SUPPORTING INFORMATION

Mono-, bi- and tri-metallic Fe-based platinum group metal-free electrocatalysts derived from phthalocyanine for oxygen reduction reaction in alkaline media

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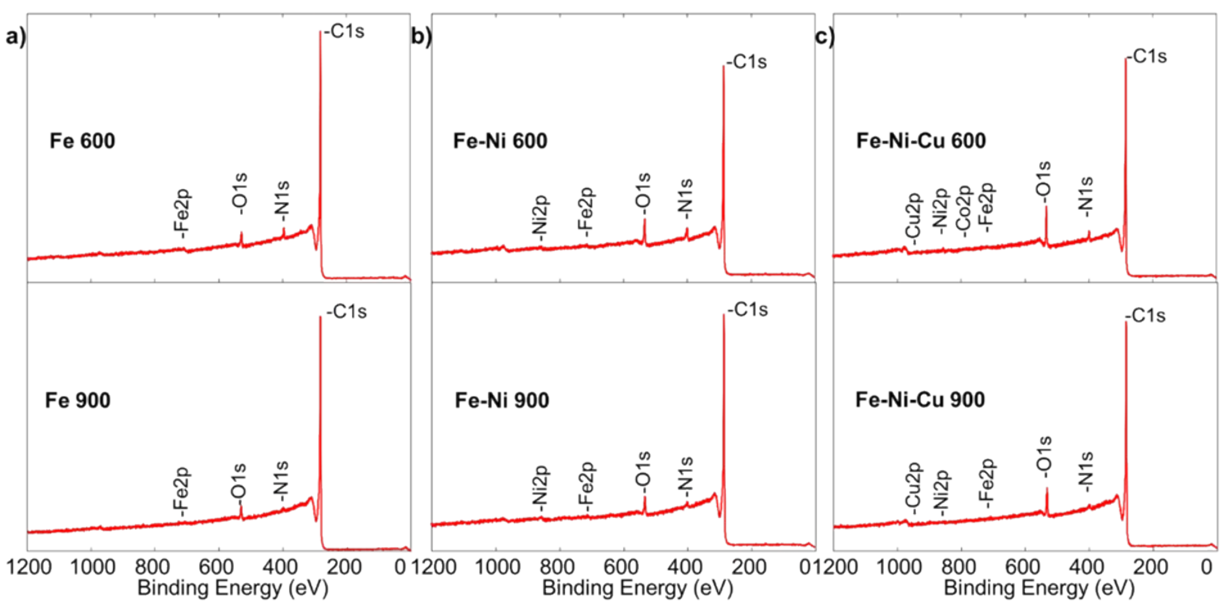

Figure S1: XPS survey spectra for a) Fe 600 and Fe 900, b) Fe-Ni 600 and Fe-Ni 900 and c) Fe-Ni-Cu 600 and Fe-Ni-Cu 900.

Table S1. Atomic percentage of C1s, N1s, Fe2p$_{3/2}$, Ni2p$_{3/2}$, Cu2p$_{3/2}$ and O1s in the KB-supported catalysts derived from XPS analyses.

Catalysts	C (1s)	N (1s)	Fe (2p$_{3/2}$)	Cu (2p$_{3/2}$)	Ni (2p$_{3/2}$)	O (1s)
Fe 600	93.4	3.2	0.3	-	-	3.1
Fe 900	95.7	1.6	0.3	-	-	2.4
Fe-Ni 600	89.4	4.4	0.2	-	0.3	5.7
Fe-Ni 900	94	2.0	0.1	-	0.1	3.8
Fe-Ni-Cu 600	89.4	3.0	0.2	0.3	0.1	7.0
Fe-Ni-Cu 900	91.9	2.4	~0.1	~0.1	<0.1	5.5

Table S2. Composition of nitrogen from N1s deconvolution spectra.

		Composition of N (relative %)					
KB-supported Catalysts	**N (at. %)**	**I$_{mine}$ (397.7 eV)**	**Pyridinic (398.3 eV)**	**N-M (M=Fe, Cu, Ni) (399.1 eV±0.1)**	**Pyrrolic (400.9 eV)**	**Graphitic (402.1 eV)**	**N-O (>403 eV)**
Fe 600	3.2	-	35.9	45.5	10.6	8.0	-
Fe 900	1.6	-	29.3	32.5	38.2	-	-
Fe-Ni 600	4.4	-	23.1	59.9	15.0	2.0	-
Fe-Ni 900	2.0	-	29.3	31.8	35.6	3.3	-
Fe-Ni-Cu 600	3.0	-	37.9	50.7	11.4	-	-
Fe-Ni-Cu 900	2.4	-	35.2	1.8	63.0	-	-

Table S3. Composition of nitrogen from C1s deconvolution spectra.

			Composition of C (relative %)				
Catalysts	**C (at. %)**	**Graphitic (284.3 eV)**	**Secondary carbons (285.0 eV)**	**C-N defects (286.2 eV)**	**C-OH and C-OC (287.1 eV)**	**C=O (288.0 eV)**	**COOH (289.4 eV)**
Fe 600	93.4	63.9	22.0	5.5	2.0	2.0	4.6
Fe 900	95.7	55.3	29.0	4.5	3.6	1.1	6.5
Fe-Ni 600	89.4	57.1	28.7	5.9	1.9	2.6	3.8
Fe-Ni 900	94	54.9	30.5	3.8	3.9	1.4	5.5
Fe-Ni-Cu 600	89.4	40.6	40.6	7.9	1.7	4.1	5.1
Fe-Ni-Cu 900	91.9	44.8	40.7	4.3	2.9	3.1	4.2

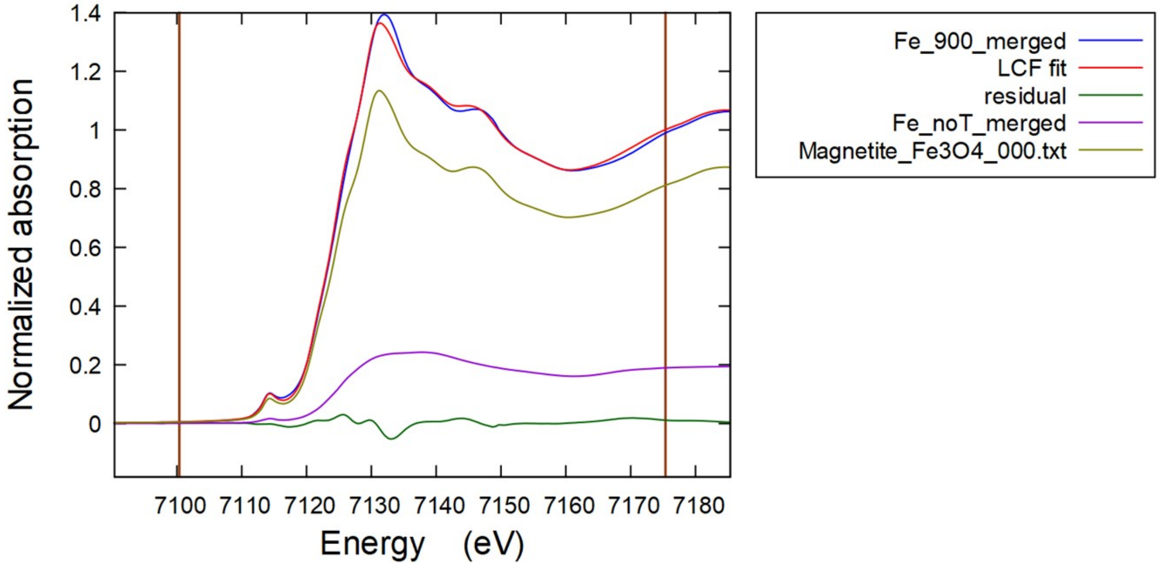

Figure S2: Spectrum of the sample treated at 900 °C (blue line) with the best LC fit (red line) obtained using 81% Fe_3O_4 (yellowish line) and 19% pristine Fe(Pc)/C (violet line).

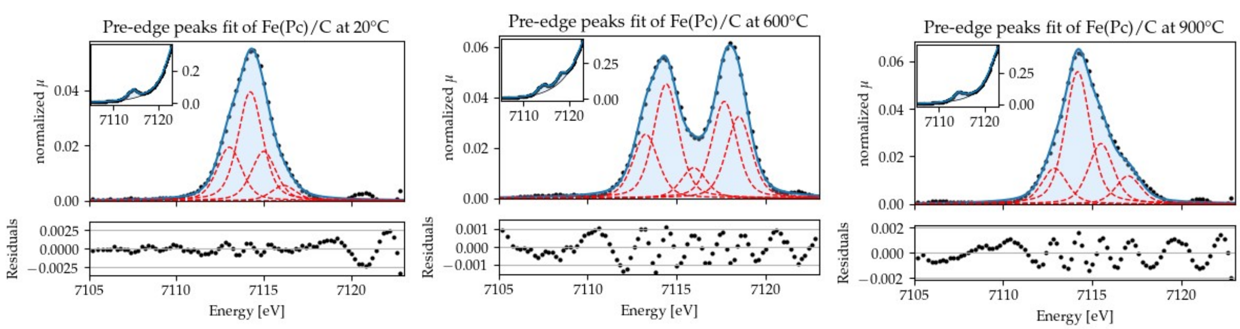

Figure S3: Pre-edge peaks fit: Black dots are the experimental data, blue lines the total fitted area, and in red the single components used. Upper-left small plate, the fit without the background subtraction.

Table S4. Onset-potential, half-potential, and limiting current density belong to the Fe-based electrocatalysts with the different (wt.%) of the FePc

Sample	Onset-potential (V)	Half-potential (V)	Limiting current density (mA cm^{-2})
Fe (30%) 600	0.96	0.90	6.2
Fe (30%) 900	0.96	0.84	5.2
Fe (20%) 600	0.95	0.88	5.8
Fe (20%) 900	0.95	0.83	5.4
Fe (10%) 600	0.94	0.86	5.2
Fe (10%) 900	0.89	0.75	5.5
Pt/C	0.98	0.85	5

Table S5: Onset-potential, half-potential, and limiting current density belong to the Fe-based electrocatalysts with the different mono/bi/tri-metallic precursors.

Sample	Onset-potential (V)	Half-potential (V)	Limiting current density (mA cm^{-2})
Fe 600	0.96	0.90	5.3
Fe 900	0.96	0.84	5.6
Fe-Ni 600	0.89	0.78	4.5
Fe-Ni 900	0.88	0.76	4.9
Fe-Ni-Cu 600	0.96	0.90	5
Fe-Ni-Cu 900	0.93	0.81	5
Pt/C	0.98	0.85	5

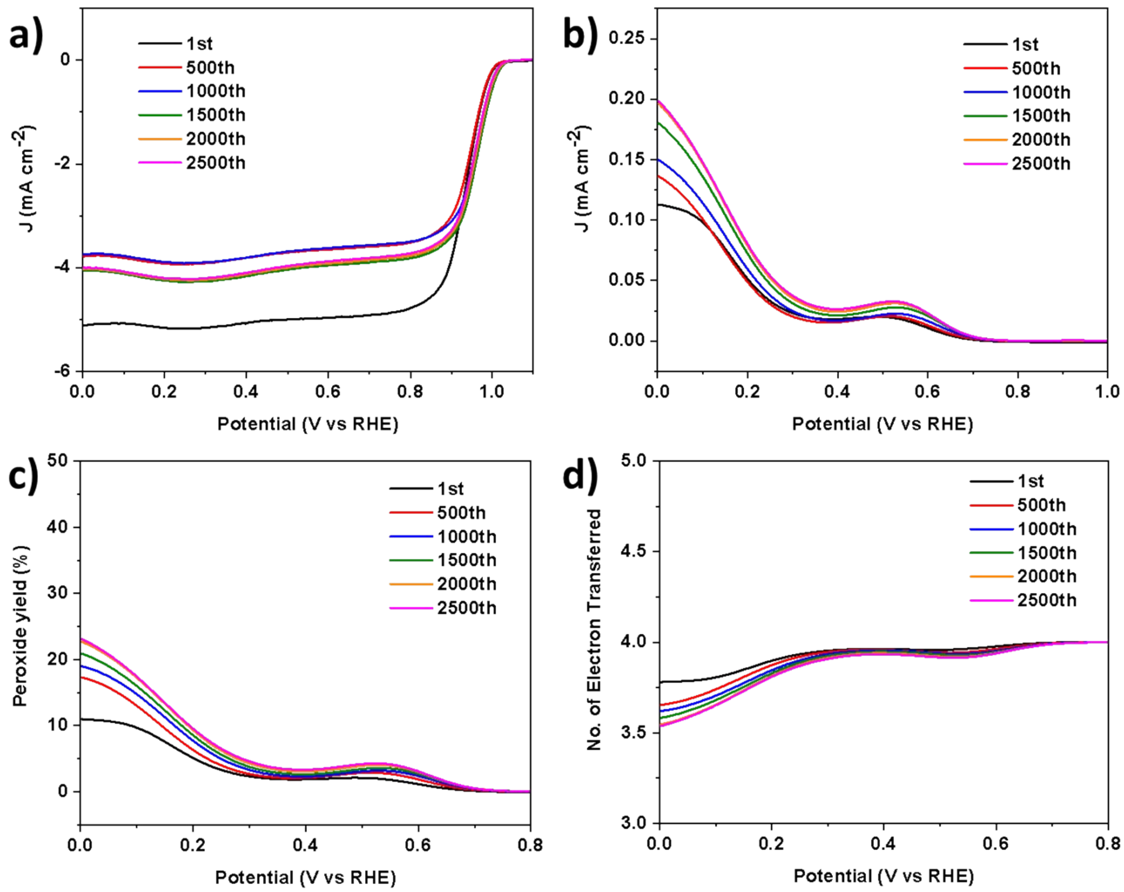

Figure S4. Accelerated ORR stability test performed over Fe 600 with the scan rate of 5 mVs^{-1} in O_2 saturated 0.1 M KOH while operating RRDE at 1600 rpm; a) LSV for disk current, b) Ring current, c) Peroxide anion yield, and d) Number of electrons transferred. Pt/C in all plots is the benchmark.

Sample	Eon (V)	$E_{1/2}$ (V)	limited current density (J_d) (mA cm^{-2})	Solution	cite
FeCoNi-CNF	-	0.77	-	0.1 M KOH	[1]
Fe-BP(N)	0.95	0.84	-6.1	0.1 M KOH	[2]
Poly-FePc	0.98	0.91	-5.49	0.1 M KOH	[3]
PPcFeCo/3D-G		0.89	-5.4	0.1 M KOH	[4]
CMP-CoFe/C	0.95	0.83	-6.5	0.1 M KOH	[5]
FePc-PcFe	0.80	0.59	-	0.1 M $HClO_4$	[6]
CoFe-COP/OMC	0.90	-	-5.35	0.1 M KOH	[7]
Fe/12Zn/CoNCNTs	1.02	0.88	-5.59	0.1 M KOH	[8]
Fe 600	0.96	0.90	-5.3	0.1 M KOH	This work
Fe-Ni-Cu 600	0.96	0.90	-5	0.1 M KOH	This work

Table S6: Comparison of ORR performance with similar electrocatalysts in other articles

Reference

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