Electronic Supplementary Information (ESI)

Graphene Quantum Dot/Phthaocyanine Conjugate:

A Synergistic Catalyst for the Oxygen Reduction Reaction

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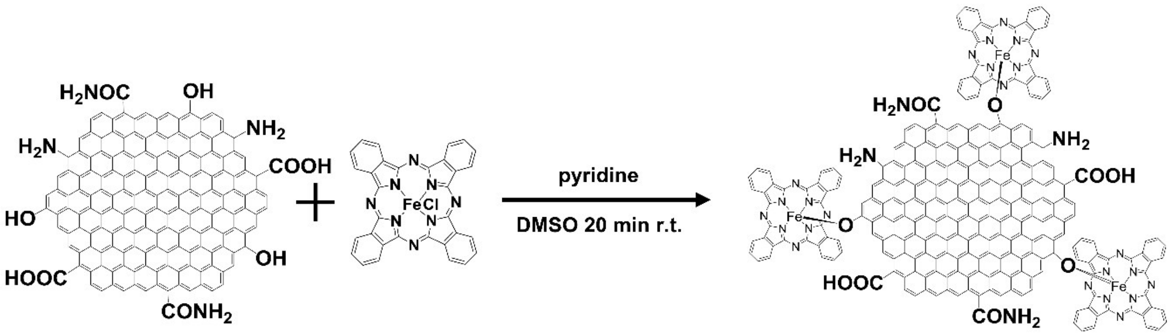

Fig. S1 A schematic conjugation process of GQD and FePC.

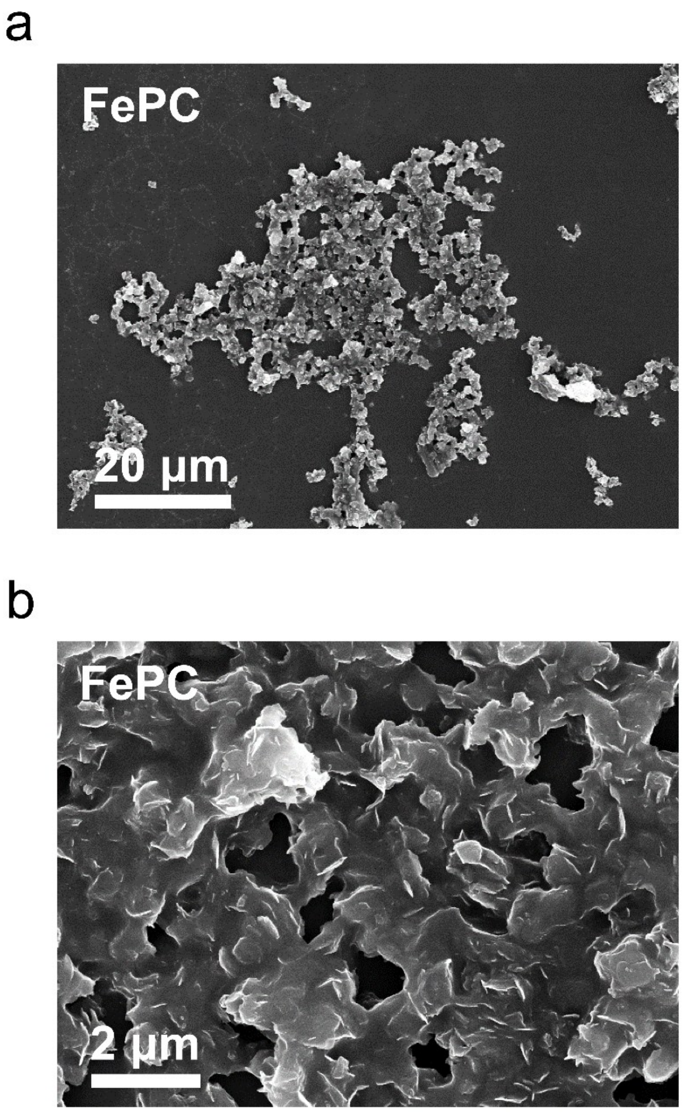

Fig. S2 SEM images of a) FePC and b) magnified FePC

Table S1. Comparison of performance values for this work with other previously reported works. The onset potential values have been rescaled to V vs RHE in 0.1M KOH.

Sample	Onset potential (V)	Electron transfer number (n)	Reference
GQD-FePC	0.88	3.77	This work
Carboxyl acid/sulfonic acid functionalized graphene	0.81	2.2-3.8	1
Edge-selectively sulfurized graphene nanoplatelets	0.75	3.3	2
PDDA-Graphene	0.86	3.5-4	3
PDDA-ACNT	0.89	3.72	4
Cu/GQD	0.85	3.64	5
Plasma-treated Graphene	0.87	3.85	6

Table S2. Comparison of stability values for this work with other previously reported works. Current-time (i-t) chronoamperometric responses in O2-saturated KOH electrolytes.

Sample	**Time (s)**	**Relative current (%)**	**Reference**
GQD-FePC	17,000	90.6	This work
Fe3C@N-CNT	15,000	94.0	7
Graphene-FePC	10,000	84.0	8
FePC covalently functionalized Graphene	10,000	83.5	9
S-doped graphene	30,000	73.0	10
N, S-co doped 3D graphene frameworks	20,000	85.2	11
$Co/CoO/CoFe_2O_4/G$	20,000	80.0	12

Supporting References

1. I-Y. Jeon, H-J. Choi, S-M. Jung, J-M. Seo, M-J. Kim, L. Dai, J-B. Baek, *Journal of the American Chemical Society,* **2013,** 135, 1386-1393.

2. I-Y Jeon, S. Zhang, L. Zhang, H-J. Choi, J-M. Seo, Z. Xia, L. Dai, J-B. Baek, *Advanced Materials,* **2013,** 25, 6138-6145.

3. S. Wang, D. Yu, L. Dai, D. W. Chang, J-B. Baek, *ACS Nano,* **2011,** 5, 6202-6209.

4. D. Yu, Q. Zhang, L. Dai, *Journal of the American Chemical Society,* **2011,**133, 5282-5185.

5. K. Liu, Y. Song, S. Chen*, International Journal of Hydrogen Energy,* **2016,** 41, 1559-1567.

6. L. Tao, Q. Wang, S. Dou, Z. Ma, J. Huo, S. Wang, L. Dai, *Chemical Communications,* **2016,** 52, 2764-2767.

7. B. Y. Guan, L. Yu, X. W. Lou, *Energy and Environmental Science*, **2016**, 9, 3092-3096

8. Y. Jiang, Y. Lu, X. Lv, D. Han, Q. Zhang, L. Niu, W. Chen, *ACS Catalysis*, **2013**, 3, 1263−1271

9. Y. Liu, Y-Y. Wu, G-J. Lv, T. Pu, X-Q. He, L-L. Cui, *Electrochimica Acta*, **2013**, 112, 269-278

10. S. Yang, L. Zhi, K. Tang, X. Feng, J. Maier, K. Mullen*, Advanced Functional Materials*, **2012**, 22, 3634-3640

11. Y. Su, Y. Zhang, X. Zhuang, S. Li, D. Wu, F. Zhang, X. Feng, *Carbon*, **2013**, 62, 296-301

12. R. Huo, W-J. Jiang, S. Xu, F. Zhang, J-S. Hu, *Nanoscale*, **2014**, 6, 203-206