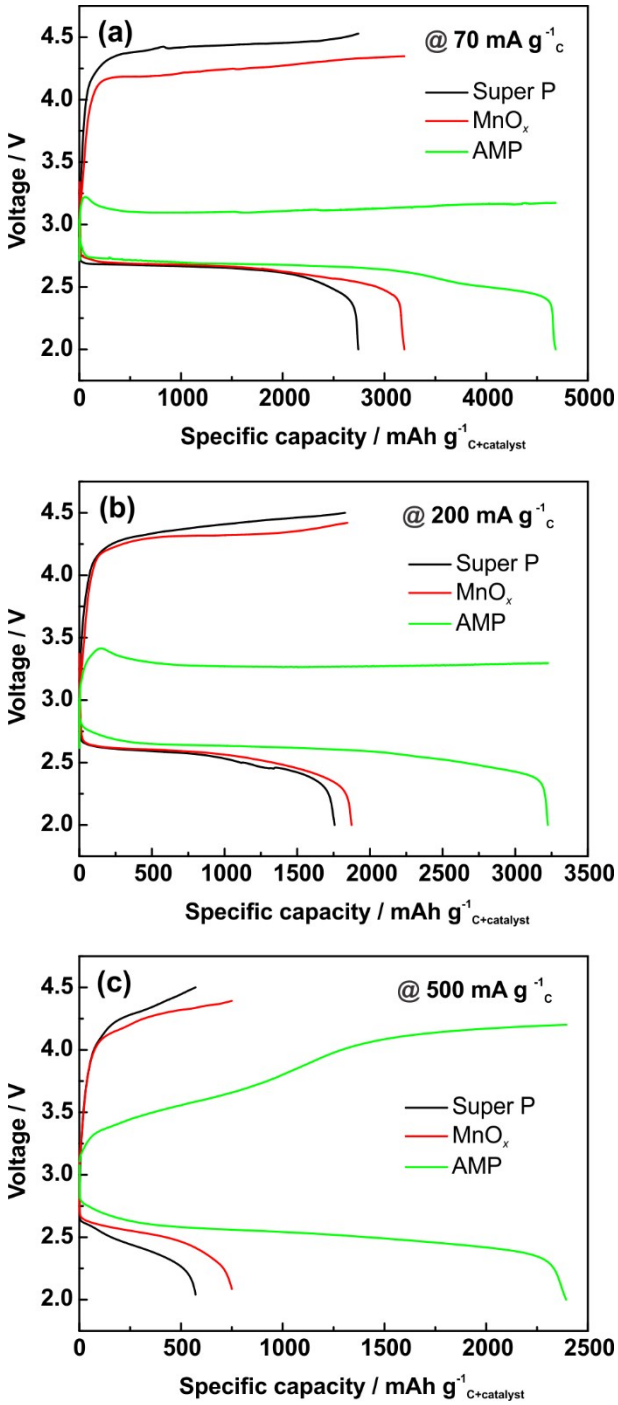

Figure S4. Discharge-charge curves of Li-O_2 batteries with Super P, MnO_x and AMP electrodes at current densities of 70 mA g^{-1}, 200 mA g^{-1} and 500 mA g^{-1}. The capacity was calculated based on the weight of carbon and catalyst.

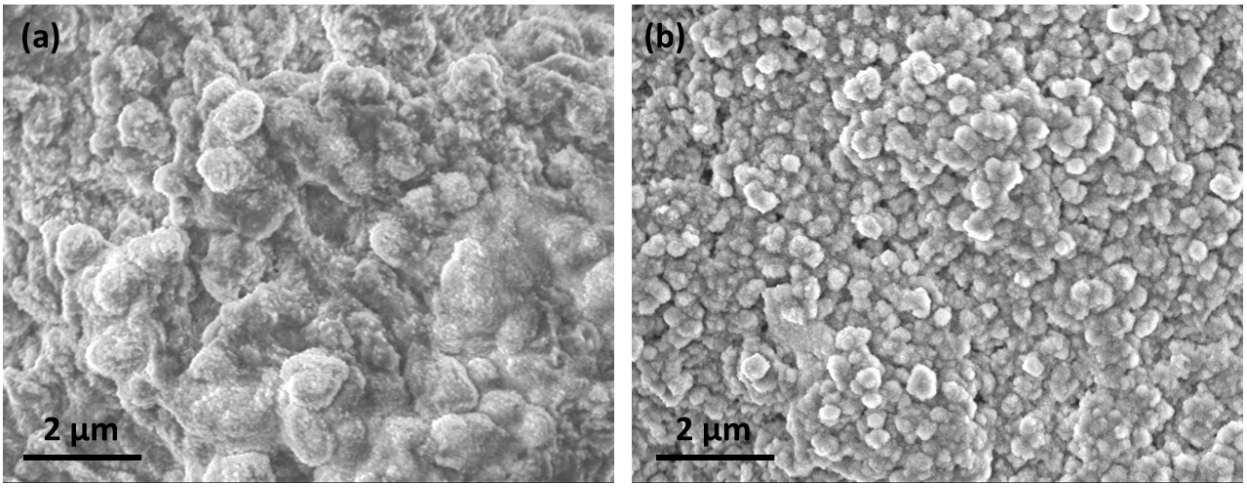

Figure S5. SEM images of Super P and MnO_x electrodes after the 1st discharge process. Large spheres are formed on the Super P electrode. Compared with Super P electrode, more and smaller spheres are generated on the MnO_x electrode after discharging.

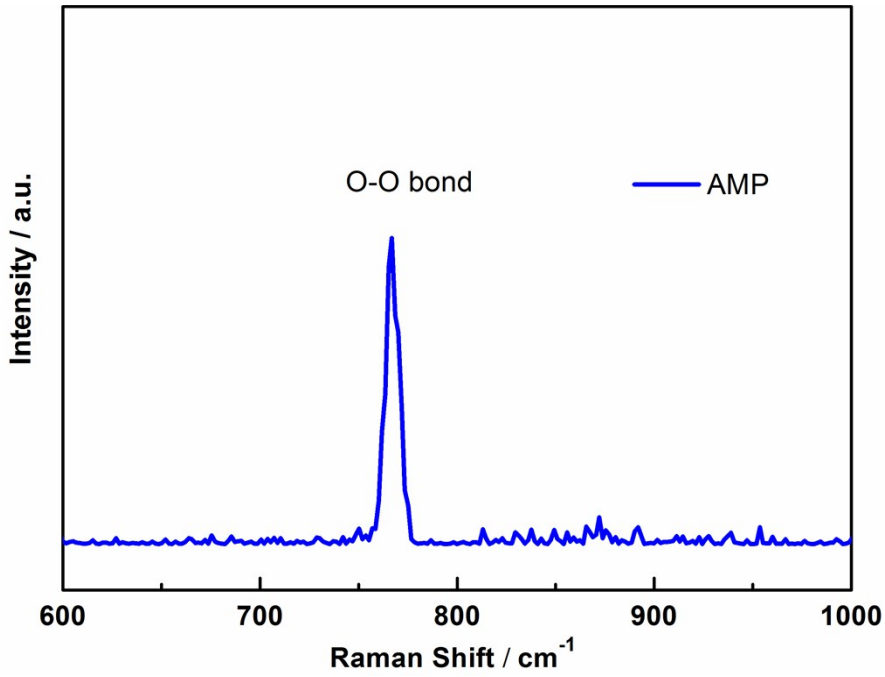

Figure S6. Raman spectra of the discharge product on AMP electrode after the 1st discharge process. The intense peak located at 770 cm^{-1} corresponds to O-O bond,[4-6] indicating that the discharge product consists of Li_2O_2.

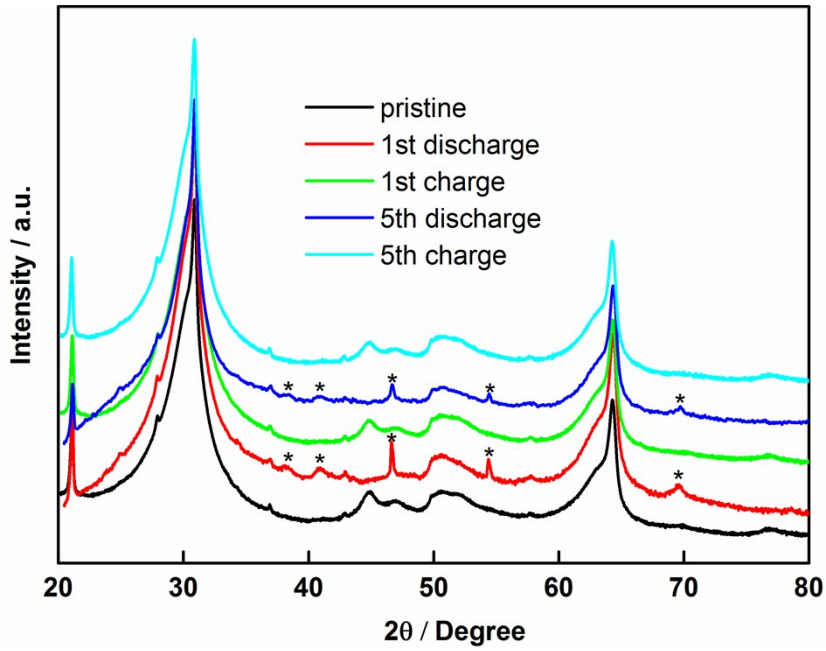

Figure S7. XRD spectra of the pristine AMP electrode and the electrode after discharge/charge processes.

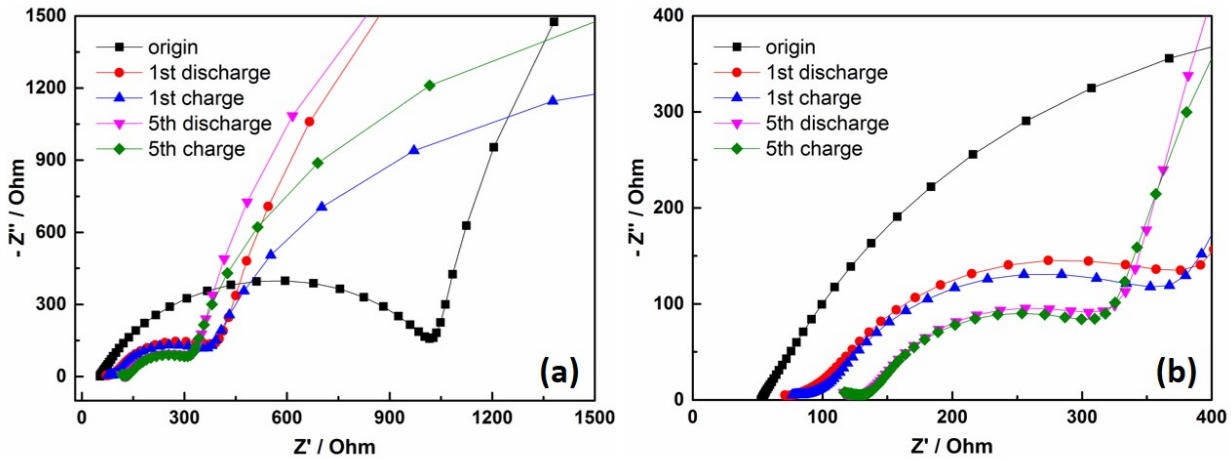

Figure S8. (a) EIS spectrum of Li-O_2 battery with AMP. (b) Magnification of the graph at high frequencies.

Table S1. Electrochemical properties of Li-O_2 batteries with manganese based materials.

Materials	Current density	Capacity /mAh g^{-1}_C	Charge voltage /V	Cycle number	References
Au/MnO_x/Pd	70 mA g^{-1}_C	6250 mAh g^{-1}_C	3.12	120	Our work
MnO_2 nanowires	70 mA g^{-1}_C	3000 mAh g^{-1}_C	4.10	-	6
MnO_2 nanorods	100 mA g^{-1}_C	1400 mAh g^{-1}_C	4.05	60	7
MnO_2 nanotubes	0.04 mA cm^{-2}	-	4.31	30	8
MnO_2/Graphene	0.083 mA cm^{-2}	7469 mAh g^{-1}_C	4.20	132	9
Freestanding MnO_2	0.1 mA cm^{-2}	1250 mAh g^{-1}	4.10	90	10
δ-MnO_2 nanoboxes	0.08 mA cm^{-2}	7862 mAh g^{-1}_C	4.10	113	11
Au/MnO_2	0.2 mA cm^{-2}	10600 mAh g^{-1}_C	3.78	100	12
Pt/MnO_2	70 mA g^{-1}_C	10 981 mAh g^{-1}_C	3.75	14	13
Pd/MnO_x	100 mA g^{-1}_{total}	10620 mAh g^{-1}_C	3.60	50	14
$La_{0.75}Sr_{0.25}MnO_3$	0.025 mA cm^{-2}	7333 mAh g^{-1}_C	4.10	124	15
$MnCo_2O_4$	0.4 A g^{-1}_C	3780 mAh g^{-1}_C	3.80	40	16

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