Supplementary Material

NiCo-ZIF Based Ternary MOFs Composite Material for High-Efficiency and Stable Oxygen Evolution Reaction

Synthesis of MOF-74(Co), MIL-100(Fe).

The preparation methods for MIL-100 (Fe) and MOF-74 (Co) are similar to that of NiCo-ZIF@MM; however, the synthesis of MIL-100 (Fe) does not involve NiCo-ZIF-67 and metallic Co, while MOF-74 (Co) was prepared without NiCo-ZIF and metallic Fe.

XRD data.

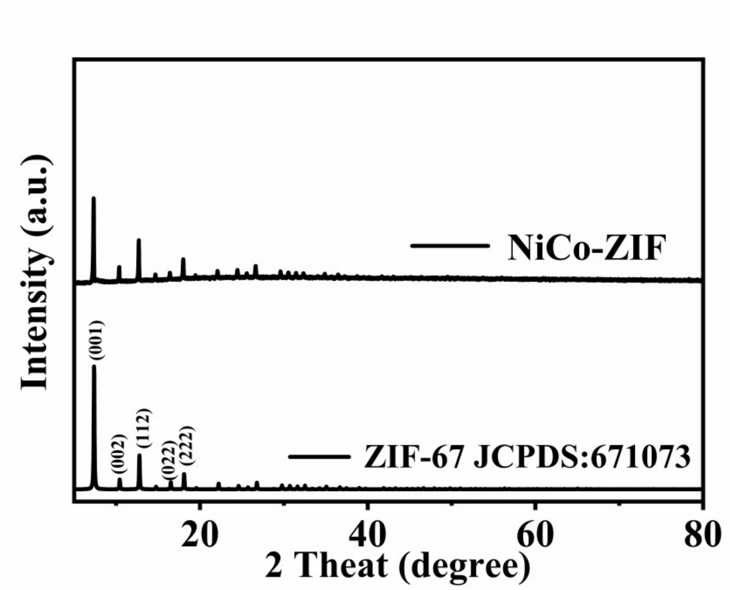

Fig. S1 Comparison of XRD between NiCo-ZIF and its standard card.

TG data.

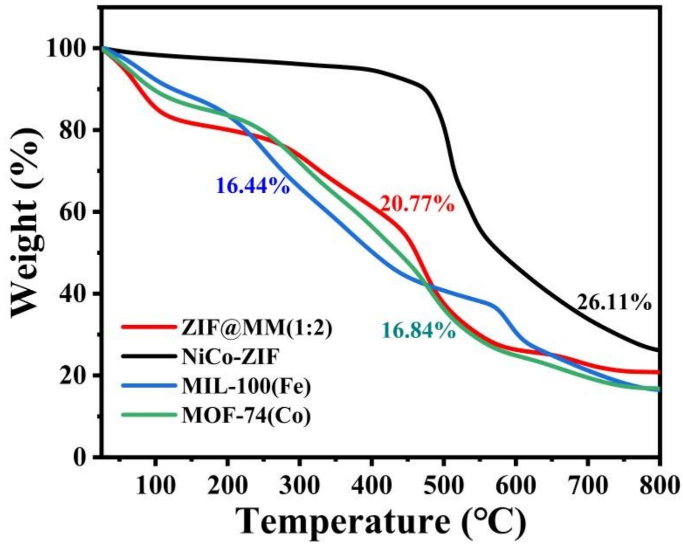

Fig. S2 Thermogravimetric analysis of NiCo-ZIF, MIL-100(Fe), MOF-74(Co) and NiCo-ZIF@MM (1:2)

LSV data

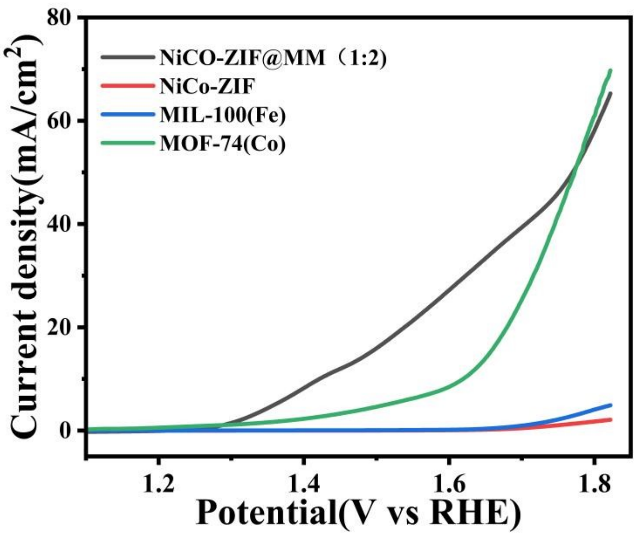

Fig. S3 LSV comparison of NiCo-ZIF, MIL-100(Fe), MOF-74(Co) and NiCo-ZIF@MM (1:2).

Table 1. Catalyst based MOFs, reaction condition, and OER performances.

Catalysts	Electrolyte	Substrate	η_{10} (mV)	Ref.
MIL- 101(Fe)@ZIF- 67	1.0 M KOH	GC	330	1
ZIF-8 @ ZIF-67 @ POM	1.0 M KOH	GC	490	2
MXene/MIL Fe-53/ZIF-67	1.0 M KOH	GC	237	3
FeNiCu-MOFs	1.0 M KOH	GC	260	4
FeCo-MOF-74/Mn-MOF-74	1.0 M KOH	GC	280	5

Tafel slope

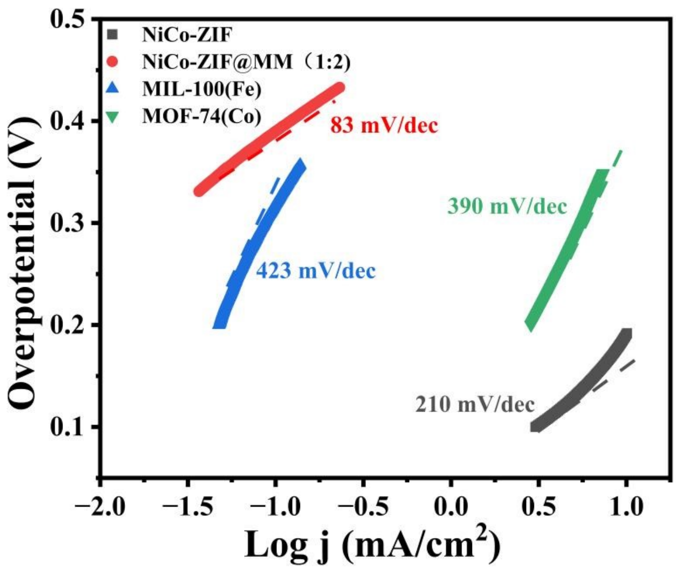

Fig. S4 Tafel slope of NiCo-ZIF, MIL-100(Fe), MOF-74(Co) and NiCo-ZIF@MM (1:2).

ECSA data

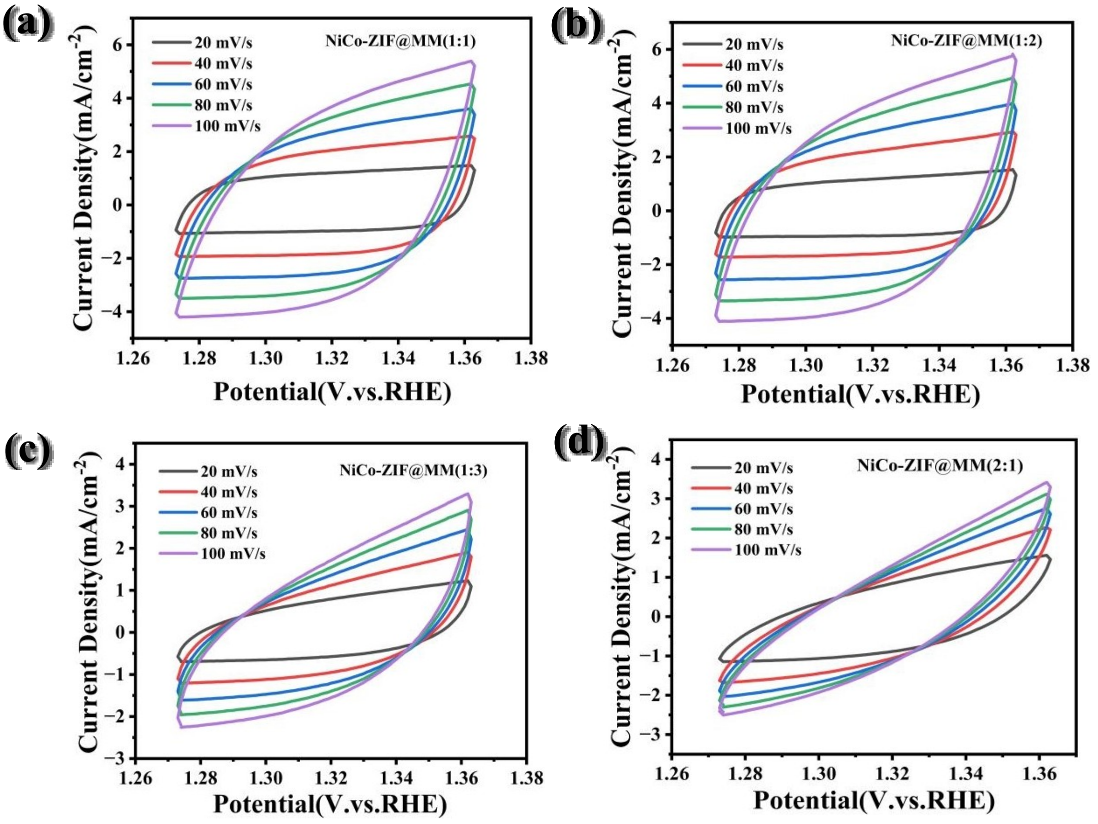

Fig. S5 The synthesis ratio of NiCo-ZIF@MM at (a) 1:1, (b) 1:3, (c) 1:2, (d) 2:1 for ECSA.

The calculation process of C_{dl} as follow[6]: First, we measured CV in a range of 1.27 V to 1.37 V vs. Ag/AgCl (1.0 M KOH solution) at different scan rates (20, 40, 60, 80 and 100 mV/s). Under each scan rate, the measurements were repeated ten cycles to reduce errors. The measured CV results are presented in Fig. S5. Second, the double-layer capacitance C_{dl} was estimated by plotting the Δj (Y-axis in Fig. S5) =($j_a - j_c$) at 1.32 V (where j_c and j_a are the cathodic and anodic current densities, respectively) against the scan rate (X-axis in Fig. S5), in which the slope was twice that of C_{dl}.

The following are the j_a and j_c values for NiCo-ZIF@MM(1:1) (at 1.32 V and different scan rates 20, 100 mV/s.):

$j_a(20) = 1.034$ mA/cm^2, $j_a(100) = 3.752$ mA/cm^2;

$j_c(20) = -1.052$ mA/cm^2, $j_c(100) = -3.694$ mA/cm^2;

Δj = (ja - jc) values：$\Delta j(20) = 2.086$ mA/cm^2, $\Delta j(100) = 7.446$ mA/cm^2，

$$\Delta j = \frac{\Delta j(100) - \Delta j(20)}{100 - 20} \times \frac{1}{2} = 0.03176 \text{ mF cm}^{-2}$$

$$C_{dl} = 0.03176 \text{ mF cm}^{-2} \times 1000 \approx 31.72 \text{ mF cm}^{-2}$$

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