Nitrogen and fluorine enriched Fe/Fe_3C@C oxygen reduction reaction electrocatalyst for alkaline/ proton exchange membrane fuel cells

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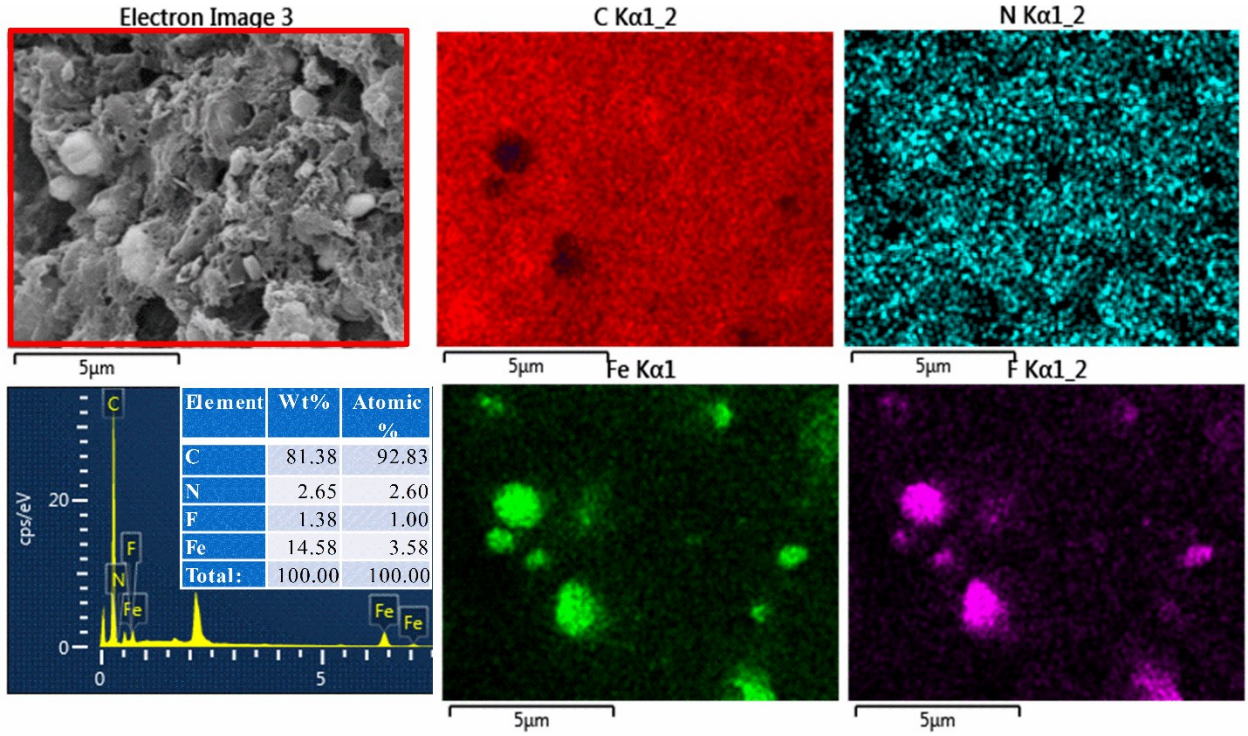

Fig. S1 SEM-EDX and elemental mapping results of NFC@Fe/Fe_3C-8.

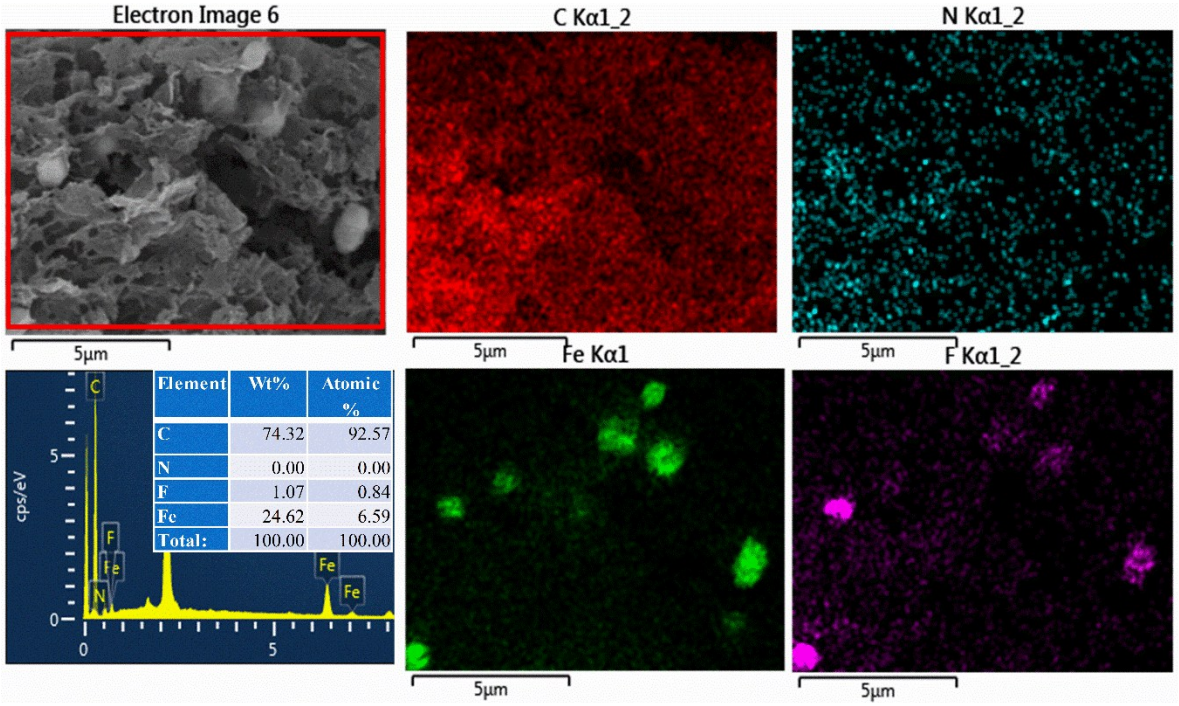

Fig. S2 SEM-EDX and elemental mapping results of NFC@Fe/Fe_3C-9.5.

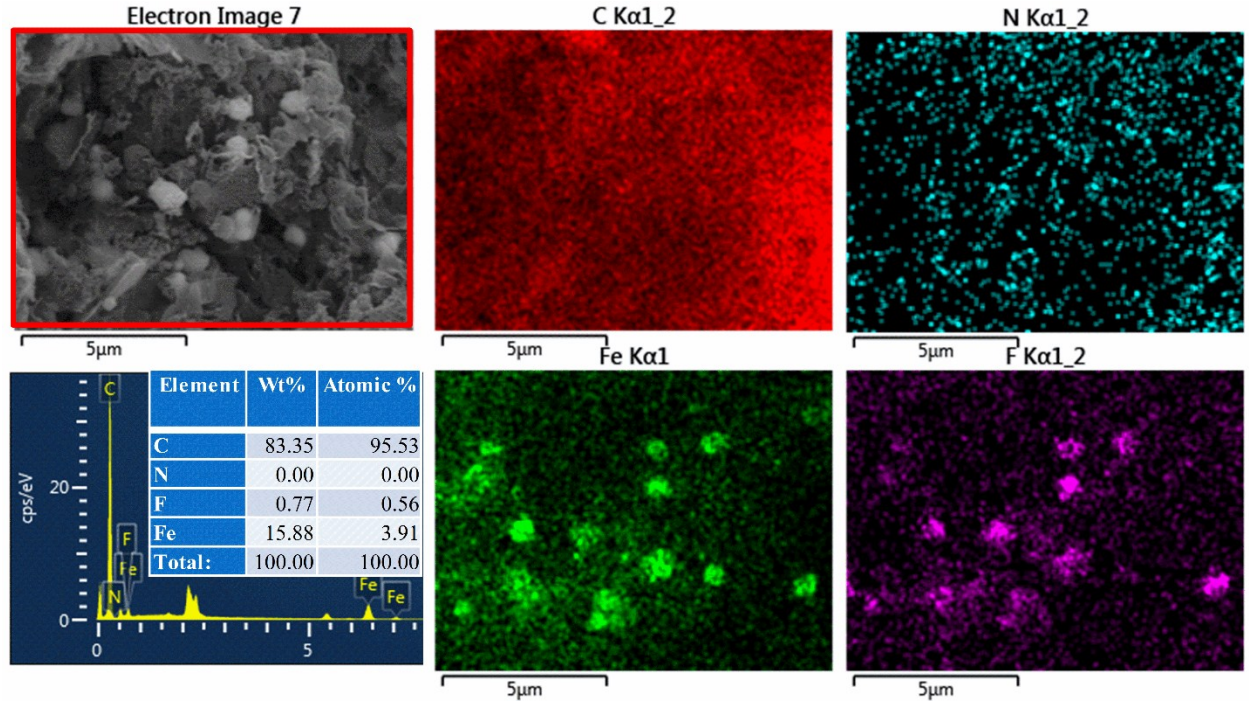

Fig. S3 SEM-EDX and elemental mapping results of NFC@Fe/Fe_3C-10.

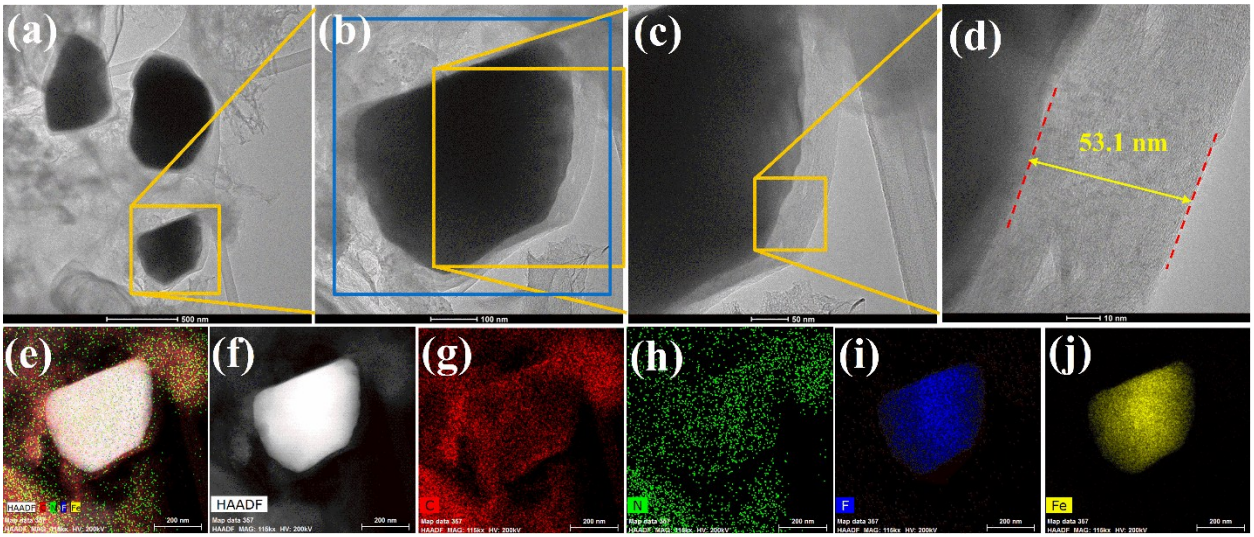

Fig. S4 TEM images in various magnifications and HAADF-STEM mapping images of NFC@Fe/Fe_3C-8.

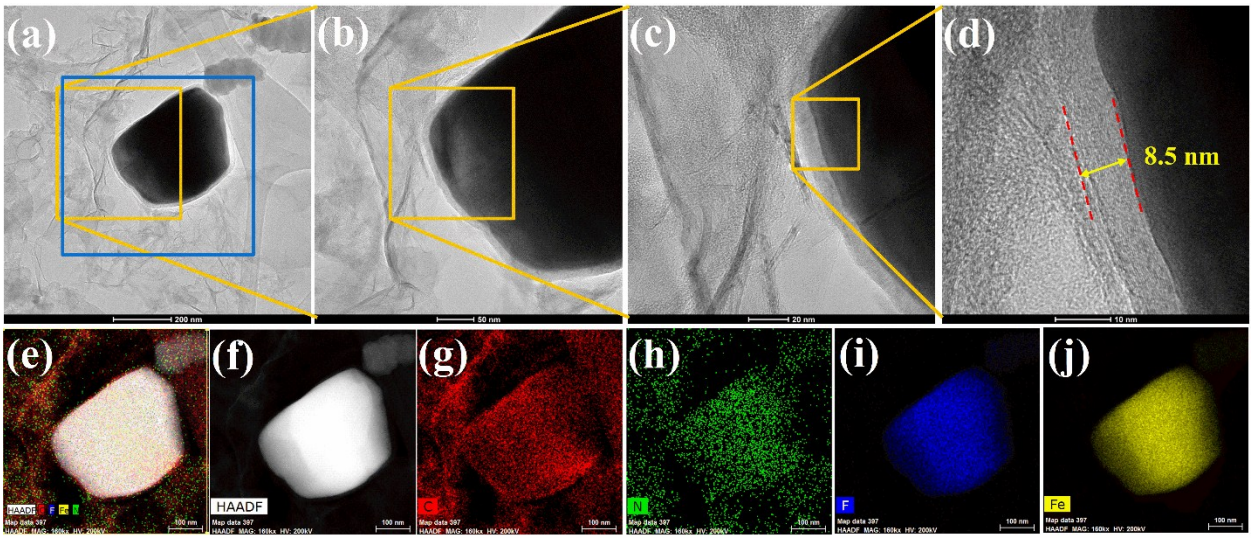

Fig. S5 TEM images in various magnifications and HAADF-STEM mapping images of NFC@Fe/Fe_3C-9.5.

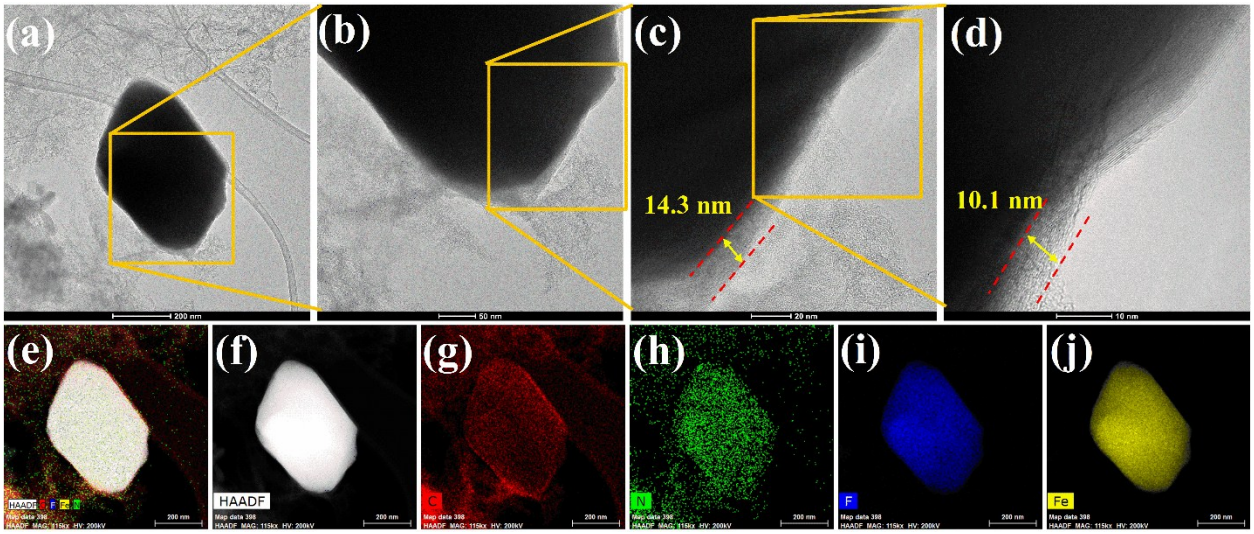

Fig. S6 TEM images in various magnifications and HAADF-STEM mapping images of NFC@Fe/Fe_3C-10.

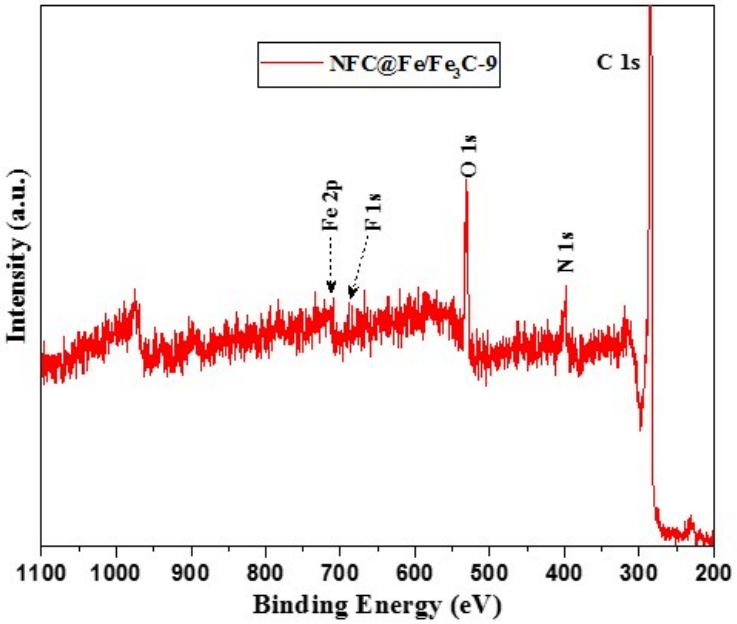

Fig. S7. The XPS survey spectrum of NFC@Fe/Fe_3C-9.

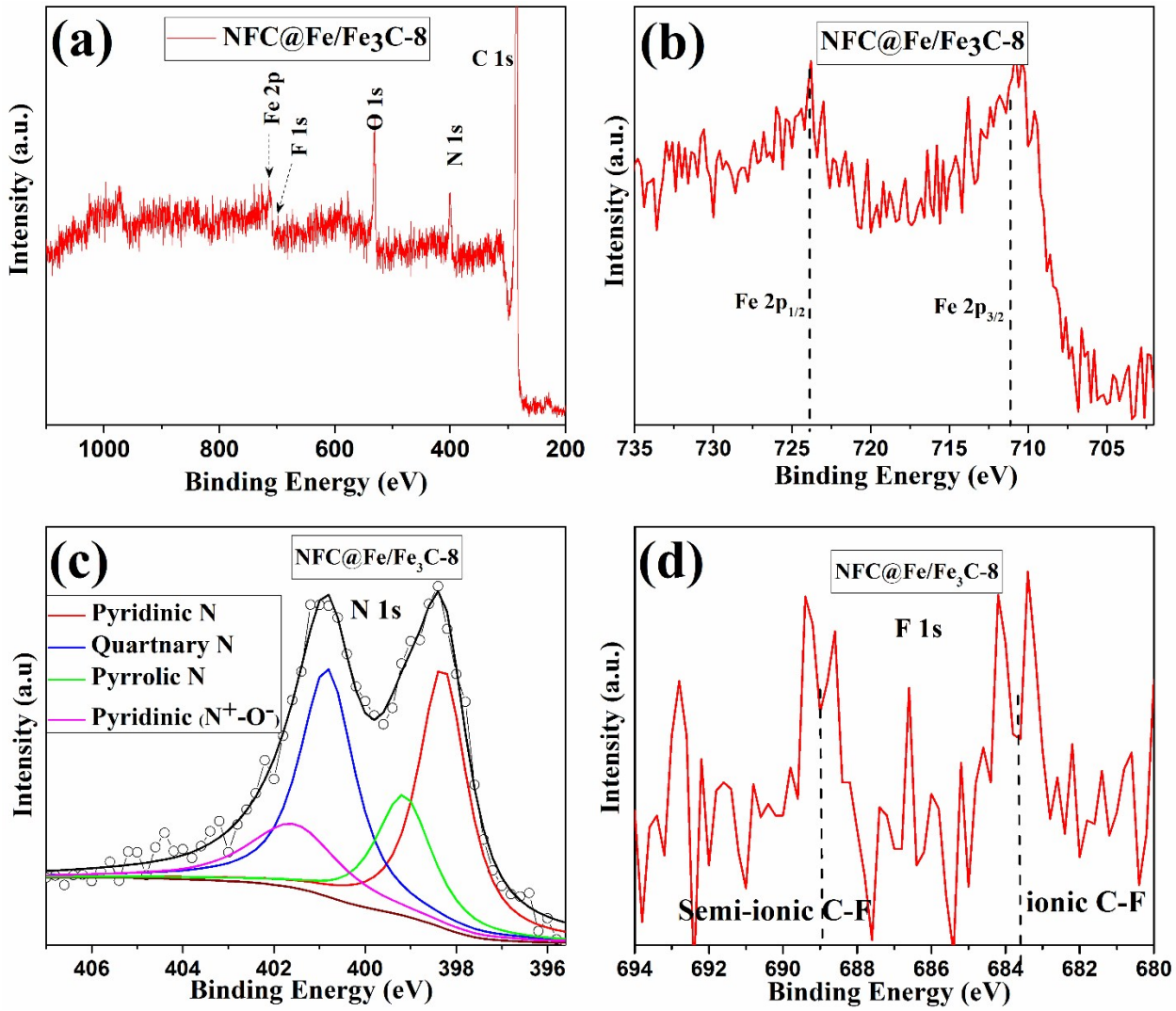

Fig. S8. The XPS survey and N 1s, F 1s, Fe 2p spectrum of NFC@Fe/Fe_3C-8.

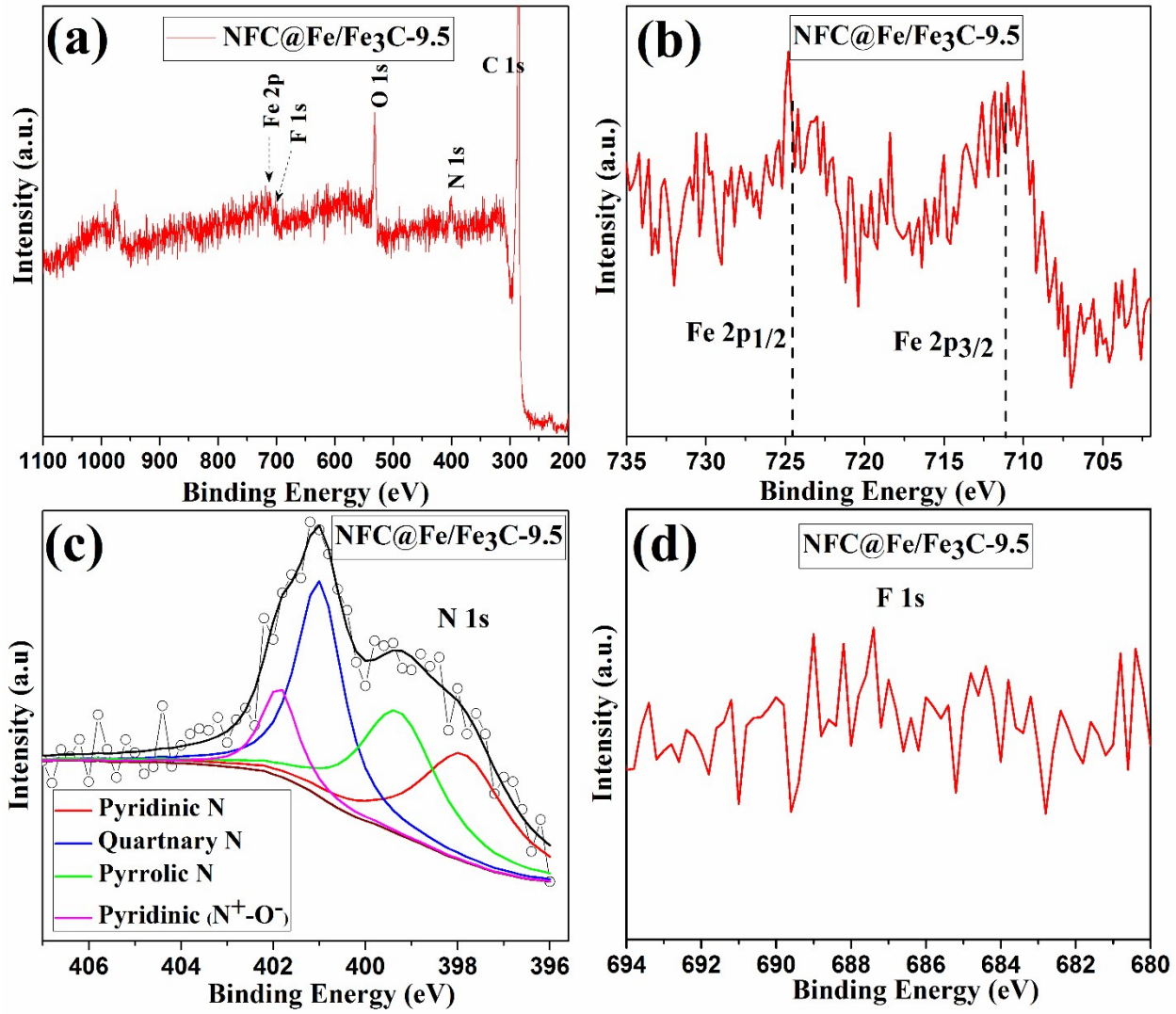

Fig. S9. The XPS survey and N 1s, F 1s, Fe 2p spectrum of NFC@Fe/Fe_3C-9.5.

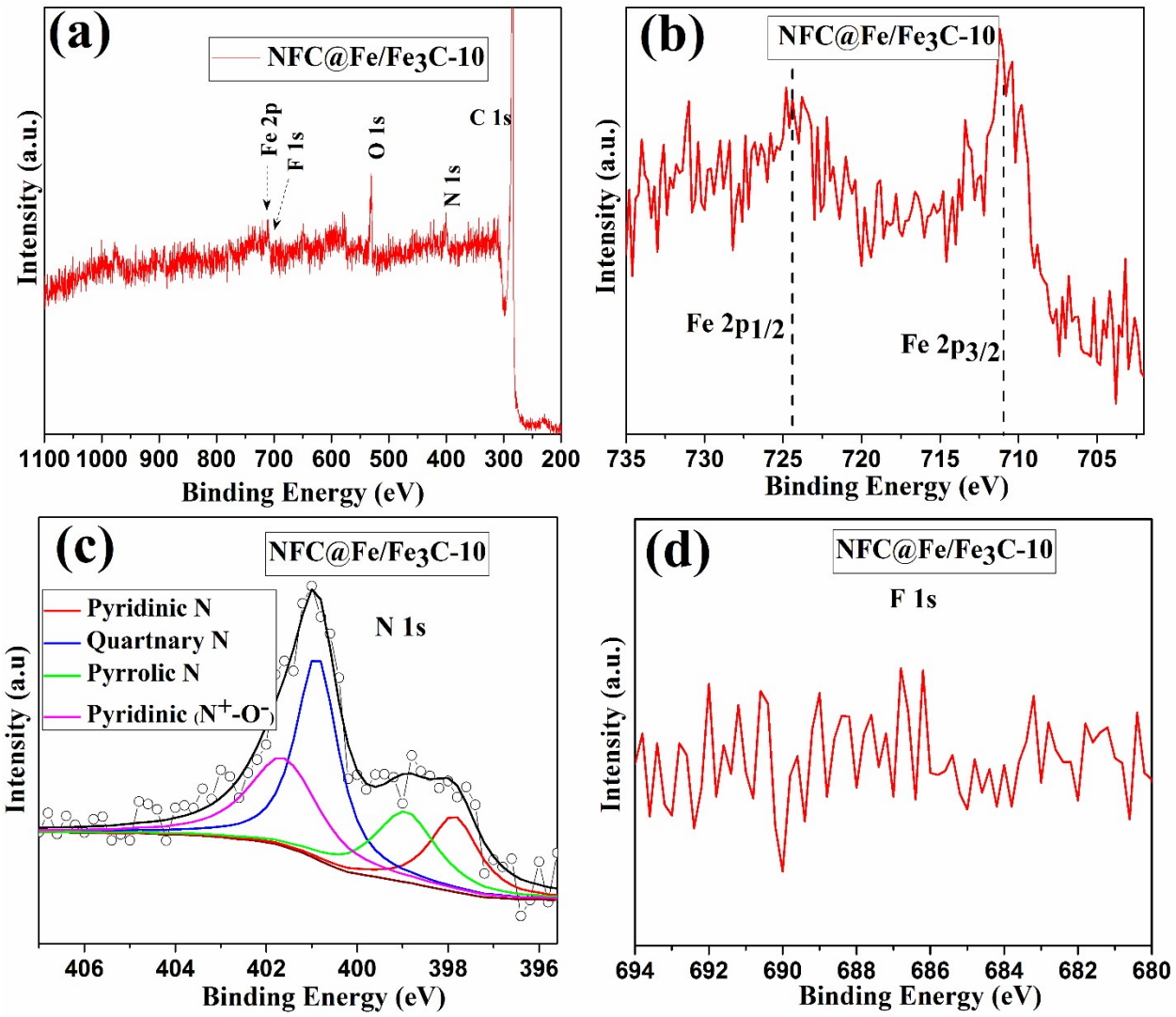

Fig. S10. The XPS survey and N 1s, F 1s, Fe 2p spectrum of NFC@Fe/Fe_3C-10.

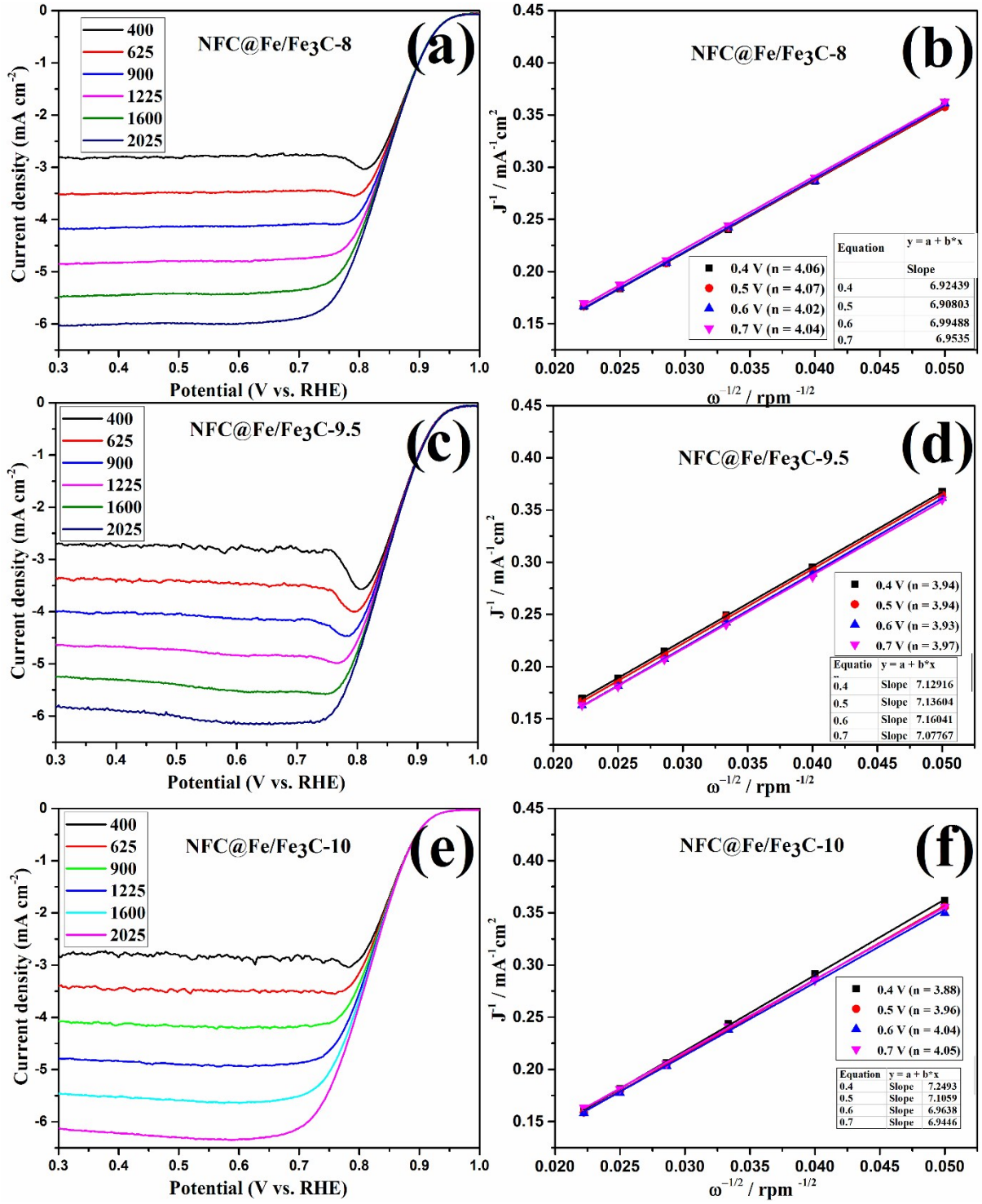

Fig. S11. LSV curves of (a) NFC@Fe/Fe_3C-8, (c) NFC@Fe/Fe_3C-9.5 and (e) NFC@Fe/Fe_3C-10 recorded at different rotating speeds in 0.1 KOH with sacn rate of 10 mV s^{-1} and corresponding K-L plots in Fig. S11 (b, d, f), respectivley.

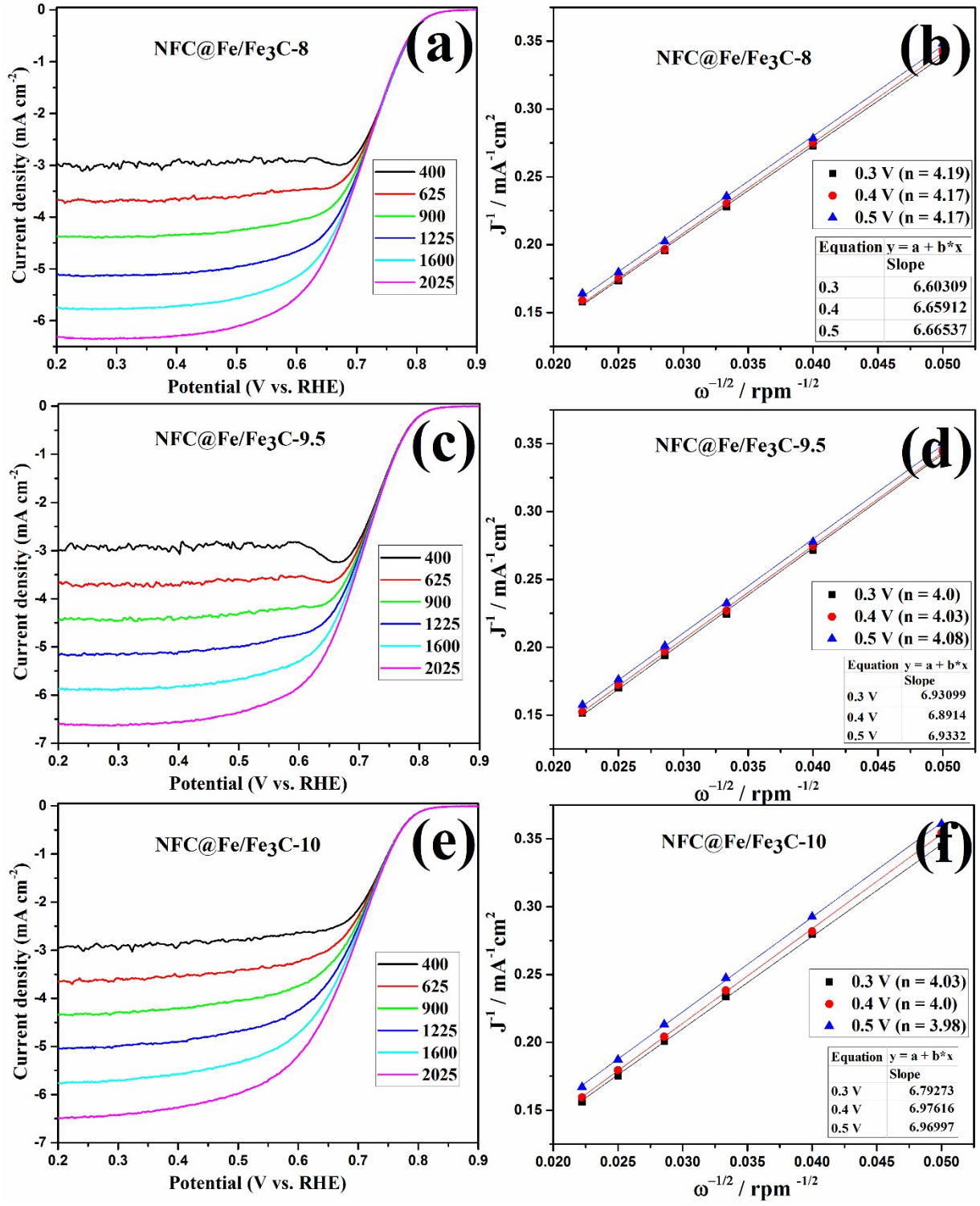

Fig. S12. LSV curves of (a) NFC@Fe/Fe_3C-8, (c) NFC@Fe/Fe_3C-9.5 and (e) NFC@Fe/Fe_3C-10 recorded at different rotating speeds in 0.1 $HClO_4$ with sacn rate of 10 mV s^{-1} and corresponding K-L plots in Fig. S11 (b, d, f), respectivley.

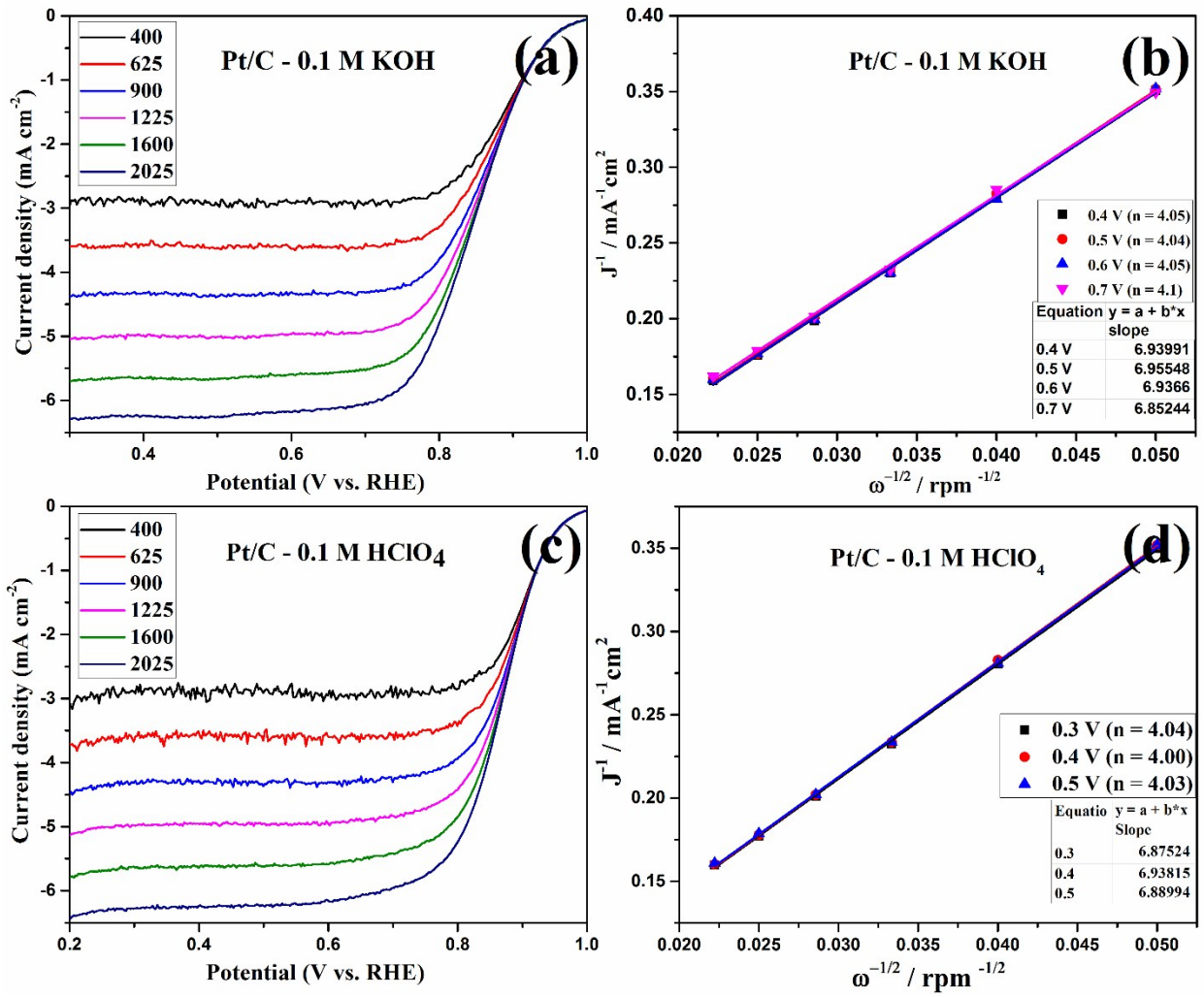

Fig. S13. LSV curves of Pt/C recorded in (a) 0.1 M KOH and (c) 0.1 M $HClO_4$ at different rotating speeds with sacn rate of 10 mV s^{-1} and K-L plots of Pt/C in (b) 0.1 M KOH and (d) 0.1 M $HClO_4$ electrolyte.

Table S1. A comparison of ORR performance of NFC@Fe/Fe_3C-9 electrocatalyst with other Fe-based electrocatalyst reported in alkaline medium.

S.No.	Catalyst	Onset potential (V vs. RHE)	$E_{1/2}$ (V vs. RHE)	Limiting current density at 0.3 V (j_d, mA cm^{-2})	Reference
1.	Fe/N/C	0.94	0.74	4.0	[1]
2.	Fe-Nx/C	0.9	0.79	5.1	[2]
3.	Fe/Co-NPGr	0.93	0.81	4.0	[3]
4.	Fe-N-C-800-acid	0.93	0.75	4.5	[4]
5.	Fe/C/N	0.94	0.83	5.0	[5]
6.	Fe-N-Graphene	1.01	0.81	10.0	[6]
7.	FeN_4/GN-2.7	0.95	0.85	3.8	[7]
8.	P12-900	1.016	0.86	7.0	[8]
9.	FeNC-20-1000	1.04	0.88	5.6	[9]
10.	Fe-N-CIG	0.95	0.84	5.6	[10]
11.	NFC@Fe/Fe_3C-9	0.991	0.87	5.47	This work

Table S2. A comparison of ORR performance NFC@Fe/Fe_3C-9 electrocatalyst with Fe-based electrocatalyst reported in acidic medium.

S.No.	Catalyst	Onset potential (V vs. RHE)	$E_{1/2}$ (V vs. RHE)	Limiting current density at 0.3 V (j_d, mA cm^{-2})	Reference
1.	PpPD-Fe-C	0.82	0.72	3.5	[11]
2.	Fe-N_x/rGO	0.8	0.56	3.5	[12]
3.	FeN/C-PANI	0.84	0.62	5.5	[13]
4.	Fe-N-C-700	0.82	0.65	3.5	[14]
5.	$(FeSO_4\text{-}PEI)_{LH}$	0.79	0.68	4.0	[15]
6.	Fe-PANI-PAN	0.90	0.70	5.1	[16]
7.	Fe-N-C-750	0.90	0.75	4.0	[17]
8.	Fe/N/C (2.0 wt.% Fe)	0.80	0.57	4.2	[18]
9.	5% Fe-N/C	0.86	0.73	5.1	[19]
10.	Fe-N-CC	0.80	0.52	3.0	[20]
11.	NFC@Fe/Fe_3C-9	0.991	0.73	5.7	This work

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