Supplementary Information

Synergistic Catalytic Effects of MoO_2 and Vulcan Carbon toward Oxygen Reduction Reaction

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Characterization

XRD was carried out using an X-ray diffractometer (Bruker D8) in the range of 50-900. XPS was done on an Escalab 250Xi X-ray photoelectron spectrometer with Al Kα as M-SRRPS (Microstrip Slit-Ring Resonator Plasma Sourece). The method of energy calibration is a charged correction, using 284.6 eV as standard value to calibrate C1s spectra. According to the difference of C1s spectra, then all the XPS spectra of the remaining elements increased or decreased to a certain value. Then Using XPS peak software to analyze data. The steps are importing data, establishing baseline, adding peak (according to references), adjusting parameters (FWHM 0.5-3.5eV, the area of peak). The scanning electron microscopy (SEM) images were measured using a scanning electron microscope (JSM-7500F, 5KV). The transmission electron microscopy (TEM) was operated by Tecnai-G20 TEM at an acceleration voltage of 200KV. The high resolution transmission electron microscopy (HRTEM) images were obtained by Tecnai G20 HRTEM. Brunner-Emmet-Teller (BET) measurements served to test the specific surface areas (Micro for TriStar II Plus 2.02). The actual content of MoO_2 on the glass-carbon disc electrode was determined by Thermo 6300 inductively coupled plasma atomic (ICP) emission spectrometry.

Figures and Tables

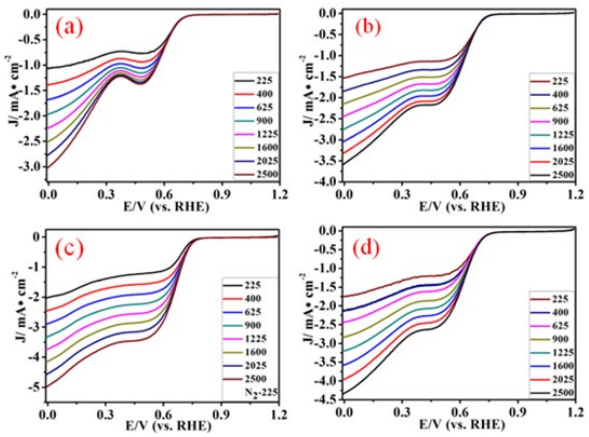

Figure S1 LSV curves of the MoO_2/C-15(a), MoO_2/C-20(b), MoO_2/C-30(c) and MoO_2/C-40(d) in O_2-saturated 0.1 M KOH solution at different rotation rates; scan rate: 10 mV s^{-1}.

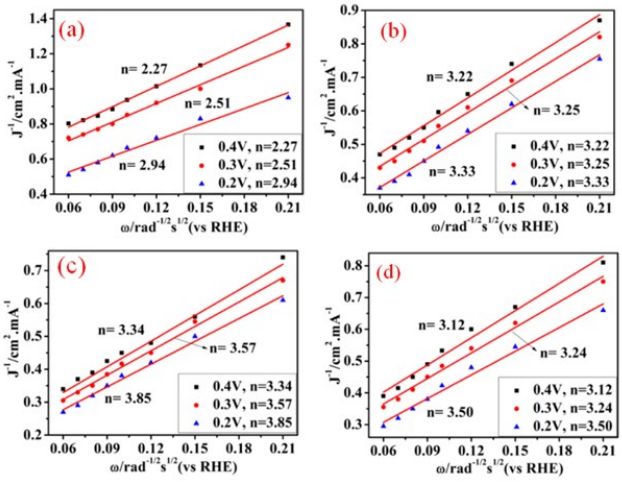

Figure S2 Koutecky-Levich plots for MoO_2/C-15(a), MoO_2/C-20(b), MoO_2/C-30(c) and MoO_2/C-40(d), at different electrode potentials.

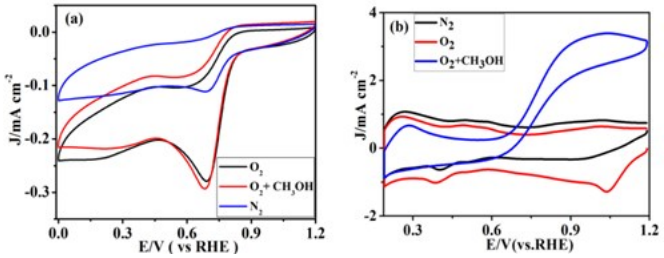

Figure S3 CV curves of (a) MoO_2/C and (b) Pt/C after adding CH_3OH (vol. 10) in N_2- and O_2-saturated and O_2-saturated 0.1 M KOH. Scan rate: 30 mV s^{-1}.

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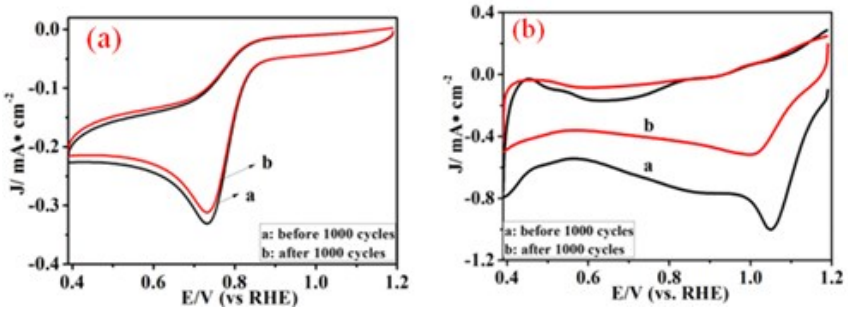


Figure S4 Continuous cyclic voltammograms of (a) MoO_2/C-30, (b) Pt/C in 0.1 M KOH solution saturated with O_2 at scan rate of 20 mV s^{-1}

Tab. S1 Physical parameters of different catalystsin in O_2-saturated 0.1 M KOH solution

Materials	E_{Onset} /V[a]	$E_{1/2}$/V[b]	Ref.[c]
Pt/C	0.97	0.87	This work
MoO_2/C	0.76	0.62	This work
MoO_2/NG	0.8	0.6	Ref.13
Mo/N-C	0.9	0.83	Ref.14

Ni_3S_2/MoS_2	0.95	0.88	Ref.15

Tab. S2 Physical parameters of different samples in O_2-saturated 0.1 M KOH solution

Materials	peak potential/V	current density/ mA cm^{-2}	kinetic currents of LSV / mA cm^{-2}
MoO_2/C-15	0.68	0.25	2.51
MoO_2/C-20	0.75	0.28	3.04
MoO_2/C-30	0.76	0.36	4.21
MoO_2/C-40	0.75	0.33	3.57

Tab. S3 Actual MoO2 load on GCDE

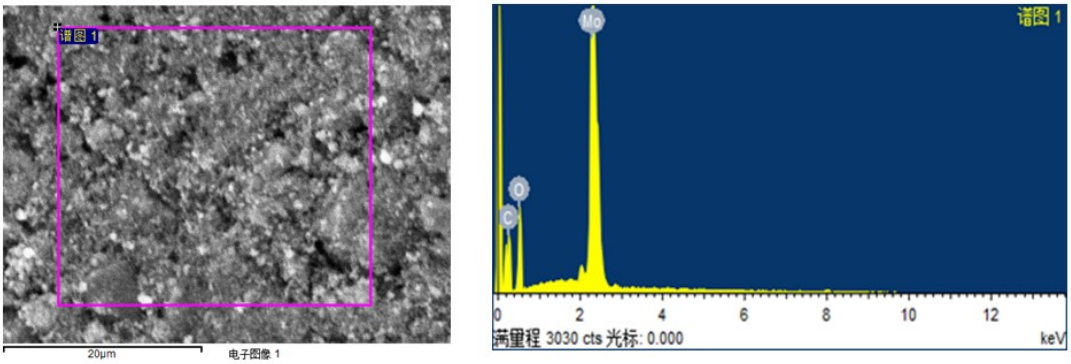
Sample name	Actual content of MoO_2
MoO_2/C-15	0.81 g/cm^{-2}
MoO_2/C-20	0.83 g/cm^{-2}
MoO_2/C-30	0.85 g/cm^{-2}
MoO_2/C-40	0.84 g/cm^{-2}

Tab. S4 Surface area of different samples

Sample name	Surface area / m^2 g^{-1}
MoO_2/C-15	94.1617
MoO_2/C-20	69.2278
MoO_2/C-30	81.7275
MoO_2/C-40	40.2054

Tab. S5 the components percentages of MoO_2/C-30

Element name	**Atomic percentage/%**	**Mass percentage/%**
C	52.32	26.22
O	35.10	23.43
Mo	12.58	50.36



[a] All of the potential values from references were converted to *vs.* RHE for comparison.

[b] To minimize the effect of the residual currents on the potential value, the onset potential in this research was defined as a potential required for generating an ORR current density of 0.1 $mAcm^{-2}$ in the LSV measurement.

[c] Ref. 13, Ref. 14 and Ref. 15 are the cited references in the main text.