Supporting Information for

Electronic and Architecture Engineering of Hammer-Shaped Ir-$NiMoO_4$-ZIF for Effective Oxygen Evolution

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1. Preparation of $NiMoO_4$ nanorods

The $NiMoO_4$ nanorods were obtained via a facile hydrothermal method according to previous works. Briefly, 582 mg $Ni(NO_3)_2$•$6H_2O$, 484 mg Na_2MoO_4•$2H_2O$, and 20 mL deionized water were mixed to form a clear solution. The mixture was transferred into a Teflon-lined stainless autoclave (50 mL) and heated at 150 °C for 6 h. After reaction, $NiMoO_4$ was re-dispersed into 10 mL deionized water for further use.

2. Preparation of $NiMoO_4$-ZIF

300 mg 2-MIM was dissolved into 14 mL deionized water. Then, 0.5 mL previously prepared $NiMoO_4$ nanorods mixture was added to above solution. Then, 2 mL of $Co(NO_3)_2$ (20 mg) solution containing 1 mg CTAB was added to above solution. After 20 min of reaction with drastic stirring at room temperature, the product was centrifuged, washed, and dried.

3. Preparation of Ir-$NiMoO_4$-ZIF

The freshly prepared $NiMoO_4$-ZIF was re-dispersed into 10 mL ethanol. 5 mg $IrCl_3$ was also dispersed into 5 mL ethanol under sonication. Then, the $IrCl_3$ solution was dropped into the $NiMoO_4$-ZIF under magnetic stirring. After 3 h of reaction with drastic stirring at room temperature, the product was centrifuged, washed, and dried. The Ir-$NiMoO_4$ and Ir-ZIF were also prepared via the same methods except for replacing the $NiMoO_4$-ZIF with $NiMoO_4$ and ZIF, respectively.

4. Characterizations

The synthesized samples were characterized by X-ray powder diffraction (XRD) coupled with a Cu radiation source (λ = 0.15406 nm). Transmission electron

microscope (TEM), high-resolution transmission electron microscopy (HRTEM), and energy-dispersive X-ray spectroscopy (EDS) were carried out on a JEOL-2100 with 200 kV. XPS data were collected with an SSI S-Probe XPS spectrometer. The binding energy was adjusted employing the C 1s peak at 284.8 eV.

5. Electrochemical measurements

The electrochemical measurements were carried on a CHI 760E electrochemical workstation with a three-electrode standard system in 1 M KOH solution. The linear sweep curves (LSV) were obtained at a scan rate of 5 mV s^{-1}. Before LSV tests, the catalysts were activated by 20 cyclic voltammetry cycles at 50 mV s^{-1}. The iR drop was compensated at 95% before each measurement. Tafel plots were evolved from the LSV and obtained by the Tafel equation. Electrochemical impedance spectroscopy (EIS) were recorded in a range of frequency (1 Hz-1000 kHz) with 5 mA amplitude of current perturbation.

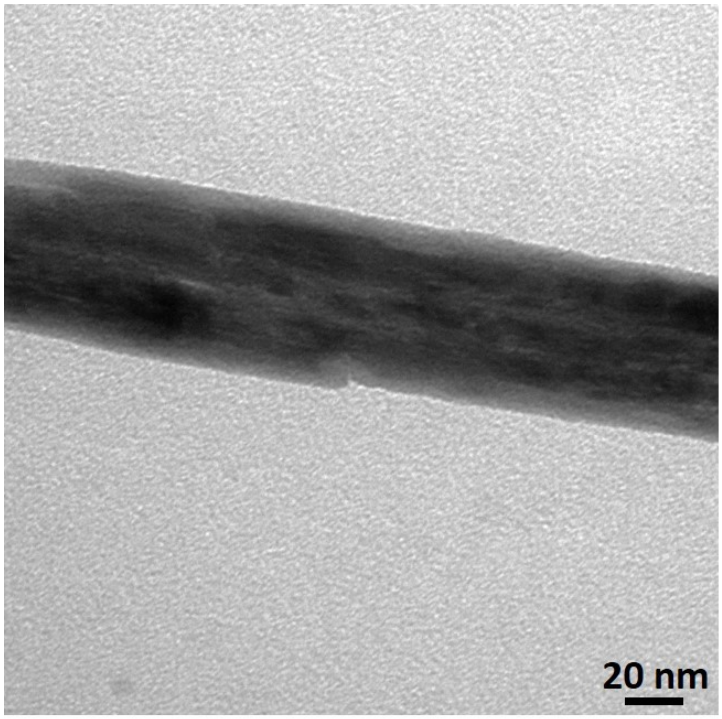

Fig.S1 Representative TEM image of the $NiMoO_4$ nanorods.

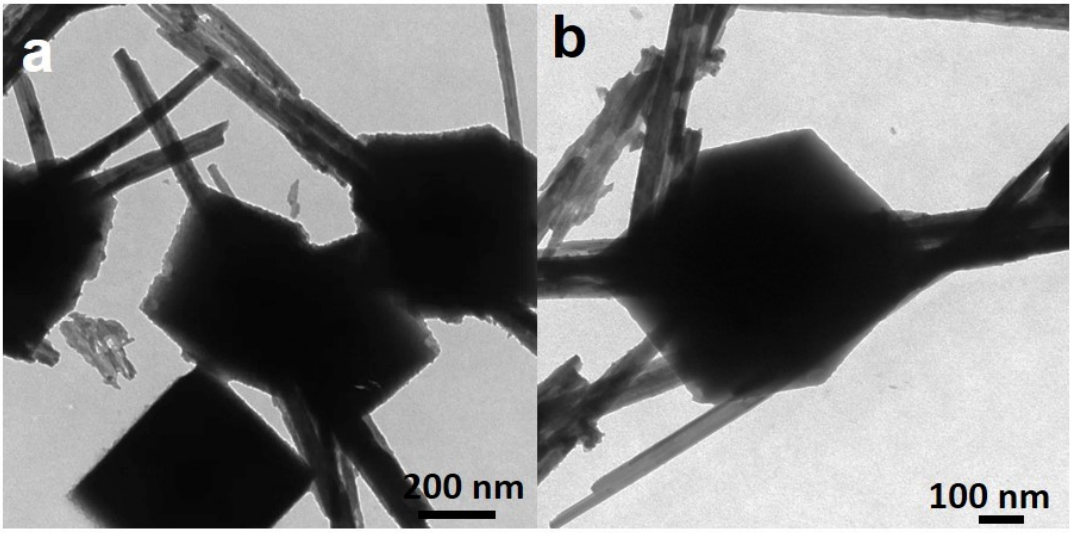

Fig.S2 Representative TEM image of the $NiMoO_4$-ZIF.

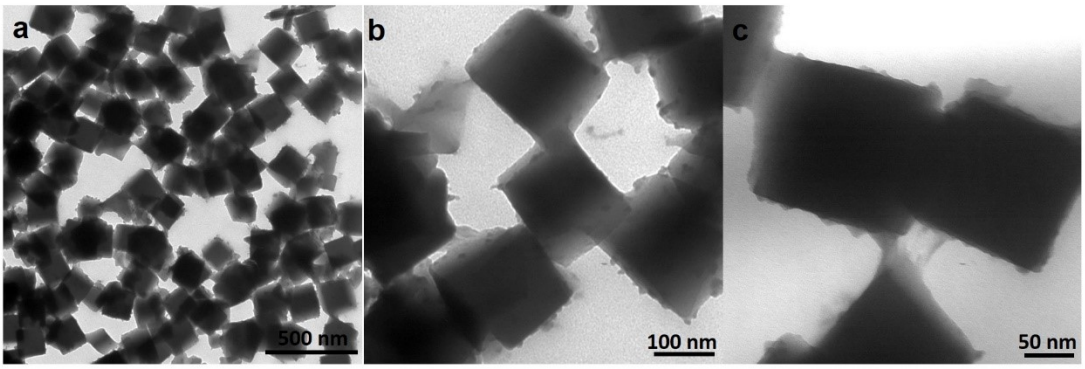

Fig.S3 TEM images of the Ir-ZIF nanocubes.

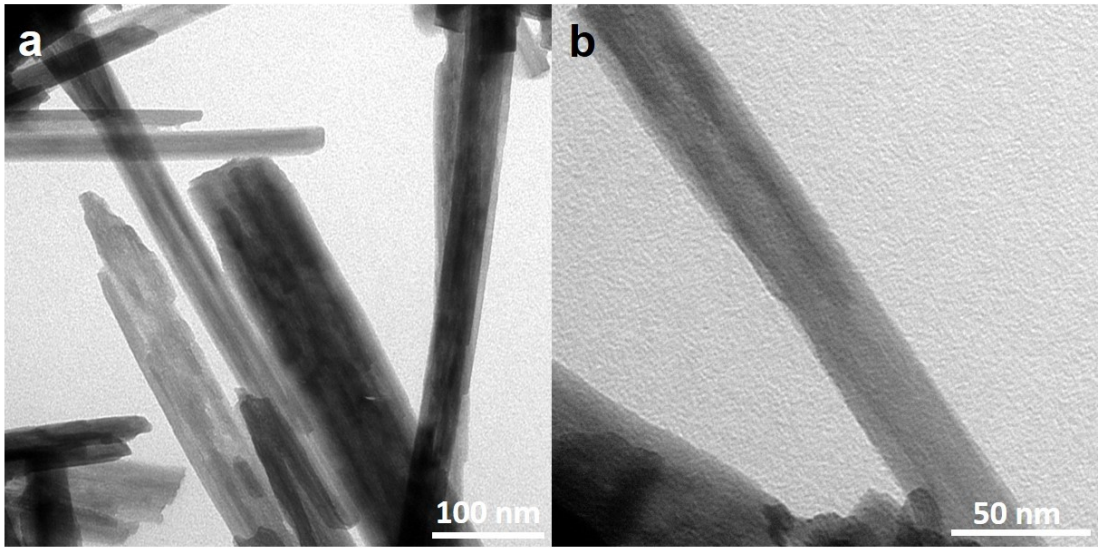

Fig.S4 TEM images of the Ir-$NiMoO_4$ nanorods.

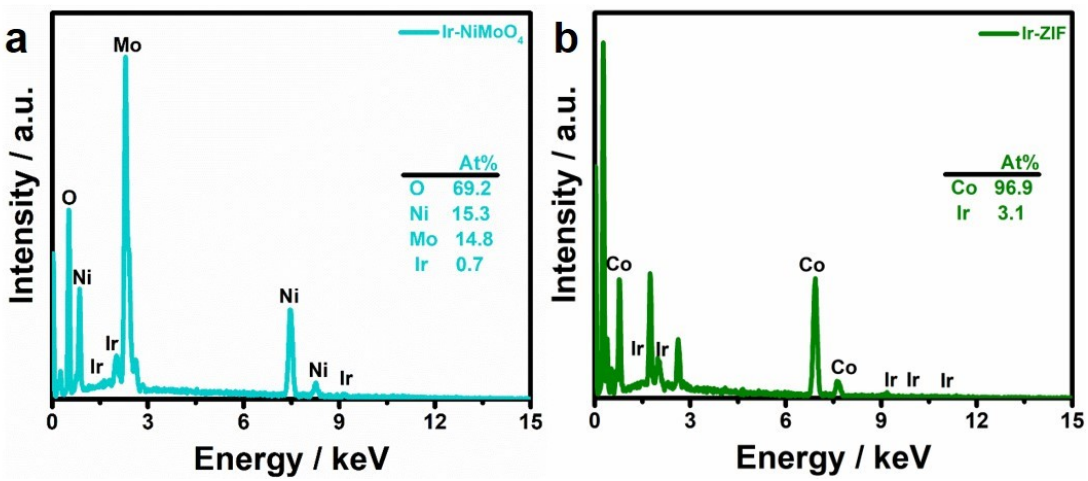

Fig.S5 EDX spectra of the (a) Ir-$NiMoO_4$ nanorods and (b) Ir-ZIF nanocubes.

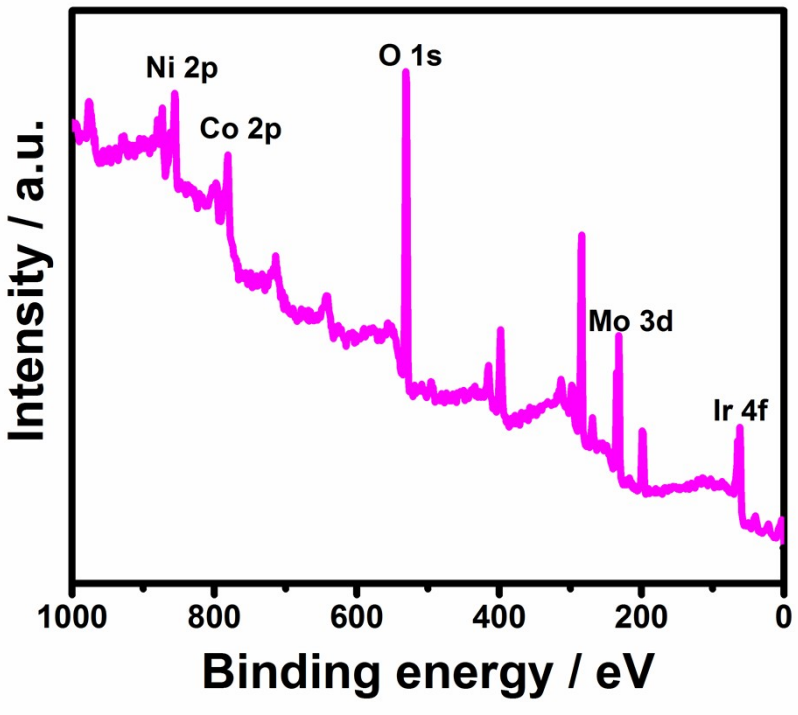

Fig.S6 XPS survey spectrum of the Ir-$NiMoO_4$-ZIF.

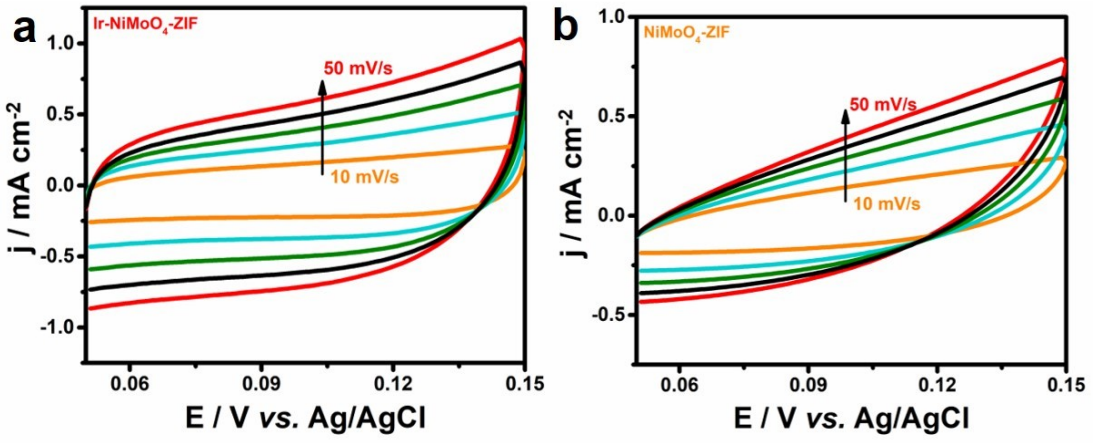

Fig.S7 CV curves of (a) Ir-$NiMoO_4$-ZIF and (b) $NiMoO_4$-ZIF at different scan rates.

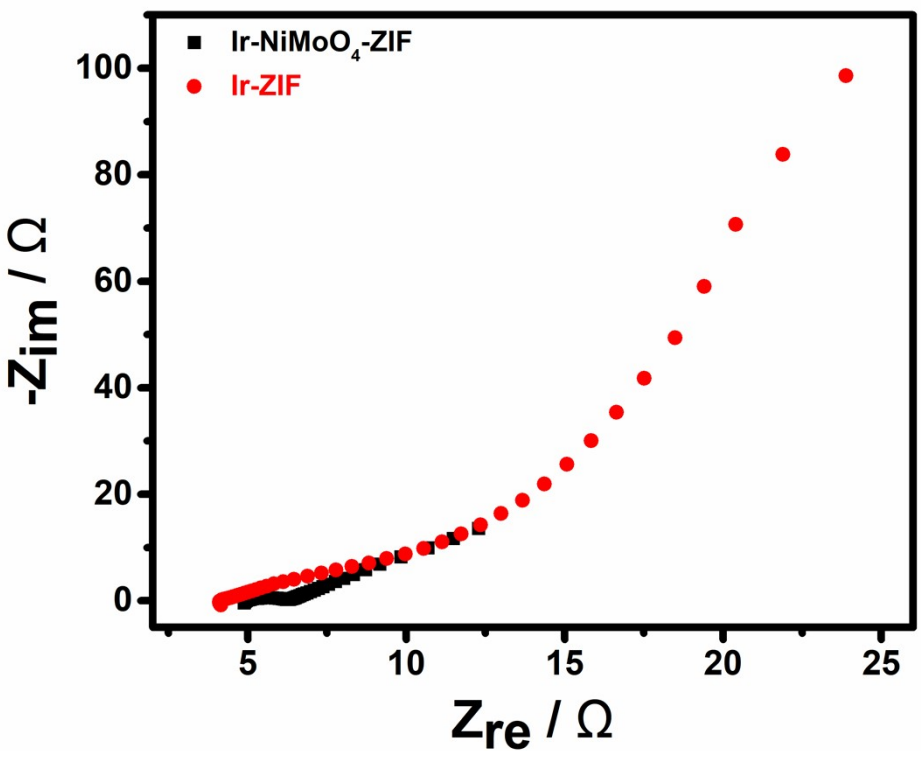

Fig.S8 Nyquist plot of Ir-$NiMoO_4$-ZIF and Ir-ZIF.