Supporting Information

Unveiling the scope and perspectives of MOF-derived materials for the cutting-edge applications†

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Table S1. Synthesis and applications of MOF-derived nano-architectures developed by solution-based etching strategies.

Targeted Materials	Sacrificial Template	Etching Reagent	Surface area (m^2 g^{-1})	Pore volume (cm^3 g^{-1})	Applications	Ref.
$Cu/MgAl_2O_4$	Al–MOF	NaOH	212.4	0.6	Catalytic steam reforming	1
Ni^0–Al_2O_3–PET	Al–MOF	$Ni(NO_3)_2.6H_2O$ aq. solution	356	1.12	Catalytic dry reforming	2
Fe_2Co_1/NPC	Co/Fe–MOFs	5M HNO_3	211.6	0.558	Electro-Fenton catalysis	3
Co_3O_4-C@FeOOH	ZIF–67	7mM $FeSO_4$	100.23	n.a	Catalytic ozonation	4
Co_3O_4	ZIF–L–Co/NF	$Co(NO)_2.6H_2O$ ethanol solution	103.9	0.52	Electrocatalytic oxidation	5
MnO@C/GF	Mn–MOF	Trimesic acid	14.005	0.0398	Electrocatalytic oxidation	6
*e*FeNSCs	FeCo–ZIF–8	Methanol	695.9	n.a	Electrocatalytic degradation	7
X-Cu-BDC (X=NH_2, OH, H, F & 2F)	Cu–MOF	0.2M NaOH	n.a	n.a	Eelctrocatalytic reduction	8
Ni-Fe-C-600-acid/GO	2D Ni–Fe–MOF	0.5M H_2SO_4	842.21	n.a	Catalytic oxidation	9
Co/CN-x	Zn/Co–ZIF–8	Aqua regia	818	0.975	Catalytic oxidation	10
Co/N–doped carbon	ZIF–67	Polydopamine	403	0.30	Catalytic oxidation	11
$CeO_2.Co_3O_4$ nanoflowers	Ce–TCPP	$Ce(NO_3)_3$•$6H_2O$ and $Co(NO_3)_2$•$6H_2O$	104.86	n.a	Catalytic oxidation	12
Mn–MP	$Mn_3(BTC)_2(H_2O)_6$	Trimesic acid	51	0.5	Catalytic reduction	13
C@Fe–800	Fe–BDC	$FeCl_3.6H_2O$	n.a	n.a	Catalytic reduction	14
fBN@NiCo–LDH	NiCo–LDH	150mL ethanol	n.a	n.a	Interface–charring catalysis	15
GMN@Co_xS_y	ZIF–67	Thioacetamide	78.5	0.41	Electrocatalytic water splitting	16
Au/Co_xS_y	ZIF–67	Thioacetamide	79.38	3.98	Electrocatalytic water splitting	17
NiCoP/CoP/Co_3O_4	CC@Co–MOF	$Ni(NO_3)_2$ in ethanol	16.09	n.a	Electrocatalytic water splitting	18
MoNiS/$Mo_2TiC_2T_x$	Ni–MOF	50 wt% HF	n.a	n.a	Electrocatalytic Water splitting	19
H-2D Co/Mo_2C@NC	Co–MOF & Zn–MOF	Ammonium molybdate tetrahydrate	n.a	n.a	Electrocatalytic water splitting	20
CuFeN/CNT	Cu–MOF	Water and ethanol mixture	n.a	n.a	Electrocatalytic water splitting	21
CoP–NC@NFP	Co–MOF	$Ni(NO_3)_2{\cdot}6H_2O$ & $FeSO_4{\cdot}7H_2O$	247	n.a	Electrocatalytic water splitting	22
Ru-NPs/SAs@N–TC	NH_2–MIL–125	Methanol	307.5	0.19	Electrocatalytic/ photocatalytic water splitting	23

Tb^{3+}@Zr–MOF	Zr–MOF	HCl	483	n.a	Fluorescence sensing	[24]
$[Tb_{0.43}Eu_{1.57}(1,4\text{-phda})_3(H_2O)]$	Ln–MOF	$Eu(NO_3)_3{\cdot}5H_2O$, $Tb(NO_3)_3{\cdot}5H_2O$ and sodium acetate	n.a	n.a	Ratiometric fluorescence sensing	[25]
Co_3O_4@C/GNP	Co–MOF	Metol, Hydroquinone & Catechol	n.a	n.a	Electrochemical sensing	[26]
Co_3O_4/NCNTs	ZIF–67	H_2O_2 and glucose	n.a	n.a	Electrochemical sensing	[27]
Hollow ZnO nanocages	ZIF–8	triethanolamine	59.4	n.a	Gas sensing	[28]
$ZnFe_2O_4$/(Fe–ZnO)	Zn–MOF–5	$Fe(NO_3)_3{\cdot}9H_2O$	n.a	n.a	Gas sensing	[29]
$CoWO_4$–modified α–Fe_2O_3	MIL–53(Fe)	NH_4F	n.a	n.a	Gas sensing	[30]
IGO@ZnO	MIL–68 (In/Ga)	Zinc acetate ethanol solution	108.71	n.a	Gas sensing	[31]
Fe_2O_3/rGO	MOF–PB	$FeCl_3$ solution	34.69	n.a	Gas sensing	[32]
α–Fe_2O_3 and γ–Fe_2O_3	PBA cubes	0.1M HCl	108.3	n.a	Gas sensing	[33]
In_2O_3/MoS_2	MIL–68(In)	Thioacetamide	32.37	n.a	Gas sensing	[34]
ZnCoNiP	Zn/Co–MOFs	1 M NaOH	20.23	0.06	Supercapacitors	[35]
MX@ ZCO	ZCM	LiF in 10 ml of 9 M HCl	40.2	n.a	Supercapacitors	[36]
Ni–ZnP/Zn–Co–S	ZnCo–MOF on NF	0.1 M Na_2S aq. solution	n.a	n.a	Supercapacitors	[37]
Ni–Fe–O/NPC @PCNFs	Ni–Fe–MOFs @PCNFs	NH_4F	52.95	0.21	Supercapacitor	[38]
Co_3O_4	Co–MOFs	1M HCl	n.a	n.a	Supercapacitors	[39]
$NiCo_2S_4/Co_3S_4$ NCs	ZIF–67	Thioacetamide	15.61	n.a	Supercapacitors	[40]
Bi/Bi_2O_3–C	Bi–MOFs	$Bi(NO_3)_3.5H_2O$ in methanol	163.6	0.251	Batteries	[41]
HPCO	Cu–BTC@PVP	2M $FeCl_3$ Solution	266	n.a	Batteries	[42]
Co/NC–TiO_2	Co–MIL–125	$Co(NO_3)_2{\cdot}6H_2O$ solution in 50 mL ethanol	437	0.352	Batteries	[43]
Si NDs⊂MDN	ZIF–8	Methanol	52.8	0.1328	Batteries	[44]
2D MXene@ $Co_9S_8/CoMo_2S_4$	MXene@ZIF–67	12M HCl soln.	n.a	n.a	Batteries	[45]
$Ni(OH)_2$@NC/CTs & Fe_2O_3@NC/CTs	Co–MOF	15µL HCl	210.4 228	n.a	Batteries	[46]
C@VO_2 @V_2O_5	V–MIL–88	2mL HCl	126.5	n.a	Batteries	[47]
CoFe@NC/KB-800	Co–MOF	melamine	1318.8	n.a	Batteries	[48]
Co_9S_8@MoS_2 nanocubes on RGO	GO@ZIF–67	aq. Na_2MoO_4	n.a	n.a	Radiation absorption	[49]
Ni@CoZn/C and Fe@CoZn/C	BMZIF	30mL absolute ethanol	n.a	n.a	Radiation absorption	[50]
*n*Co1–NPs@NC	Co–MOF	8M HNO_3	431	0.6	Selective bond	[51]

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Where n.a = not available.

Table S2. MOF-derived and MOF-supported nanostructures for electrode materials in energy storage batteries.

Battery	Derived Material	MOF Template	Specific capacity [m Ah g^{-1}]	Charge density [mA g^{-1}]	Capacity retention [%]	Cycle life [cycles]	Ref.
LIB	Si NDs⊂MDN	ZIF–8	1327	100	92.99	300	[44]
LIB	CoP@N/P–(C/CNTs)	ZIF–67	1215	500	57.3	200	[52]
LIB	LCO@ACF	Li@ZIF67@ACF	154.1	340	79.2	550	[53]
LIB	LCO@C	ZIF–67	171.1	170	65	200	[54]
LIB	Co_xP@NC	ZIF–67	928	100	81.2	100	[55]
LIB	CoF_2/Fe_2O_3	ZIF–67	130.4	100	92.6	400	[56]
LIB	CoS_2/C/C	Co(IPC).H_2O	1076	100	77	100	[57]
LIB	PCNF–Co/N	Co/Zn–MOF	108.7	170	89	500	[58]
LIB	CC@CN–Co	CC@Co–MOF	158	170	98.7	300	[59]
LIB	ES–CNCo_3O_4@rGO	ZIF–67@GO	1315	100	99	500	[60]
LIB	Si@c–ZIF	ZIF–67	3714	200	99.4	1000	[61]
LIB	$CoFe_2O_4$@CNF	MIL–101	1230	100	74.9	500	[62]
LIB	CoO/$Co_2Mo_3O_8$@ MXene	ZIF–67	947.4	100	98.5	1200	[63]
LSB	Co/NC–TiO_2	Co–MIL–125	941	n.a	68.8	500	[43]
LSB	MoS_2@CZIF67	ZIF–67	1391	1000	70.5	400	[64]
LSB	Co–SAs@NC	Co–Zn–MOF	737	170	n.a	600	[65]
LSB	$Co_{3-x}Mn_xO_4$/C	Mn–ZIF–67	1082	170	60.4	500	[66]
LSB	FeSA–CN/S	Fe–ZIF–8	605	680	70	500	[67]
LSB	HPCNs	ZIF–8	335	34	89	100	[68]
LSB	CoZn-Se@N-MX	CoZn–MOFs	362.5	510	99.5	2000	[69]
LAB	MnO/$CoMn_2O_4$@N–C	α–MnO_2@ZIF–67	8625	200	78.3	48	[70]
LAB	Co_3O_4@$NiCo_2O_4$/CC	Co–MOF	10645	100	n.a	225	[71]
Mg-Li battery	Cu_2S@C	Cu–MOF	399.2	8.6	46.4	50	[72]
NIB	2D MXene@ $Co_9S_8/CoMo_2S_4$	MXene@ZIF–67	196	5000	83.2	350	[45]
NIB	Co-C	Co–Bpdc	172	100	58	60	[73]
NIB	CoS_2/C/C	Co(IPC).H_2O	712	100	92.1	100	[57]
NIB	$NiCoSe_4$	NiCo–MOF	325	1000	87.3	1500	[74]
NIB	rGO@MCSe	Mo/Co–MOF	123.6	100	88.4	700	[75]
NIB	ZnSe@NCNF	PAN@ZIF–8	197.3	340	76.95	1700	[76]
Ni-Fe battery	$Ni(OH)_2$@NC/CTs & α–Fe_2O_3@NC/CTs	Co–MOF	94.8	50	86.1	10,000	[46]
KIB	Bi/Bi_2O_3–C	Bi MOFs	426	50	76.6	350	[41]
KIB	rGO@MCSe	Mo/Co–MOF	114.8	100	99.9	125	[75]
KIB	ZnSe@PCNF	ZIF–8	139	170	98	1000	[77]
AIB	$CoTe_2$@N–PC	ZIF–67	635.8	200	90	200	[78]
AIB	HPCO	Cu–BTC@PVP	60.8	100	98	200	[42]
ZIB	C@VO_2 @V_2O_5	V–MIL–88	376	50	90.3	2000	[79]
ZIB	Zn/Co doped MnO/C	ZnCoMn–BTC	428.9	100	98.7	3000	[80]
ZIB	Mn_2O_3	Mn–MOF	453	100	99	500	[81]
ZIB	CoO/Ni_2P–Co_2P	Co–MOF	322.8	2000	104.9	6000	[82]
ZIB	MnO–C	Mn–MOF	727.7	100	~10	50	[83]
ZIB	MnO/C@rGO	Mn–MOF	170.6	500	43.1	300	[84]
ZIB	ZnO/N/C	ZIF–8	172.2	300	97	8000	[85]
ZIB	$ZnMn_2O_4/Mn_2O_3$	ZIF–8/MnO_2	230	100	n.a	n.a	[86]
ZIB	α–Mn_2O_3	Mn–MOF	225	50	53.3	1700	[87]
ZIB	$Cu_{0.26}V_2O_5$@C	Cu–MOF	163.8	2000	93.5	500	[88]
ZIB	N–doped 1T MoS_2	Mo–MOF	149.6	100	97.1	600	[89]

ZIB	Zn@3D–ZGC//MnO_2	Zn–MOF	238.3	200	99.4	1500	[90]
ZIB	α–V_2O_5@C	MIL–88B(V)	620.2	300	91.4	20000	[91]
ZIB	Mn_2O_3–$ZnMn_2O_4$	Mn–MIL	247.4	100	93.3	2000	[92]
ZIB	MnO_x@N–C	ZIF–8	305	2000	85.2	1600	[93]
ZIB	Mn_3O_4@C–NA/CC	Mn–MOF	396.2	200	95.7	12000	[94]
ZAB	CoFe@NC/KB–800	Co–MOF	654	n.a	90.1	50,000	[48]
ZAB	FeCo–N–C–T	ZnCo-–ZIF	518	10	80.1	360	[95]
ZAB	Co–NCS@CNT	ZIF–L	798	n.a	n.a	480	[96]
ZAB	Co_3O_4/Mn_3O_4/CN_x@C NFs	Co, Mn–ZIF	n.a	n.a	82.5	175000	[97]
ZAB	CoP/NC	ZIF–67	695.08	n.a	95	10,000	[98]
ZAB	FeCoNC	Co/Fe–MOF	n.a	n.a	95.45	690	[99]
ZAB	ZOMC	ZIF–67	795.3	n.a	95	500	[100]
ZAB	FeS/Fe_3C@NS–C–900	Fe–MOF	750	2	53.7	1730	[101]
ZAB	ZIF–8	NHCP	740	100	n.a	10000	[102]
ZAB	Ni@N–HCGHF	Ni–BTC	706	100	97.2	2000	[103]

Where n.a = not available.

Table S3. MOF–derived and MOF–supported materials for supercapacitor applications.

Derived Material	MOF Template	Specific Capacitance [F g^{-1}]	Energy Density [Wh kg^{-1}]	Power Density [W kg^{-1}]	Capacitance retention [%]	Life Cycle [cycles]	Ref.
Cobalt oxide/C	Co–MOF	1372	51.5	1687	75	2000	[104]
Co_3O_4–C/$Ni_2P_2O_7$	ZIF–67	2537.78	n.a	n.a	88.5	3000	[105]
Ni–CoP@C@CNTs	ZIF–67	708.1	17.4	699.1	76.1	3000	[106]
$LaFeO_3$	MOG–La–Fe	241.3	34	900	92.2	5000	[107]
ZnO/C@(Ni,Co)Se_2	ZIF–8	945.67	65.67	800	97.87	10000	[108]
SAPC	Mg–BTC	362.5	15.6	372.2	94.2	150000	[109]
Ni–Fe–P–C@HCNFs	(Ni–Fe)–MOFs	1392	62.7	8238.2	89	10000	[110]
P–Co_3O_4@PNC	Co–MOF	198	69.6	750	96.8	10000	[111]
Cu(Co–Ni)$_2S_4$NTs/Ni	Co–MOF	1047.74	36.46	316.6	96.2	5000	[112]
CoP–CoNC/CC	Co–MOF	144	39.2	1960	86.5	5000	[113]
Co_3O_4@Co–MOF	Co–MOF	1020	21.6	1373.3	96.7	5000	[114]
Co_3O_4/N–CNTs@CNF	ZIF-67	238	52.9	873.5	90.1	10000	[115]
NiO/C@CNF	Ni–MOF	742.2	58.43	1947	88	5000	[116]
(CuCo)Se/NC	CuCo–ZIF	206.38	16.3	155.3	96	5000	[117]
NC/Ni−Ni_3S_4/CNTs	Ni–MOF	1489.9	39.8	749.8	84.5	3000	[118]
IM–HPC	Cu–MOF	224	n.a	n.a	72	10000	[119]
TiO_2/C	MIL–125	400	43.5	0.865	95	2000	[120]
PPy/Cu9S8@C–CC	HKUST–1	270.72	n.a	n.a	80.36	3000	[121]
NCSG	Ni–Co–MOF	2506	n.a	n.a	51.8	6000	[122]
NFO	$NiFe_2$–MOF	833	42	154	74	3000	[123]
PC	Cu–MOF	385	10.51	5.454	90	10000	[124]
Ni/Co–MOF/rGO	Ni/Co–MOF	1162	n.a	n.a	109	5000	[125]
PPNF@Co−Ni	Co–MOF	1096.2	93.6	1600	85.5	10000	[126]
MXene–NPO	Ni–MOF	300	72.6	932	85	10000	[127]

Where n.a = not available.

Table S4. Gas sensing performances of various reported MOF–derived and MOF–supported materials.

Gas Sensing material	MOF precursor	Target species	Conc. [ppm]	Optimal Temp. [°C]	Response	T_{Res} [sec]	T_{recov} [sec]	Ref.
Ni_3BTC_2/–OH–SWNTs	Ni-MOF	SO_2	15	25	n.a	4.59	11.04	[128]
Ni-MOF/–OH–SWNT	Ni-MOF	SO_2	1	25	n.a	10	30	[129]
CuO/In_2O_3	CPP-3(ln)	H_2S	5	70	229.3	10	3600	[130]
Zn–Co–Ni MOF@CNT	TMOM	H_2S	100	325	166	126	23	[131]
ZIF–8/ZnO	ZIF-8	H_2S	10	25	52.1	420	n.a	[132]
UiO–66/GO	Zr-MOF	H_2S	n.a	30	8.7	n.a	n.a	[133]
WO_3@ZIF–71	ZIF-71	H_2S	20	250	19.12	118	431	[134]
ZnO	ZIF-8	ethanol	100	325	139.41	2.8	56.4	[28]
$Cu_3(HITP)_2$ NFAs	Cu-MOF	ethanol	20	25	3.5	50	64	[135]
$ZnFe_2O_4$/(Fe–ZnO)	Zn-MOF-5	acetone	100	190	30.8	4.7	10.3	[29]
IGO@ZnO	MIL-68(ln/Ga)	acetone	100	300	27.1	6.8	6.1	[31]
α–$Fe_2O_3/NiFe_2O_4$	Fe_3 MIL–88	acetone	200	100	23	4	350	[136]
Co_3O_4/Fe_2O_3 cubes	ZIF-67	acetone	100	250	3.27	42	65	[137]
$Ni_xCo_1xFe_2O_4$	Fe-MOF	acetone	200	240	1.67	9	34	[138]
ZnO@ZIF–71	ZIF-71	acetone	50	250	5.7	71	53	[139]
QCM based ZIF–90	ZIF-90	acetone	100	25	n.a	12	17	[140]
$CoWO_4$–α–Fe_2O_3	MIL-53(Fe)	Ethyl acetate	100	206	21.04	7	9	[30]
CeO_2@ZIF-8	ZIF-8	Propanol	n.a	170	n.a	0.7	88	[141]
$LaFeO_3$	Fe-CN-La	Propanol	100	120	28.1	9	34	[142]
Fe_2O_3/rGO	MOF-PB	n-butanol	100	25	171	53	42	[32]
α–Fe_2O_3 and γ–Fe_2O_3	PBA cubes	n-butanol	100	230	10.3	58	59	[33]
ZnO nanocubes	ZIF-8	Formaldehyde	100	350	10	4	4	[143]
Co_3O_4/ZnO	Co/Zn-MOF	Formaldehyde	10	120	6.17	n.a	n.a	[144]
QCM based MOF–14	MOF-14	Benzene	100	25	n.a	10	n.a	[145]
$Ni_{0.4}Fe_{2.6}O_4$ NRs	Fe-MIL-53 & Fe/Ni-MIL-53	DEA	30	175	93.5	4	38	[146]
rGO/α–Fe_2O_3	Fe-MIL-88	TEA	50	280	24	2	7	[147]
In_2O_3 microtubes	MIL-68	TEA	1	140	145	5	20	[148]
$Fe_2O_3/ZnFe_2O_4$	ZIF-8	TEA	100	300	2.44	2	7	[149]
Co_3O_4/ZnO NHs	ZIF-8@ZIF-57	TMA	50	190	232	2.1	11.8	[150]
$NiMoO_4$@NiO	Ni-MOF	TMA	50	220	150	20	16	[151]

n.a = not available

Table S5. Summary of reported MOF–derived and MOF–supported nanostructures based catalysts for pollutants' degradation.

Catalyst	MOF Precursor	Catalytic reaction	Efficiency [%]	Catalysis method	Ref.
Co_3O_4	ZIF–L–Co/NF	Oxidation of 5-hydroxymethylfurfural	96.7	Electrocatalysis	5
*e*FeNSCs	FeCo–ZIF–8	Elimination of trichloroacetamide DBP	97	Electrocatalysis	7
Fe_3O_4–CuO@C	Cu–BDC/ Cu–BTC	Degradation of methylene blue	98.65	Photocatalysis	152
		Bisphenol A	>85		
		Brilliant red	>85		
		Acid red	>85		
ZFCN	ZIF–8	Degradation of reactive red	94	Photocatalysis	153
Fe_2O_3/TiO_2	MIL–101(Fe)	Degradation of NSAID	79	Photocatalysis	154
		Ibuprofen	91		
		naproxen	100		
ZnO/C	Zn–MOF	Degradation of methylene blue	100	Photocatalysis	155
C–ZnO/PVDF	ZIF–8	Degradation of methylene blue	>90	Photocatalysis	156
ZIF–67@ZIF–8	ZIF–67 & ZIF–8	Degradation of methylene blue	59.2	Photocatalysis	157
Ag, Pd and Pt-/NH_2–MIL–125	NH_2–MIL–125	Degradation of acetaminophen	90	Photocatalysis	158
$CuFe_2O_4$	Fe–MOF	Degradation of rhodamine B	90	Photocatalysis	159
$ZnCo_2O_4$	ZnCo–MOF	Degradation of methylene blue	87.9	Photocatalysis	160
		Rhodamine B	89.5		
		Crystal violet	84.3		
Fe_2O_3@Ag-ZnO@C	Fe–MOF	Degradation of tetracycline	99	Photocatalysis	161
		Methylene blue	92		
N–TiO_2	NH_2–MIL–125	Degradation of methylene blue	90.5	Photocatalysis	162
C doped ZnO/TiO_2	Zn/Ti–MOF	Degradation of rhodamine B	94	Photocatalysis	163
CeO_2/NC/Ce-TCPP	Ce–TCPP	Degradation of rhodamine B	>99	Photocatalysis	164
		Methylene blue	98.6		
		Oxytetracycline	97.8		
		Tetracycline	84.5		
		Methyl orange	94.4		
$Bi_2O_2CO_3$/g–C_3N_4	CAU–17	Degradation of sulfamethazine	90.31	Photocatalysis	165
*n*Co1–NPs@NC	Co–MOF	Selective C–O bond cleavage	97	Homogenous catalysis	51
PtNi–C	Ni–BTC	Oxidation of alcohol fuels	64.31	Oxidation	166
ZSA-1-Co_3O_4	ZIF–67	Oxidation of toluene	100	Oxidation	167
X–Cu–BDC(X=N H_2, OH, H, F &2F)	Cu–MOF	Hydrogenation of CO (C–C coupling)	63	Reduction	8
$CeMO_x$ (M = Ti, Cu)	CeCu–MOF	Low-temperature NO_x removal	80	Reduction	168
Mn–MP	$Mn_3(BTC)_2(H_2O)_6$	Low-temperature NO_x removal	85	Reduction	13
C@Fe–800	Fe–BDC	Reduction of 4-nitrophenol & MO	94 & 92.5	Reduction	14
Co@C	Co–MOF	Hydrolysis of sodium borohydride	93.1	Hydrolysis	169
fBN@NiCo–LDH	NiCo–LDH	Catalytic conversion of CO	100	Interface–charring	15
Cu/$MgAl_2O_4$	Al–MOF	Catalytic conversion of methanol	96	Steam reforming	1

Ni/ALC	Ni–MOF	Acetic acid conversion	91.32	Steam reforming	[170]
Ni^0–Al_2O_3–PET	Al–MOF	Catalytic conversion of methanol	n.a	Catalytic dry reforming	[2]
Fe_2Co_1/NPC	Co/Fe–MOFs	Degradation of tetracycline	91	Electro-Fenton catalysis	[3]
NPs/SAs–Co@NC	PAN@ZIF–67	Degradation of bisphenol A	n.a	Fenton-like catalysis	[171]
Co_3O_4–C@FeOOH	ZIF–67	Ozonation of norfloxacin	56.7	Ozonation	[4]
Ru_0/ZrO_2	Ru/UiO–-66	Hydrogenation of CO_2	95	Hydrogenation	[172]
Co–Fe/NC@GCS	ZIF–-67	Degradation of sulfamethoxazole	87.1	Adsorption	[173]
ZIF–8/PAN	ZIF–8	Degaradation of tetracycline	97	Adsorption	[174]
Fe_3O_4@MIL–100(Fe)/β–CD	Fe_3O_4@MIL–100	Degradation of triazole fungicides	99.7	Adsorption	[175]
NPC	ZIF–L	Degradation of tetracycline	99.99	Adsorption	[176]

Where n.a = not available.

Table S6. HER, ORR, OER and ECR activities of various reported MOF-derived electrocatalysts.

Type	Catalyst	MOF–precursor	OER & HER		ORR			Electrolyte	Ref.
			Overpotential [mV@10 mA cm^{-2}]	Tafel slope [mV/dec]	E_{onset} [V *vs.* RHE]	$E_{1/2}$ [V *vs.* RHE]	J_L [mA cm^{-2}]		
HER	FeNiCo@NC/NF	MIL–53(FeNi)/NF	145	82	-	-	-	1M KOH	[177]
HER	Co_2P/CoNPC	ZIF–67	130	58.2	-	-	-	1M KOH	[178]
HER	Ni@N–HCGHF	Ni–BTC	95	57	-	-	-	1M KOH	[103]
HER	ZIF–67–Pt/rGO	ZIF–67	14.3	12.5	-	-	-	0.5M H_2SO_4	[179]
HER	MOFDC	Co–MOF	35	261	-	-	-	0.1M KOH	[180]
HER	FeP/NPC	Fe–MOF	75	66	-	-	-	0.5M H_2SO_4	[181]
HER	$NiSe_2$/C/CF	Ni–MOF	209	74.1	-	-	-	0.5M H_2SO_4	[182]
HER	t–Ni/Co–MOF	Ni–MOF & Co–MOF	n.a	57	-	-	-	1M KOH	[183]
HER	Cu–MOF/CeO_2	Cu–MOF	145.9	54.6	-	-	-	1M KOH	[184]
HER	Cu_3P/C	HUKST–1	233	91	-	-	-	1M KOH	[185]
HER	Ru–Cu@C	Cu–BTC	20	37	-	-	-	1M KOH	[186]
HER	W–SAC	UiO–66–NH_2	85	53	-	-	-	1 M KOH	[187]
HER	Fe-MoS_x/C	MIL–100 (Fe)	-321	62	-	-	-	1M KOH	[188]
HER	Co/N–CNT@PCNF	ZIF–67	150	73	-	-	-	1M KOH	[189]
OER	Au/Co_xS_y	ZIF–67	343	62	-	-	-	0.1M KOH	[17]
OER	H–2D Co/Mo_2C@NC	Co–MOF & Zn–MOF	256	48	-	-	-	1M KOH	[20]
OER	CoS_x@MnO_2	ZIF–67@MnO_2	329	81.4	-	-	-	1M KOH	[190]
OER	CuFeN/CNT	Cu–MOF–H_2O	420	56.9	-	-	-	1M KOH	[21]
OER	M–PCBN	PCB	232	32	-	-	-	1M KOH	[191]
OER	NiCo–MOF	RNCMs	319	78.2	-	-	-	1M KOH	[192]
OER	Co–NC/CF	Co–MOF/CF	246	68	-	-	-	1M KOH	[193]
OER	N-doped Ni@C	$Ni_2(BDC)_2$(DABCO)	307	48	-	-	-	1M KOH	[194]
OER	FeNiCo@NC/N	MIL–53(FeNi)/N	245	36	-	-	-	1M KOH	[177]

	F	F							
OER	NiFe–BDC	NiFe–BDC	210	28	-	-	-	0.1M KOH	[195]
OER	$Co_{1.6}Ni0_{.4}P_4O_{12}$–C	CoNi–ZIF	230	51	-	-	-	1M KOH	[196]
OER	Co–MNS	CoP_x@CNS	286	70	-	-	-	1M KOH	[197]
OER	Ni/Co–HHTP	cMOF/LDH	227	34.1	-	-	-	1M KOH	[198]
OER	Co_2P/CoNPC	ZIF–67	326	83.9	-	-	-	1M KOH	[178]
OER	Ni@N–HCGHF	Ni–BTC	260	63	-	-	-	1M KOH	[103]
OER	Fe–Co_3O_4 HHNPs	ZIF–67	262	43	-	-	-	1M KOH	[199]
OER	FeCo–C/N	ZIF–L	353	102	-	-	-	1M KOH	[200]
OER	CoMoOS	ZIF–67	281	75.4	-	-	-	1M KOH	[201]
OER	$CoSe_2$	ZIF–67	287	54.3	-	-	-	1M KOH	[202]
OER	Ni–Fe LDH DSNCs	MIL–88A	123	71	-	-	-	1M KOH	[203]
OER	CoP–NC@NFP	Co–MOF	270	46	-	-	-	1M KOH	[22]
ORR	HNCSs	Zn–BTC	-	-	0.92	0.82	5.34	0.1M KOH	[204]
ORR	RNCMs	NiCo–MOF	-	-	0.90	0.45	82.1	1M KOH	[192]
ORR	Pd/Co_3O_4–N–C	ZIF–67	-	-	1.1	0.93	5.88	0.1M KOH	[205]
ORR	ZFN	ZIF–8	-	-	n.a	0.85	190.7	0.1M KOH	[206]
ORR	BSCF@Co–N_x–C	ZIF–67	-	-	0.45	1.56	5	0.1M KOH	[207]
ORR	Ni@N–HCGHF	Ni–BTC	-	-	n.a	0.875	5.87	0.1M KOH	[103]
ORR	CoFeNi/NC	ZIF–67	-	-	0.914	0.842	2.593	0.1M KOH	[208]
ORR	FeCo–C/N	ZIF–L	-	-	n.a	0.864	7.3	1M KOH	[200]
ORR	Co–Cu@CN	Cu–MOF@Co–MOF	-	-	0.06	0.037	n.a	0.1M KOH	[209]
ORR	Co–C (X–C)	ZIF–67	-	-	0.88	0.82	33.2	0.1M KOH	[210]
ORR	GC@COF–NC	ZIF–-67	-	-	0.923	0.841	n.a	0.1K KOH	[211]
ORR	Fe/N–PCNs	Zn/Fe–MOF	-	-	n.a	0.86	n.a	0.1M KOH	[212]
ORR	FePPc@CB	Fe–MOF	-	-	n.a	0.908	5.38	0.1M KOH	[213]
ORR	CuPt/NC	Cu–tpa MOF	-	-	0.9	n.a	4.2	0.1M $HClO_4$	[214]
ORR	FeSAs/CNF	ZIF–8	-	-	1.01	0.89	6.51	0.1M KOH	[215]
ECR	FeSAs/CNF	ZIF–8	-0.47	-	-	-	-	0.5M $KHCO_3$	[215]

Where n.a = not available.

Table S7. MOF–derived and MOF–supported materials used for radiation absorptions.

Absorber Material	MOF Precursor	Absorption Bandwidth [GHz]	Thickness [mm]	Reflection loss [dB]	Radiations	Ref.
CNT/Co/C	ZIF–67	7.8	2.0	-53.5	Microwave	[216]
Fe–Co/NPC/RGO	Co–MOF	10.1	2.5	-52.9	Microwave	[217]
FeCoNi@C	FeCoNi–MOF	5.52	3.1	-64.75	Microwave	[218]
CoS_2/NCNT	ZIF–67	6.2	1.6	-65	Microwave	[219]
Co–NG/CNT	Co–ZIF–67	18	1.5	-65.45	Microwave	[220]
FeNi@CNT/CNRs	FeNi–MIL–88B	4.5	2.3	-47.0	EMW	[221]
CoNi/C	ZIF–67	5.2	2.0	-61.02	EMW	[222]
Cu/C	Mo–MOF	6.8	2.3	-52	EMW	[223]
CoNC/CNT	CoZn–ZIF–L	5.2	1.5	-44.6	EMW	[224]
CoNi/MnO@C	CoNiMn–MOF	8.0	2.1	-55.2	EMW	[225]
$NiSe_2$–$CoSe_2$@C/Ti_3	ZIF–67	5.68	2.6	-60.46	EMW	[226]

C_2T_x						
Fe@NPC@CF	Fe–MOF	5.2	2.5	-46.2	EMW	[227]
FMCFs	Fe^{III}–MOF–5	4.44	1.4	-39.2	EMW	[228]
NC@Co/NC	ZIF–8@ZIF–67	4.4	2.2	-52.5	EMW	[229]
Ni/NiO/Cu@C	Cu@C–MOF	na	3.2	-38.1	EMW	[230]
Cu_9S_5/C	HKUST–1	4.7	1.3	-62.3	EMW	[231]
$NiFe_2S_4$/PC	Ni–MOF/PC	4.08	1.8	-51.41	EMW	[232]
$TiO_2/ZrTiO_4$	TiZr–MOF	5.9	2.7	-67.8	EMW	[233]
MPC@Ni/C	Ni–MOF	5.8	2.2	-73.8	EMW	[234]
CuO	Cu–MOF	0.238	n.a	55	Near IR	[235]

Where n.a = not available.

List of abbreviations

PET = polyethylene terephthalate

NPC = N-doped porous carbon

NPs = nanoparticles

SAs = single-atom sites catalysts

PAN = polyacetonitrile

ZIF-L = leaf-like zeolite imidazole framework

NF = nickel foam

GF = graphite felt

*e*FeNSCs = electron-rich Fe-N_4 single site catalysts

BDC = benzene dicarboxylate

NSC = nano sheet of carbon

GO = graphene oxide

Co/CN-x = Co-based N-doped carbon catalysts

TCPP = tetra(4-carboxyphenyl) porphine

fBN = few-layered boron nitride

$Mo_2TiC_2T_x$ = Titanium and molybdenum carbide

LDH = layered double hydroxides

GMN = gold multipod nanoparticles

CC = carbon cloth

H-2D Co/Mo_2C@NC = hydrangea type 2D Co and Mo carbide

N-TC = N-doped TiO_2/C support

NC = N-doped carbon

NRs = nanorods

PNS = porous nanosheets

NCNTs = N-doped carbon nanotubes

Ni-Fe-O = Nickel iron oxide (mixed metal oxide)

MX@ZCO = MXene@$ZnCo_2O_4$

ZCM = ZnCo-MOF

Ni-Zn-P = nickel zinc phosphide

Zn-Co-S = zinc cobalt sulphide

CNF = carbon nanofibers

PCNFs = porous carbon nanofibers

NCs = nanocages

Bi/Bi_2O_3-C = carbon encapsulated Bi/Bi_2O_3 heretostructures

HPCO = hierarchical porous carbon octahedrons

CTs = carbon textiles

BTC = 1,3,5-benzene tricarboxylate

PVP = polyvinylpyrrolidine

Si NDs = Si nanodots

MDNs = MOF-derived nanoreactors

RGO = reduced graphene oxide

NC/KB = N-doped porous Ketjen Black

BMZIF = bimetallic zinc imidazolate framework

Bpdc = biphenyl-4,4'-dicarboxylate

CZIF =carbonized ZIF

LCO = $LiCoO_2$

ACF = Au-coated copper foam

IPC = 4-(imidazole-1-yl) phthalic acid

ZOMC = ZIF derived ordered macroporous carbon

ZGC = ZnO nanoclusters anchored in N-doped amorphous carbon modified graphene

SDA = 4,4'-stilbenedicarboxylate

DMF = dimethyl formamide

ES-CNCo_3O_4@rGO = Co_3O_4/N-doped hierarchical porous carbon nanofibers with reduced graphitic oxide

MCSe = molybdenum/cobalt binary metal selenide

MIL = materials of Institute Lavoisier frameworks

CM53 = carbonized MIL-53

HNCSs = hollow N-doped carbon spheres

NHC = N-doped hollow carbon

RNCMs = regrown nickel cobalt MOFs

MPC = microporous carbon

NS-C = N,S dual doped carbon

PCB = Poly [Co_2(benzimidazole)$_4$]

M-PCBN = metal oxide nanoparticle embedded PCB nanosheets

NHCP = nitrogen-doped hollow carbon polyhedrons

DABCO = ,4-diazabicyclo[2.2.2]octane

SURMOF = surface mounted MOFs

ZFN = N-doped carbon network encapsulated Fe_3N

BSCF = $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_3$

Co-MNS = Co-MOF nanosheets

CNS = carbon nanosheets

HHTP = 2,3,6,7,10,11-hexahydroxytriphenylene

cMOF = conductive MOF

Ni@N-HCGHF = hollow-microsphere (HM) Ni-MOF derived N-doped CNT/rGO heterostructure film

PC@PFN = Pt-Co alloy NPs on the Pt free nanowire

HHNPs = hierarchically hollow nanoparticles

C-FeHZ8 = hollow ZIF-8 carbon polyhedra doped with Fe and N

COF = covalent organic framework

PCNs = Porous carbon nanosheets

FePPc = iron polyphthalocyanine

CB = carbon black

AC = activated carbon

tpa = terephthalic acid

FeSAs/CNF = Fe-sigle atoms embedded carbon nanoframes

OER = oxygen evolution reaction

ORR = oxygen evolution reaction

NRR = nitrogen reduction reaction

ECR = electrochemical carbon dioxide reduction

CoMoS = $CoMoO_x$/$CoMoS_x$/CoS_x

DSNCs = double shelled nanocages

MOFDC = metal organic framework derived carbon

DEA = diethyl amine

TEA = triethyamine

CPP = coordination polymer particles

MBioFs = metal biomolecules frameworks

BC = biomass carbon

MIL = molecularly imprinted polymers

CBT = copper-4,4'-bipyridine-trimesic acid

HITP = 2,3,6,7,10,11-hexaiminotriphenylene

NFA = nanofibers array

TMOM = trimetallic organic material

NHs = nano heterojunctions

HKUST-1 = Cu_3(benzenetricarboxylate)$_2$

F@PDMS@HKUST-1 = functionalized films of polydimethyl siloxane coated HKUST-1

QCM = quartz crystal microbalance

NCNFs = nitrogen-doped porous carbon nanofibers

ZFCN = ZIF-8/Fe_2O_3 composite nanofibers

PVDF = poly(vinylidene fluoride)

W-SAC = tungsten containing single atom catalysts

DUT = Dresden University of Technology

SPAC = spherical-like activated porous carbon

IM-HPC = hierarchical porous carbon with interconnected macropores

PPy = polypyrrole

NCSG = Ni-Co sulfide nanotubes/graphene oxide

NFO = $NiFe_2O_4$

ALC = Al_2O_3/La_2O_3/CeO_2

ZTNs-Ce20 = Ce-Doped $ZnIn_2S_4$ tetrakaidecahedron hollow nanocages

UiOS = thiol functionalized UiO-66

GSC = glutaraldehyde-crosslinked chitosan

rh/c = rhombohedral corundum

HPCN = hollow porous carbon nanofibers

HNCs = homobimetallic hollow nanocages

CD = cyclodextrin

PDA = polydopamine

TFN = thin film nanocomposites

TpPa = COF synthesized by 1,3,5-triformylphloroglucinol (Tp) and 2,5-dimethyl-*p*-phenylenediamine (Pa-2)

p(XA) = polyxanthuranic acid

MNPs = magnetic nanoparticles

HMF = hydroxymethylfurfural

NDC = nitrogen doped-carbon

NA = nanorod array

POPs = persistent organic pollutants

ILCS = ionic liquid modified chitosan.

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