Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Heteroatom-Doped Carbon Electrocatalysts Prepared from Marine Biomass Cellulose Nanocrystals and Bio-inspired Polydopamine for Oxygen Reduction Reaction

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Supplementary information

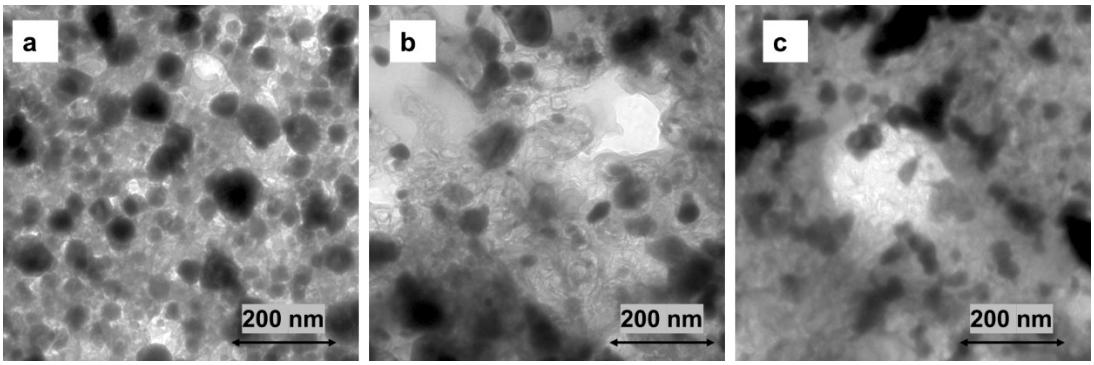


Figure S1: TEM images (cross-section) of pyrolyzed celluloseA-PDA-PEI-Fe (a), pyrolyzed celluloseB-PDA-PEI-Fe (b), and pyrolyzed celluloseC-PDA-PEI-Fe (c) respectively.

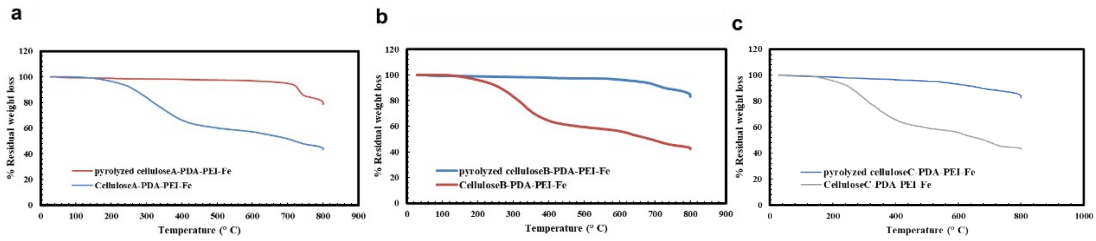


Figure S2: TG-DTA curves of (a) CelluloseA-PDA-PEI-Fe and pyrolyzed celluloseA-PDA-PEI-Fe, (b) CelluloseB-PDA-PEI-Fe and pyrolyzed celluloseB-PDA-PEI-Fe, and (c) CelluloseC-PDA-PEI-Fe and pyrolyzed celluloseC-PDA-PEI-Fe respectively.

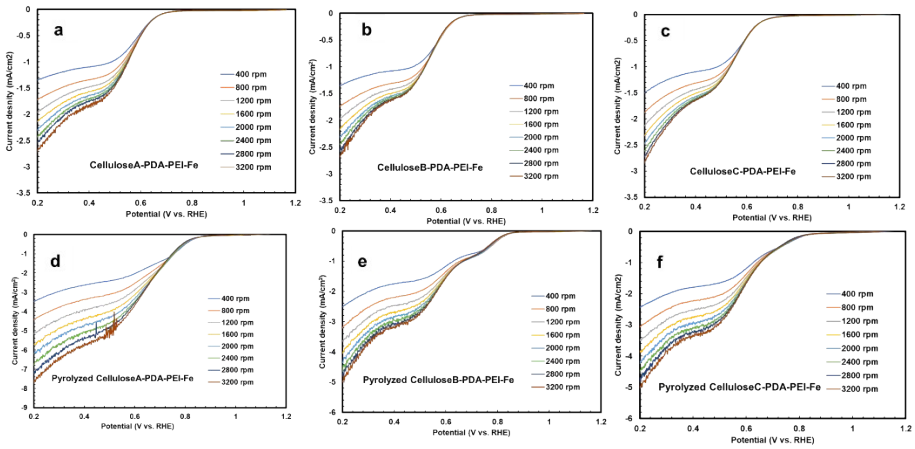


Figure S3: LSV curves of celluloseA-PDA-PEI-Fe (a), celluloseB-PDA-PEI-Fe (b), celluloseC-PDA-PEI-Fe (c), pyrolyzed celluloseA-PDA-PEI-Fe (d), pyrolyzed celluloseB-PDA-PEI-Fe (e), and pyrolyzed celluloseC-PDA-PEI-Fe (f) respectively at 400 rpm to 3200 rpm in O_2-saturated 0.1 M KOH.

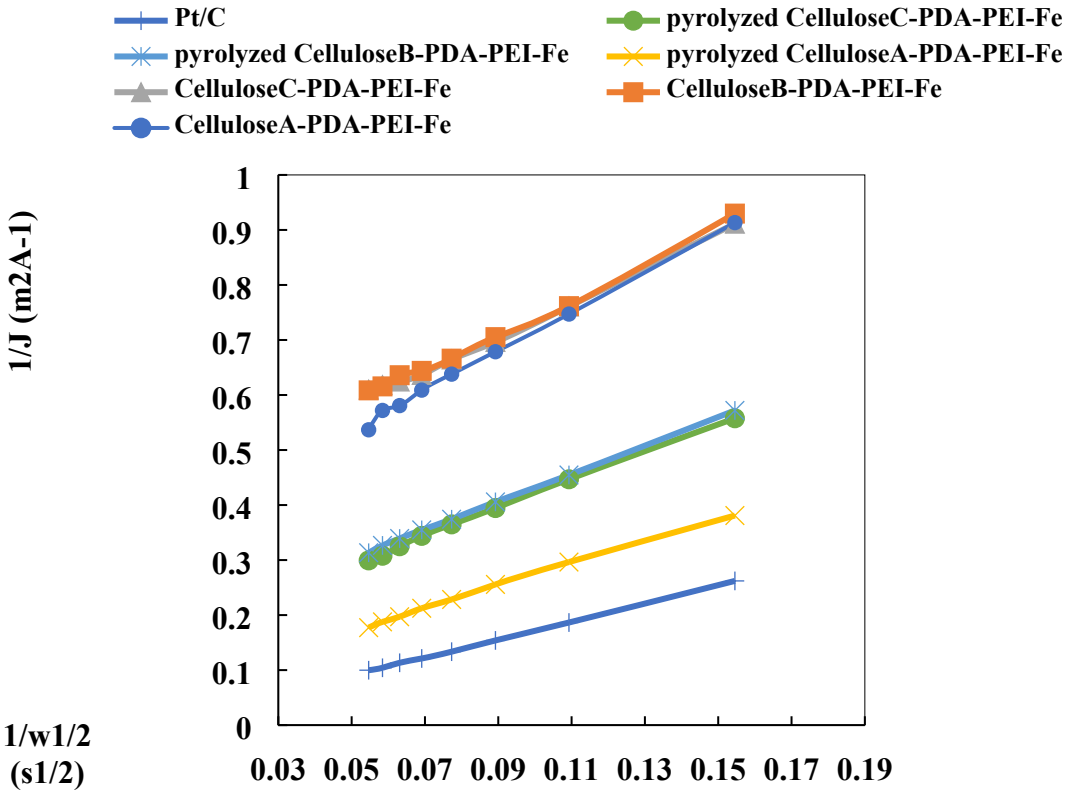


Figure S4: K-L plots derived from S1 plots.

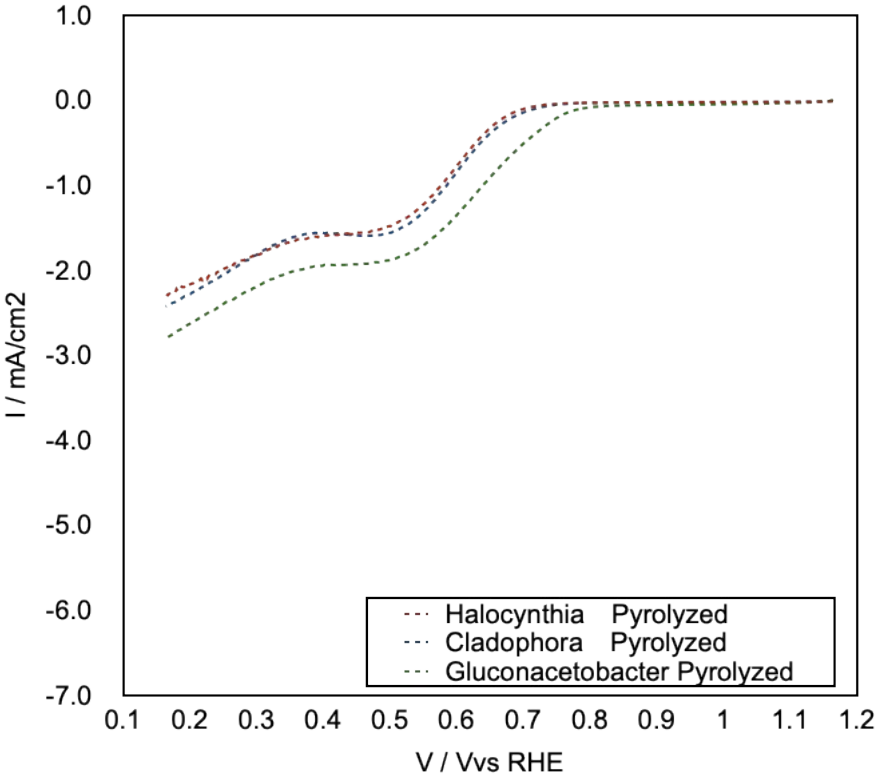


Figure S5: LSV curves of pyrolyzed CNCs at 1,600 rpm in O_2-saturated 0.1 M KOH.

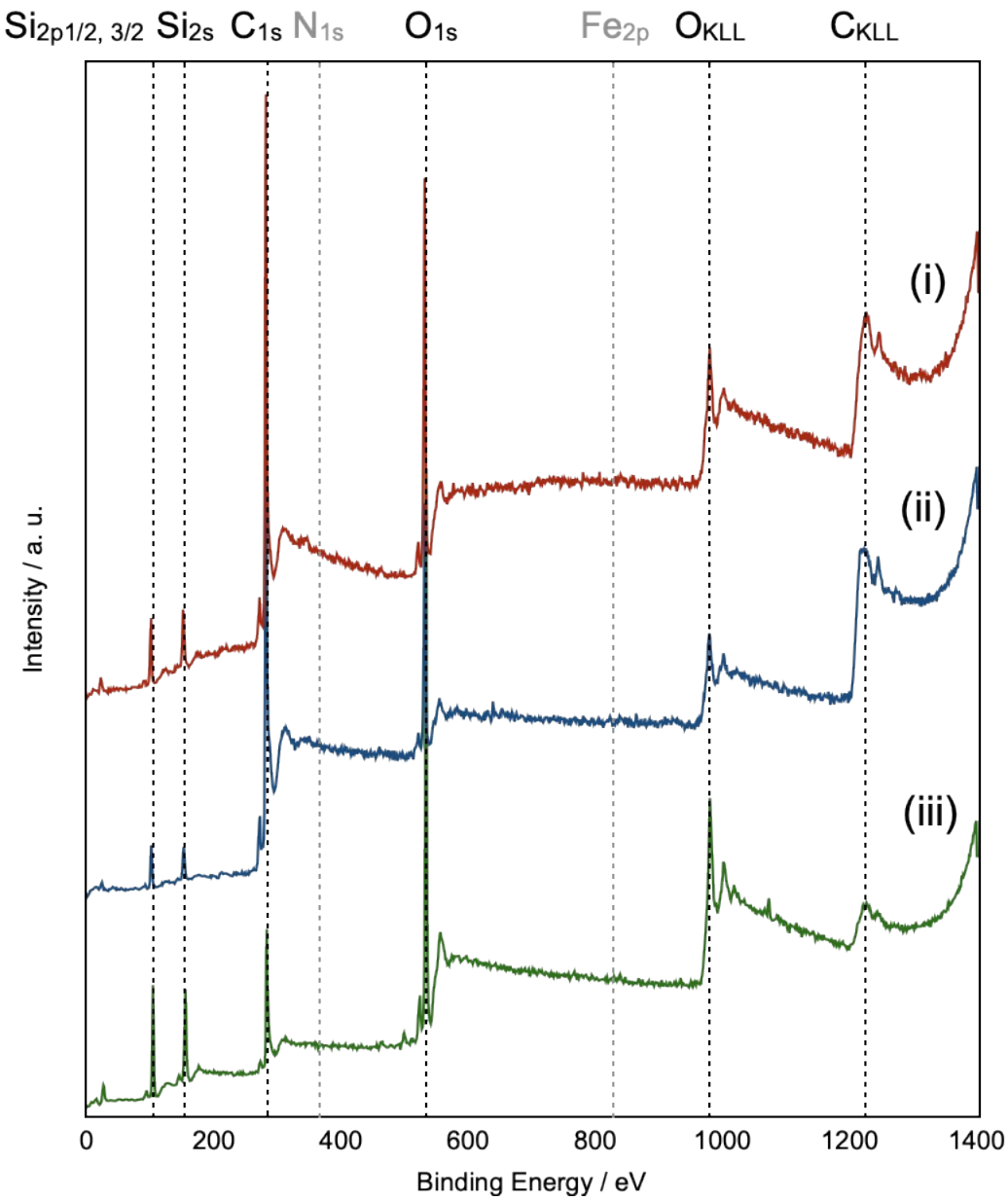
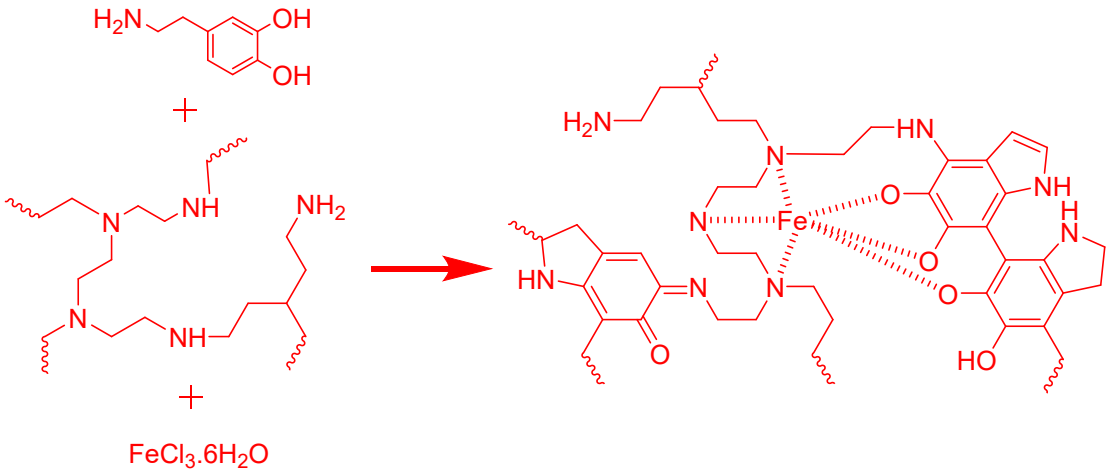


Figure S6. Wide scan XPS spectra of pyrolyzed CNCs obtained from Halocynthia (i), Cladophora (ii) and Gluconacetobacter (iii), respectively. No peak attributed to N and Fe was found and there are clear peaks attributed to carbon and Si, O peaks from the substrate.

Scheme S1: Reaction scheme for PDA-PEI-Fe coating.



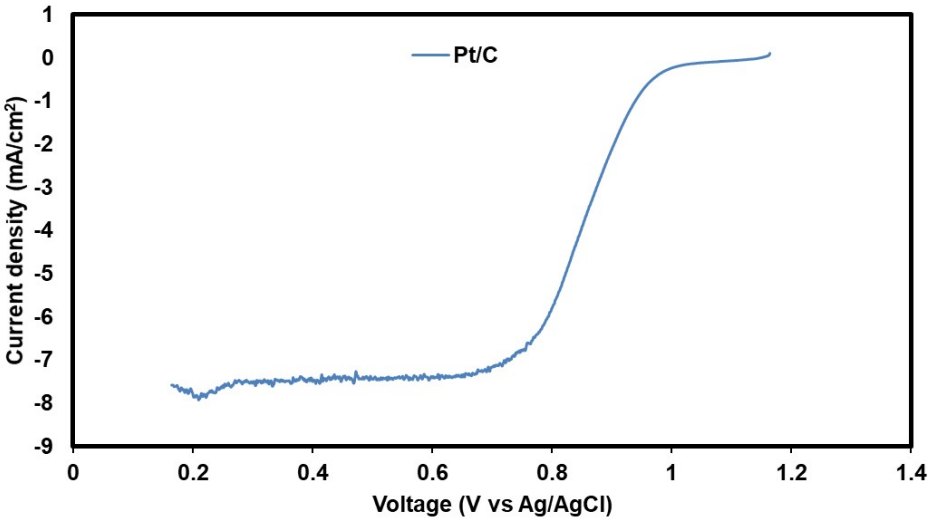


Figure S7: LSV curves of Pt/C at 1,600 rpm in O_2-saturated 0.1 M KOH.

Table S1: Comparison of electrochemical performance with previous heteroatom doped carbon catalysts in literature.

S. No.	Sample	Literature	*V onset*	*I max*	*n*
1	Calcined PDA-PEI-Fe	20	0.914	3.4	3.2
2	pS-PDA	26	0.863	5.6	3.2
3	pS-HPDA	26	0.903	6.1	3.6
4	NBSCP	30	1.01	5	-
5	ANDC-900-10	31	0.84	5.5	-

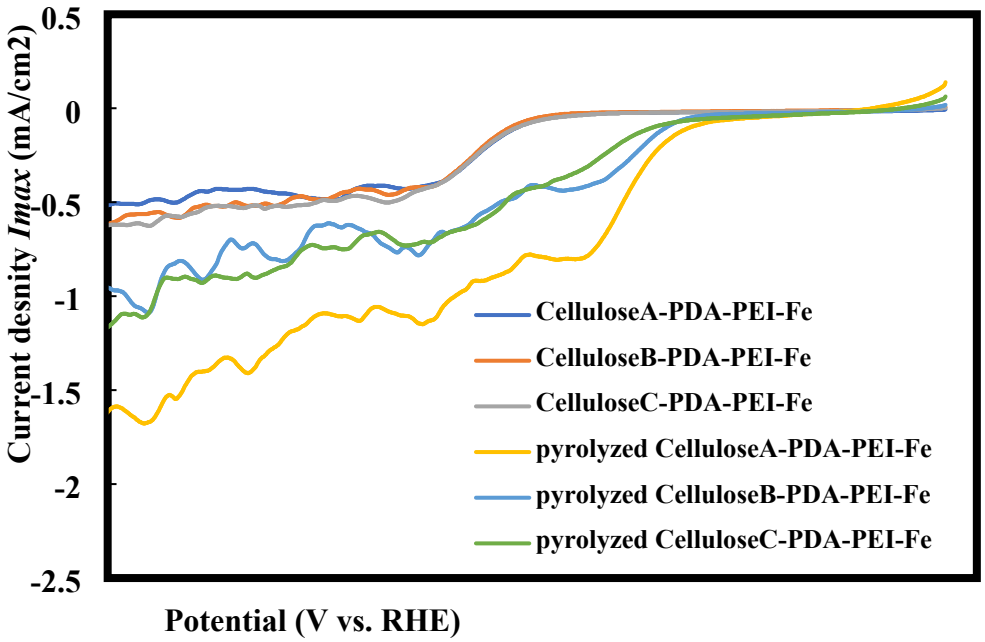


Figure S8: LSV curves of pyrolyzed and non-pyrolyzed samples at 0 rpm in O_2-saturated 0.1 M KOH.

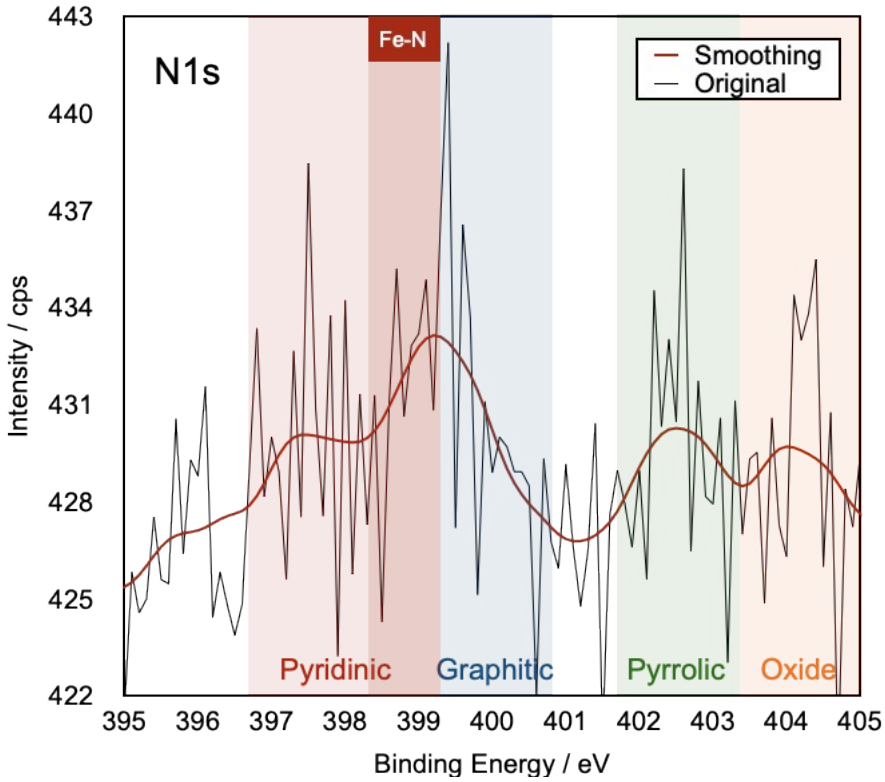


Figure S9. High resolution narrow scan original and smoothing XPS spectra of N1s of pyrolyzed CNC-A after PDA-PEI-Fe coating. From the smoothing spectrum, peaks attributed to pyridinic, graphitic, pyrrolic and oxide nitrogen were observed, and there is strong peak attributed to Fe-N pyridinic nitrogen clearly existed at 399 eV. Note that the peak was overlapped both with pyridinic and graphitic nitrogen.

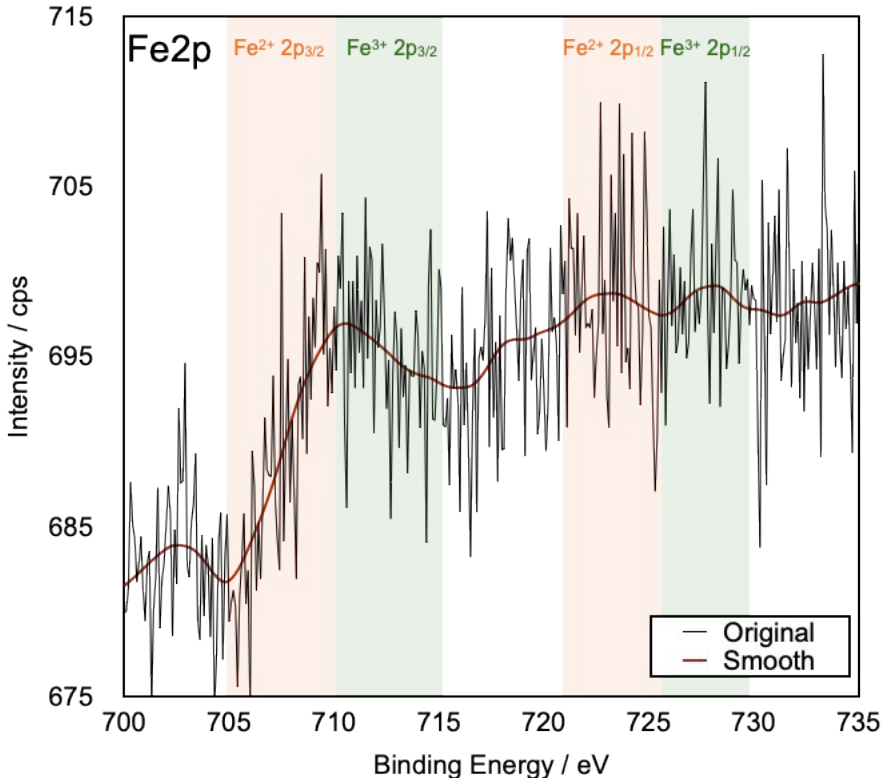


Figure S10. High resolution narrow scan original and smoothing XPS spectra of Fe2p of pyrolyzed CNC-A after PDA-PEI-Fe coating. From the smoothing spectrum, peaks attributed to Fe^{2+} $2p_{3/2}$, $Fe^{3+}2p_{3/2}$, Fe^{2+} $2p_{1/2}$, and $Fe^{3+}2p_{1/2}$ were clearly found.

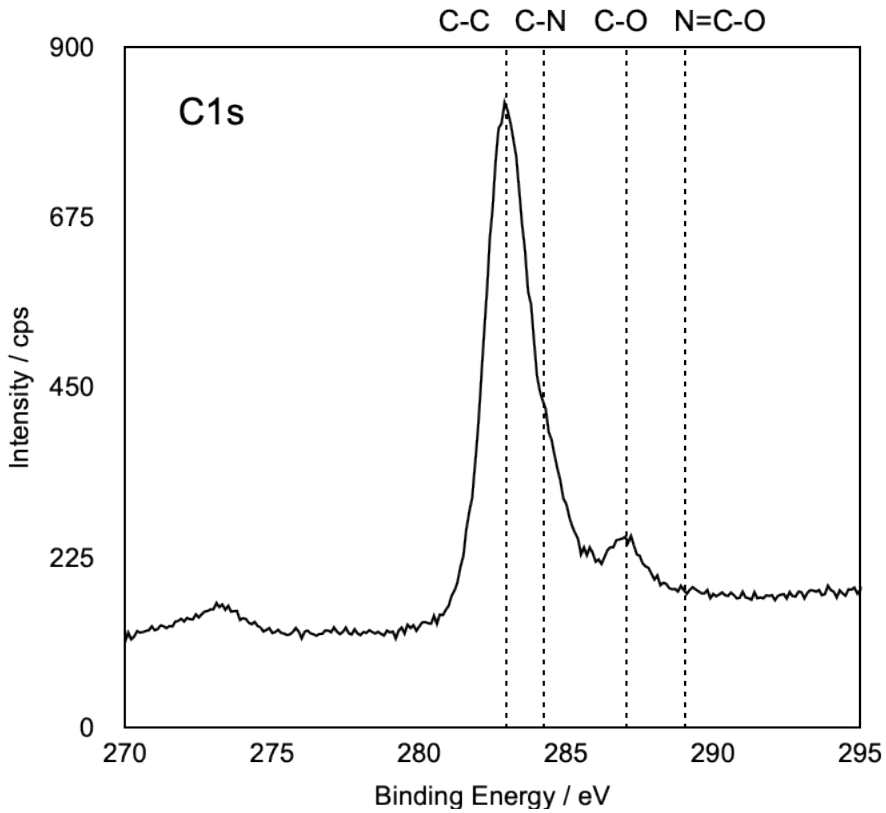


Figure S11. High resolution narrow scan XPS spectra of C1s of pyrolyzed CNC-A after PDA-PEI-Fe coating. Clear C-C and C-O peaks found and C-N peak was found as a shoulder of the C-C peak, which indicated that formation of nitorogen doped carbon. There was no clear C=N-O peak found.