Supplementary information

# Hybrids of reduced graphene oxide aerogel and CNT for electrochemical $O_2$ reduction

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Figure S1. Autoclave used for the preparation of aerogels

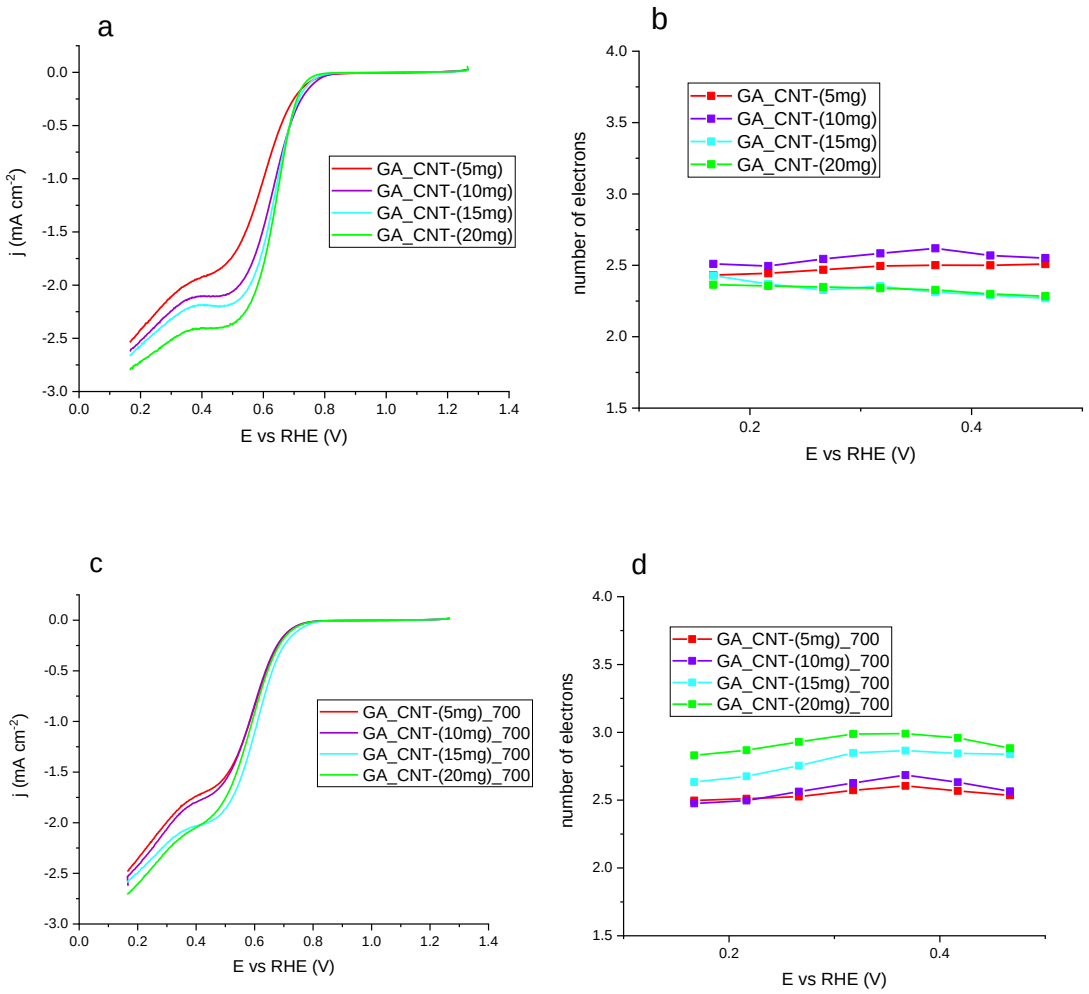


Figure S2. LSV polarization curves (a,c) and number of electrons exchanged of GA-CNT hybrids with different amounts of CNT before as sinthesised (a,b) and after pyrolizing at 700 ℃ (c,d).

Figure S3. Digital photograph of graphene aerogel (GA) at the left and hybrid GA-CNT at the right

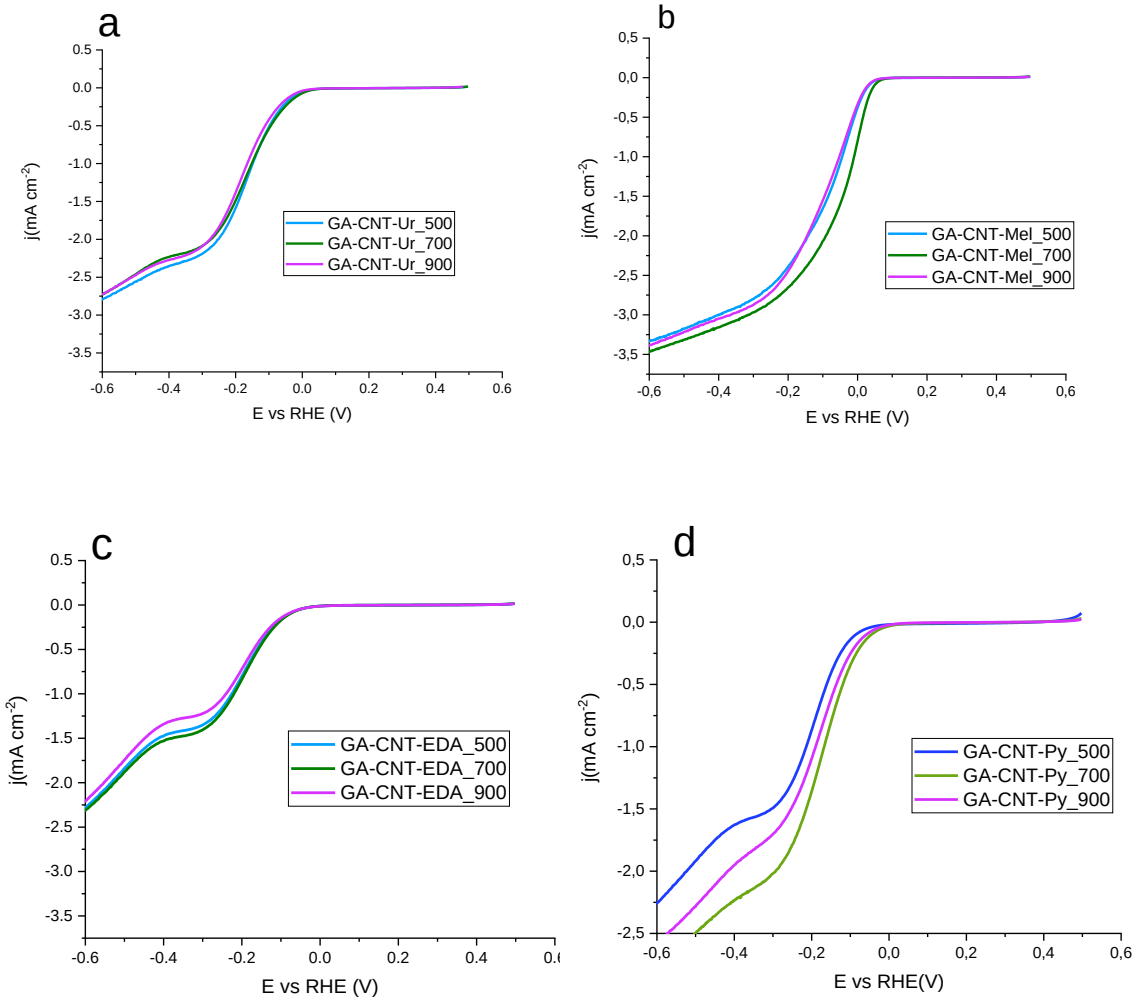


Figure S4. LSV curves for GA-CNT hybrids doped with different N-doping precursors and pyrolised at three different temperatures 500, 700 and 900 ℃: (a) Urea precursor; (b) melamine precursor; (c) Ethylene diamine precursor; (d) Pyrrol precursor.


Figure S5. Digital photograph of GA-CNT aerogels with ethylendiamine

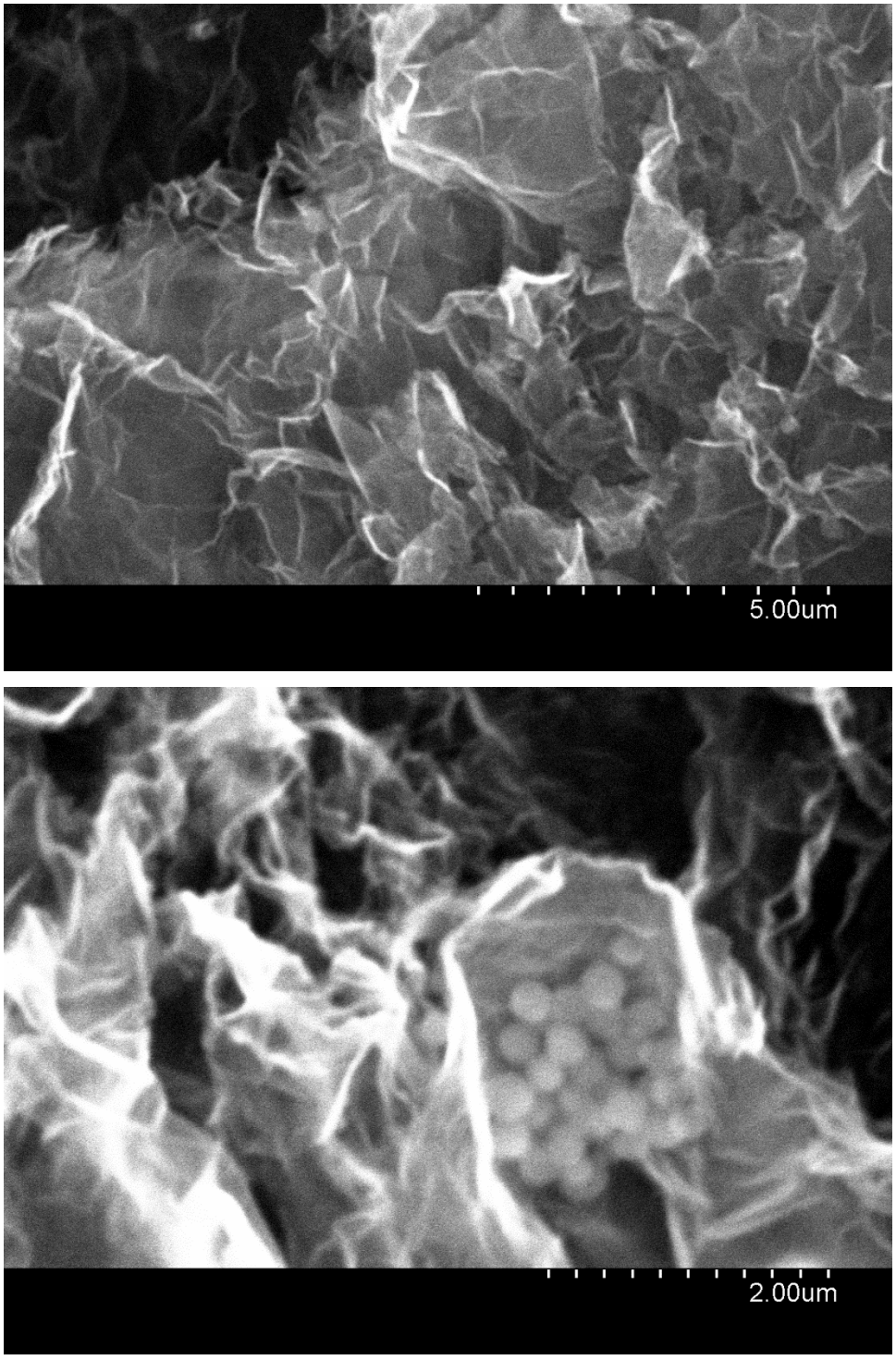


Figure S6. Representative SEM image of GA-CNT-Py_700

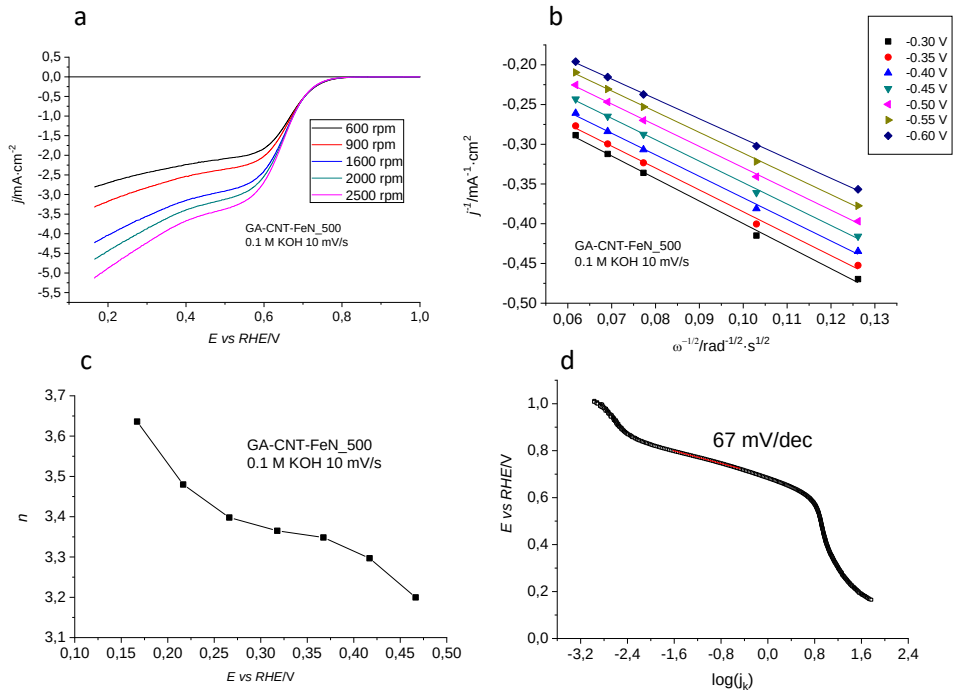


Figure S7. ORR electrochemical results for GA-CNT-FeN_500 CNT using RDE: (a) linear sweept voltametry at different rotating speeds; (b) Koutecky–Levich plots; (c) number of electrons transferred; (d) Tafel plot

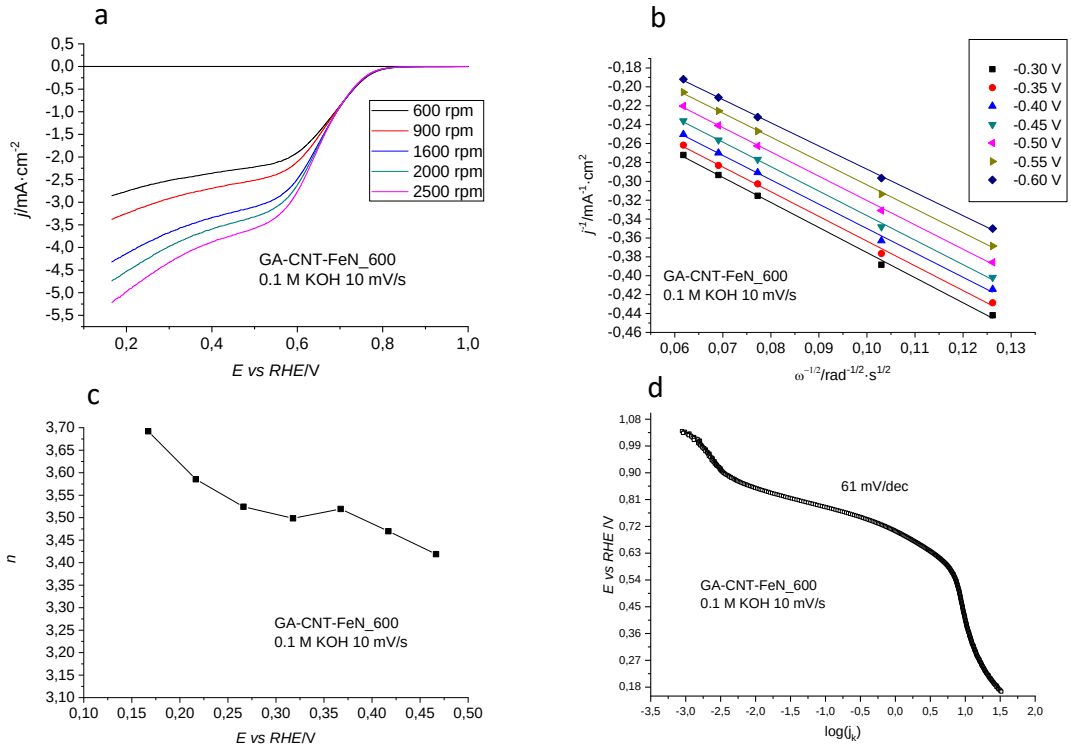


Figure S8. ORR electrochemical results for GA-CNT-FeN_600 CNT using RDE: (a) linear sweept voltametry at different rotating speeds; (b) Koutecky–Levich plots; (c) number of electrons transferred; (d) Tafel plot

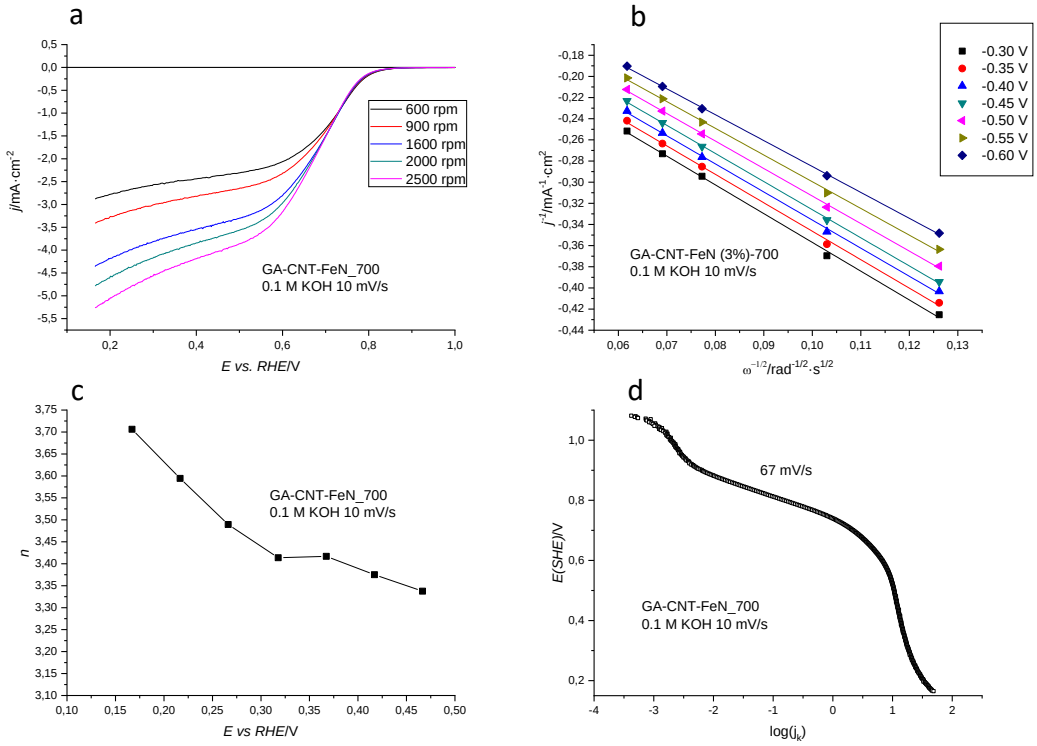


Figure S9. ORR electrochemical results for GA-CNT-FeN_700 CNT using RDE: (a) linear sweept voltametry at different rotating speeds; (b) Koutecky–Levich plots; (c) number of electrons transferred; (d) Tafel plot

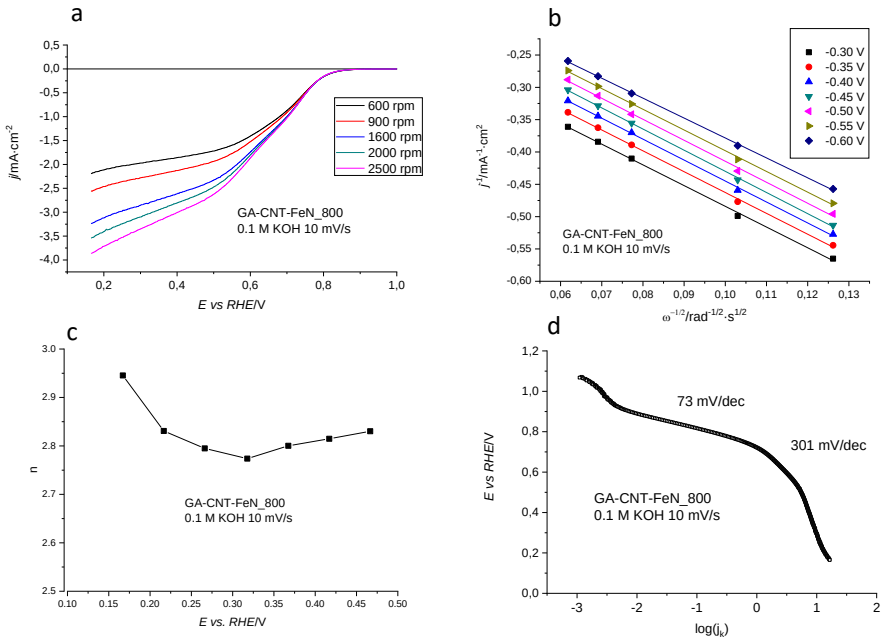


Figure S10. ORR electrochemical results for GA-CNT-FeN_800 CNT using RDE: (a) linear sweept voltametry at different rotating speeds; (b) Koutecky–Levich plots; (c) number of electrons transferred; (d) Tafel plot

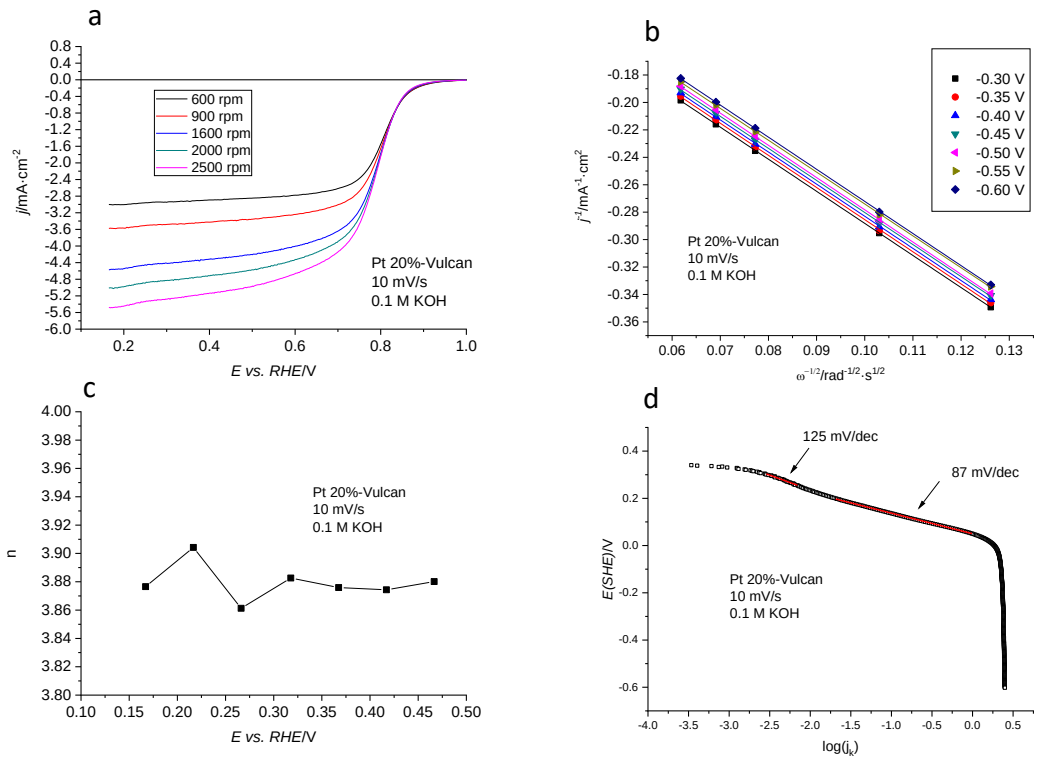


Figure S11. ORR electrochemical results for Pt 20%-Vulcan using RDE: (a) linear sweept voltametry at different rotating speeds; (b) Koutecky–Levich plots; (c) number of electrons transferred; (d) Tafel plot

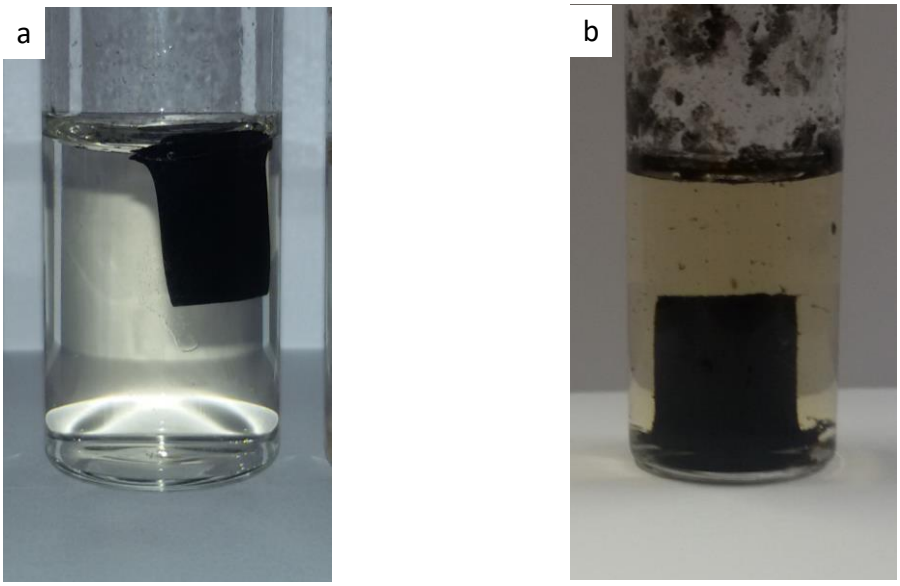


**Figure S12**. Hydrogel after hydrothermal synthesis: (a) in the absence of Fe phenanthroline and (b) in the presence of Fe phenanthroline

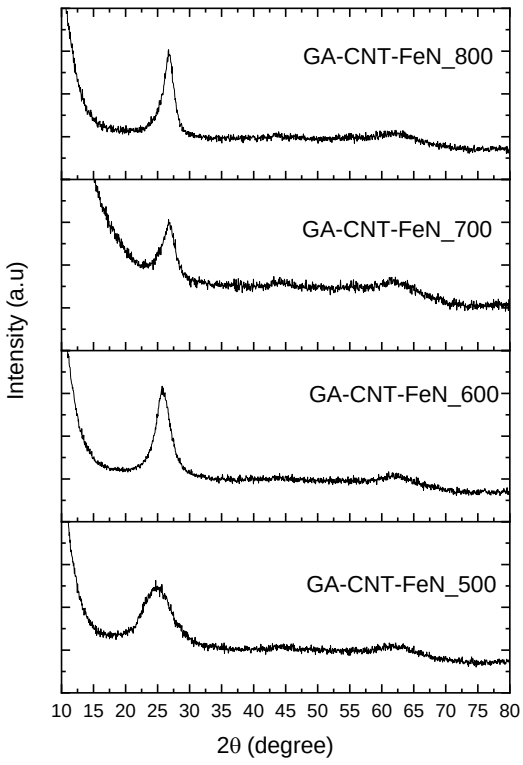


**Figure S13.** XRD of the composites with Fe

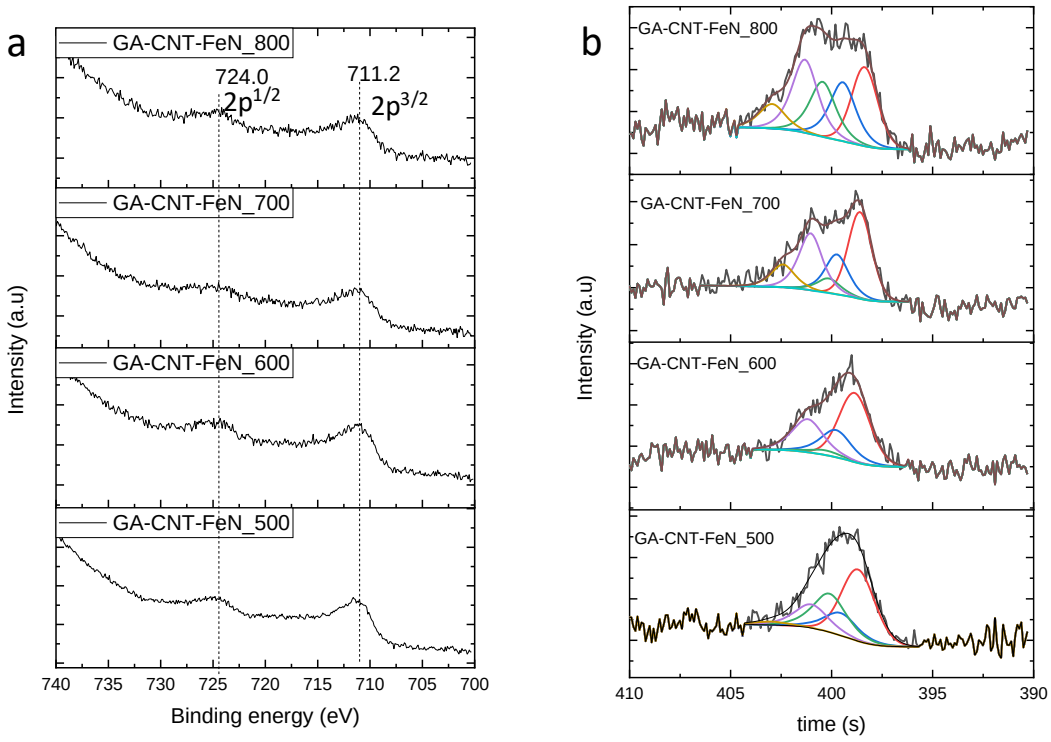


**Figure S14**. XPS spectra of Fe 2p and 1 deconvolution of the N1s XPS core level spectra

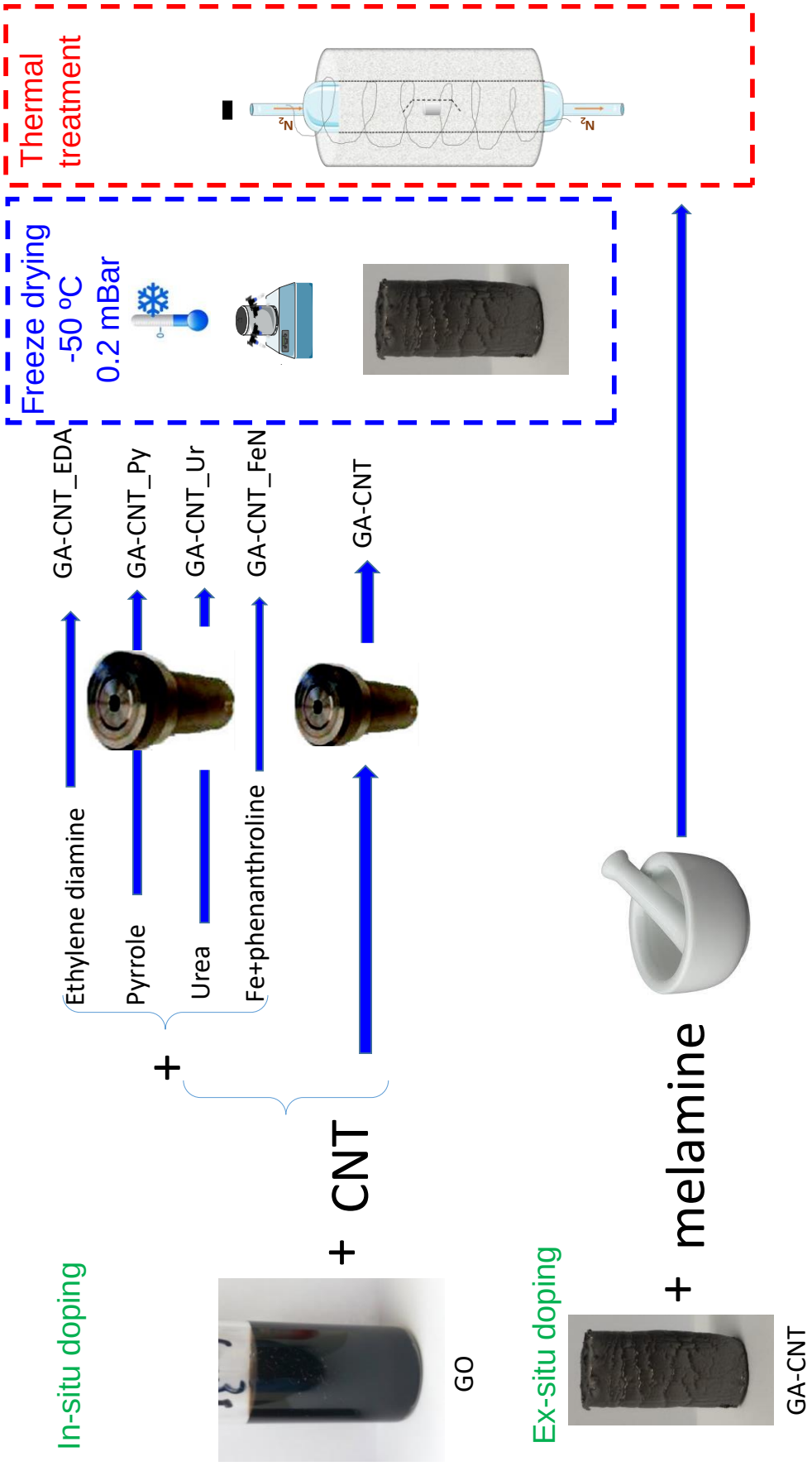


**Figure S15**. Scheme of the preparation of the different electrocatalysts

**Table S1. Graphene aerogel-CNT hybrid doped with nitrogen and metal**

| sample | Treatment temperature ℃ | Onset potential V | Limiting current, $j_k$ ($mA/cm^2$) | Number of electrons | Tafel slope (mV/dec) |
|---|---|---|---|---|---|
| 20%Pt/vulcanXC-72 | - | 0.96 | -23.19 | 3.9 | 87 |
| GA-CNT-FeN | 500 | 0.80 | -16.1 | 3.6 | 67 |
| GA-CNT-FeN | 600 | 0.83 | -16.0 | 3.7 | 61 |
| GA-CNT-FeN | 700 | 0.86 | -18.9 | 3.7 | 67 |
| GA-CNT-FeN | 800 | 0.86 | -11.2 | 2.9 | 73 |

## References


[1] R. Hudson, A. Rivière, C.M. Cirtiu, K.L. Luska, A. Moores, Iron-iron oxide core–shell nanoparticles are active and magnetically recyclable olefin and alkyne hydrogenation catalysts in protic and aqueous media, Chem. Commun. 48 (2012) 3360–3362. https://doi.org/10.1039/C2CC16438H.

[2] F.A. Westerhaus, R.V. Jagadeesh, G. Wienhöfer, M.-M. Pohl, J. Radnik, A.-E. Surkus, J. Rabeah, K. Junge, H. Junge, M. Nielsen, A. Brückner, M. Beller, Heterogenized cobalt oxide catalysts for nitroarene reduction by pyrolysis of molecularly defined complexes, Nat. Chem. 5 (2013) 537–543. https://doi.org/10.1038/nchem.1645.