One pot synthesis and characterization of binary and ternary metal organic frameworks (MOFs) as tri-modal catalysts for thiophene electrooxidation, water splitting and 4-nitrophenol reduction

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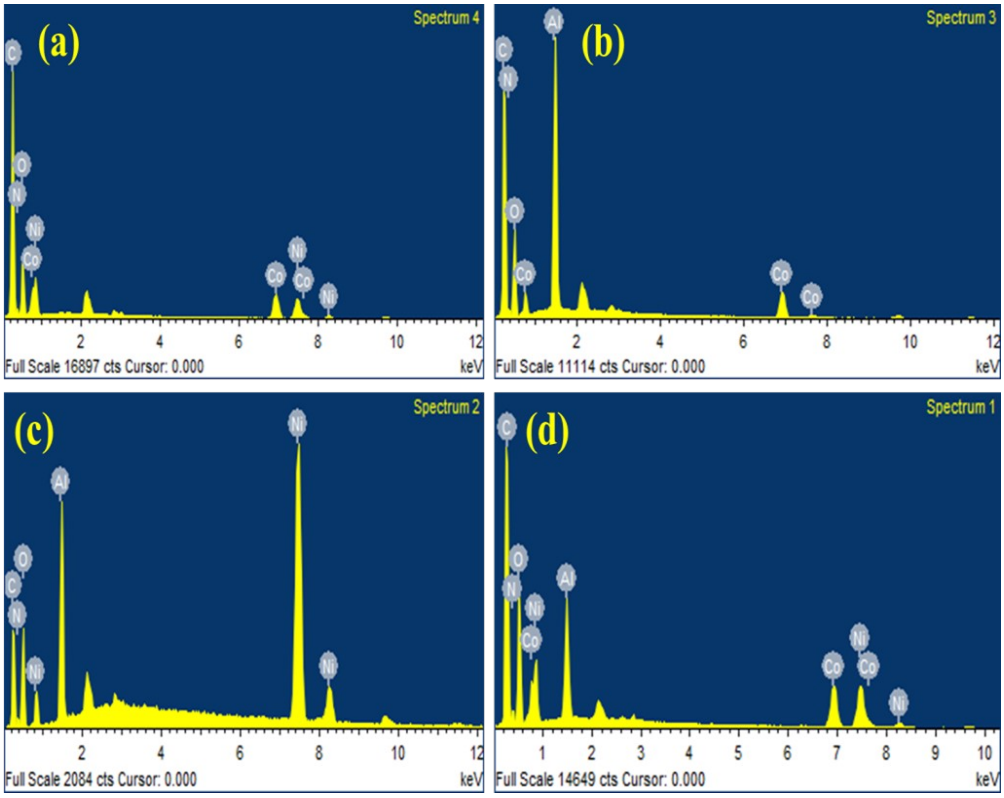

Figure S1. EDAX images of a) Co-Ni-MOF, b) Co-Al-MOF c) Ni-Al-MOF, and d)Co-Al-Ni-MOF.

Table S1. EDAX analysis of the synthesized composite weight percentage

S.No.	Catalyst	Element weight (%)					
		Al	**Co**	**Ni**	**C**	**N**	**O**
1	Co-Ni-MOF	-	7.71	7.22	53.59	9.20	22.29
2	Co-Al-MOF	10.49	6.22	-	51.85	7.15	24.30
3	Ni-Al-MOF	8.70	-	49.57	25.92	3.72	12.09
4	Co-Al-Ni-MOF	3.94	7.41	8.61	44.66	8.83	26.54

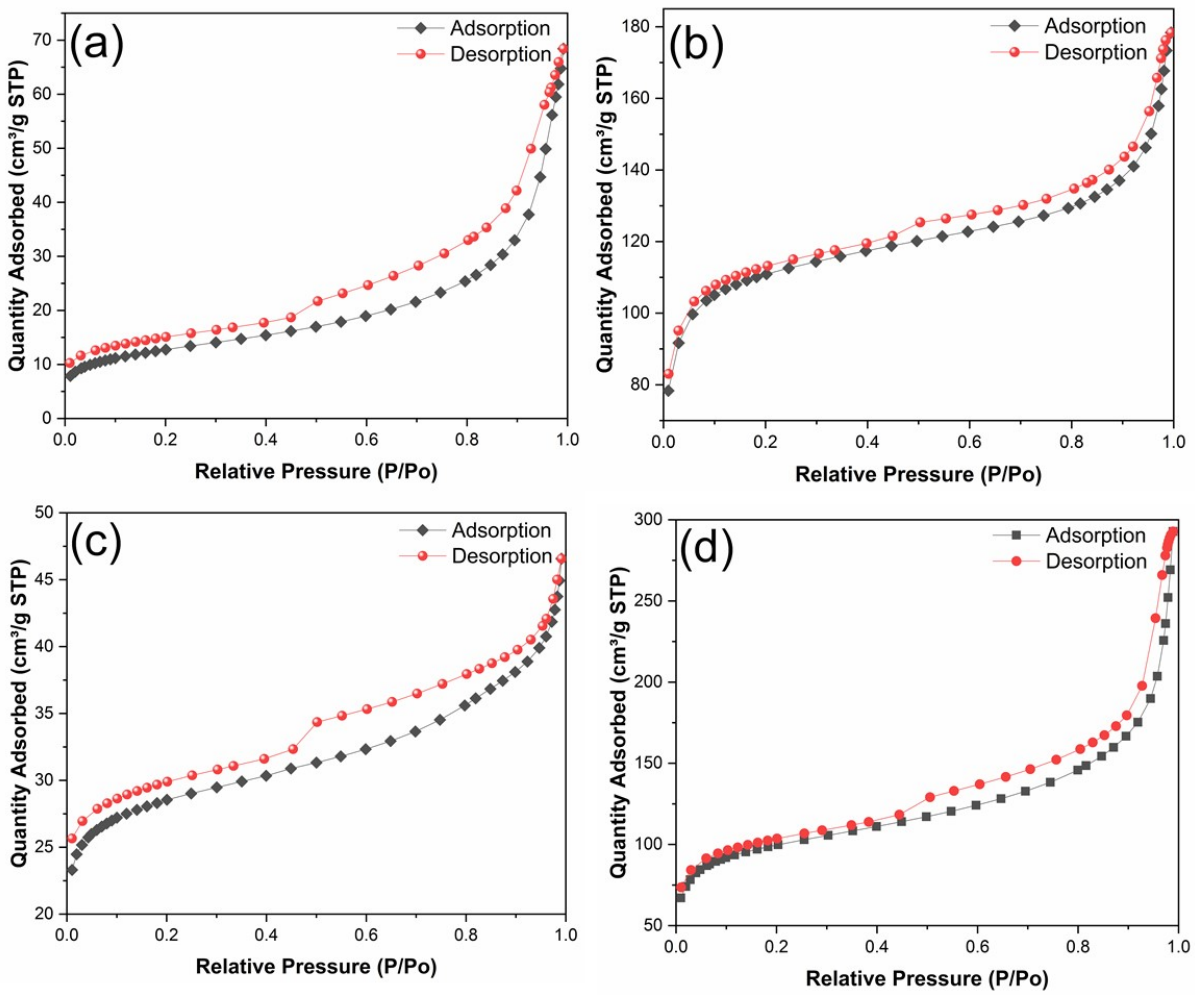

Figure S2. BET results of a) Ni-Al-MOF, b) Co-Al-MOF, c) Co-Ni-MOF and d) Co-Al-Ni-MOF.

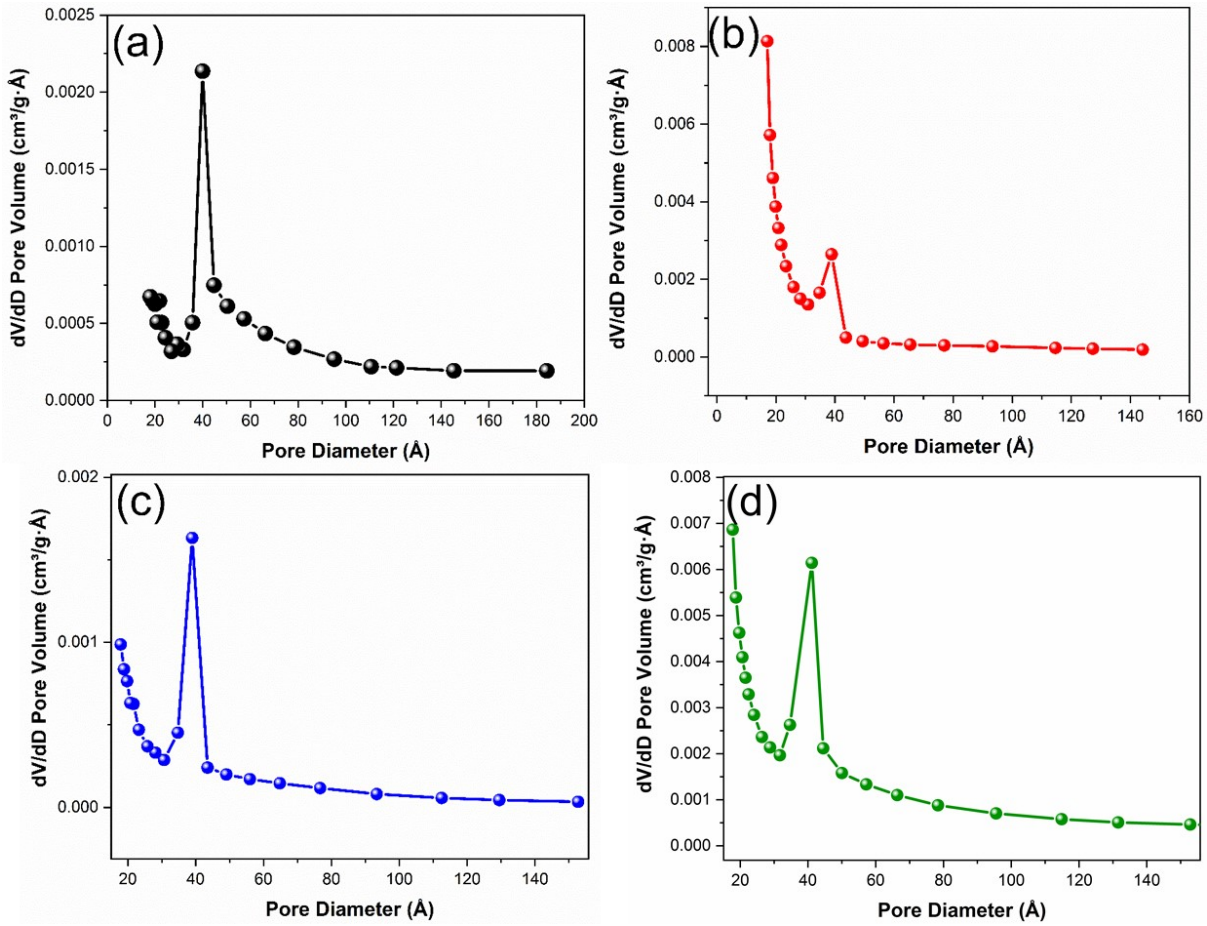

Figure S3. BET pore size distribution plot of a) Ni-Al-MOF, b) Co-Al-MOF, c) Co-Ni-MOF and d) Co-Al-Ni-MOF.

Table S2. BET surface area ($m^2\ g^{-1}$), pore volume ($cm^3\ g^{-1}$) and mean pore diameter (Å) of Ni-Al-MOF, Co-Al-MOF, Co-Ni-MOF and Co-Al-Ni-MOF obtained using the N_2 absorption- desorption isotherms.

S.No.	Catalyst	BET surface area ($m^2\ g^{-1}$)	pore volume ($cm^3\ g^{-1}$)	mean pore diameter (Å)
1	Ni-Al-MOF	7.8144	0.1058	40
2	Co-Al-MOF	19.8026	0.2758	38.77
3	Co-Ni-MOF	6.0303	0.0720	39.26
4	Co-Al-Ni-MOF	38.777	0.4528	41.58

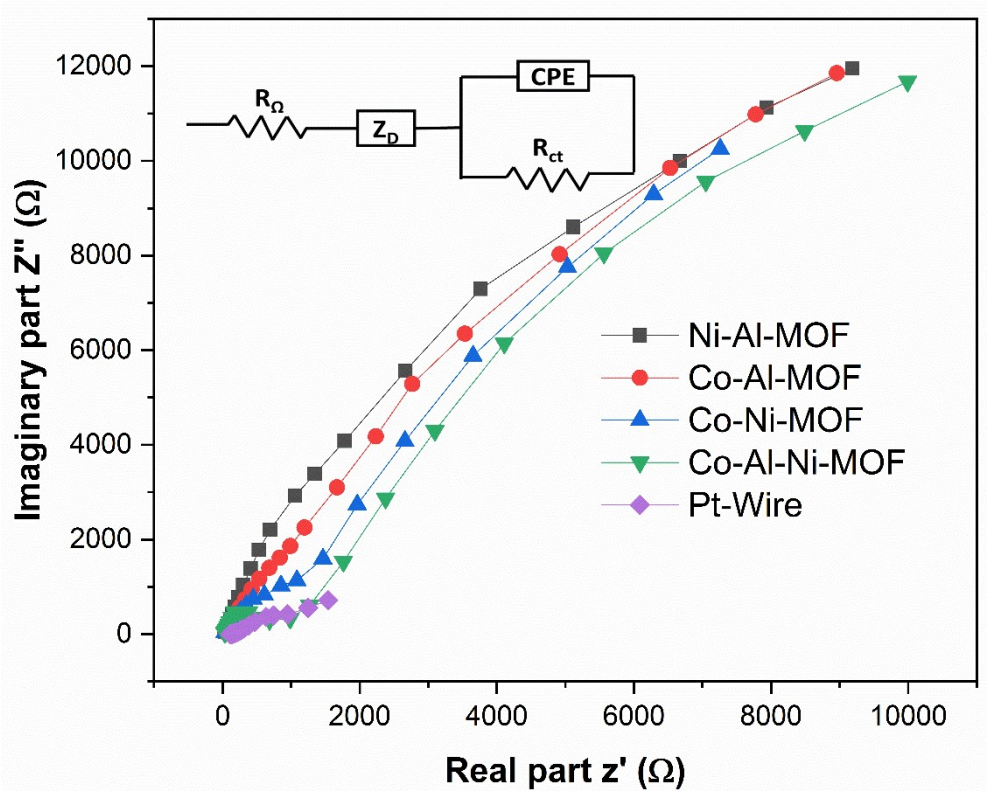

Figure S4. Impedance curves for synthesized MOFs for electrooxidation of thiophene

Table S3 Summary of comparative performance of Ni and Co based MOF catalysts recently reported for water splitting along with the present one.

No.	Catalyst	Electrolyte	Overpotential [mV]	Tafel slope [mV dec^{-1}]	References
1	Ni-MOF	0.1 M KOH	296	45	1
2	Ni-BTC	0.1 M KOH	330	63	2
3	Ni-MOF-74	1.0 M KOH	313	134.1	3
4	Ni-MOF	1.0 M KOH	268	132.5	4
5	3D NibpyfcdHp	0.5 M H_2SO_4	350	60	5
6	3D CobpyfcdHp	0.5 M H_2SO_4	400	65	5
7	Co_2(Hpycz)4$H2O	0.5 M H_2SO_4	223	121	6
8	THTA–Co $H_3[Co_3(tht)(tha)]$	0.5 M H_2SO_4	283	71	7
9	$H_3[Ni_3(tht)(tha)]$	0.5 M H_2SO_4	315	76	7
10	CoNi-MOF	1.0 M KOH	265	56	8
11	Ni/Co(10:1)-MOFs	1.0 M KOH	248	40.92	9
12	Co, 0.3Ni	1.0 M KOH	330	66	10
13	CoNi-MOF/rGO	1.0 M KOH	318	48	11
14	NiCo-UMOFNs	1.0 M KOH	250	42	12
15	CoNi-MOF	1.0 M KOH	304	89.7	13
16	3D Co/Ni-MOFs	0.5 M H_2SO_4	357	107	14
17	Ni/Co(II) MOFs/PPPT	0.5 M H_2SO_4	369	127.1	15
18	Ni-Co-Al -MOF	1.0 M KOH (OER)	220	97	This work
		1.0 M KOH (HER)	174	108	This work

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