

Novel Cost-effective Synthesis of Non-doped Turbostratic Graphene from Graphite
Intercalation compound: Development of a Durable and Stable Electrocatalyst for
Oxygen Reduction Reaction

Vijayasree Haridas¹, Zahira Yaakob², Sankaran Sugunan², Binitha N. Narayanan^{1,*}

¹Department of Chemistry, Sree Neelakanta Government Sanskrit College

Pattambi, Palakkad-679306, Kerala, India

Ph: +91 466-2212223. Fax: +91-466-2212223, *binithann@yahoo.co.in

² Department of Chemical and Process Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, UKM Bangi 43600, Selangore, Malaysia

³Department of Applied Chemistry, Cochin University of Science and Technology,

Cochin 22, Kerala, India

Table S1. Performance of various graphene-modified electrodes in the oxygen reduction reaction.

Sl.No	Catalyst	Current density (mAcm ⁻²)	Onset potential (V)	Half-wave potential (V)	Ref
1	S1N6C900*	4.86	0.95	0.83	1
2.	N-graphene (900) ⁺	-	0.308 vs SHE	0.43	2
3.	N, S-doped graphene [@]	-3.49 to 4.17	0.87	-	3
4.	NrGO [#]	2.5	1.1	0.84	4

5.	NG [§]	-	-0.10 vs Ag/AgCl	-	5
6.	NG-C ^{&}	-3.3	0	-	6
7.	g-C ₃ N ₄ @GO	5.98	0.98	0.859	7
8.	Fe ₃ O ₄ /N-Gas ^{**}	-2.56	-0.19 vs Ag/AgCl	-	8
9.	Turbostratic graphene	-6.45	0.92	0.80	This work

^{*}S, N dual-doped Graphene liked carbon nanosheet, + N-graphene (900), @N,S-doped graphene Co/N₃S₃-GF and Mn/N₃S₃-GF, [#]Nitrogen-doped reduced-graphene oxide, [§]Nitrogen-doped graphene, [&]N-doped graphene from citric acid, ^{**}Three-dimensional (3D) N-doped graphene aerogel (N-GA)-supported Fe₃O₄ nanoparticles.

References

- (1) Li, J.; Zhang, Y.; Zhang, X.; Huang, J.; Han, J.; Zhang, Z.; Han, X.; Xu, P.; Song, B. S. N Dual-Doped Graphene-like Carbon Nanosheets as Efficient Oxygen Reduction Reaction Electrocatalysts. *ACS Appl. Mater. Interfaces* **2017**, *9* (1), 398–405. <https://doi.org/10.1021/acsami.6b12547>.
- (2) Geng, D.; Chen, Y.; Chen, Y.; Li, Y.; Li, R.; Sun, X.; Ye, S.; Knights, S. High Oxygen-Reduction Activity and Durability of Nitrogen-Doped Graphene. *Energy Environ. Sci.* **2011**, *4* (3), 760–764. <https://doi.org/10.1039/C0EE00326C>.
- (3) Fernandes, D. M.; Mathumba, P.; Fernandes, A. J. S.; Iwuoha, E. I.; Freire, C. Towards Efficient Oxygen Reduction Reaction Electrocatalysts through Graphene Doping. *Electrochimica Acta* **2019**, *319*, 72–81. <https://doi.org/10.1016/j.electacta.2019.06.175>.
- (4) Dumont, J. H.; Martinez, U.; Artyushkova, K.; Purdy, G. M.; Dattelbaum, A. M.; Zelenay, P.; Mohite, A.; Atanassov, P.; Gupta, G. Nitrogen-Doped Graphene Oxide Electrocatalysts for the Oxygen Reduction Reaction. *ACS Appl. Nano Mater.* **2019**, *2* (3), 1675–1682. <https://doi.org/10.1021/acsanm.8b02235>.
- (5) Lin, Z.; Waller, G.; Liu, Y.; Liu, M.; Wong, C.-P. Facile Synthesis of Nitrogen-Doped Graphene via Pyrolysis of Graphene Oxide and Urea, and Its Electrocatalytic Activity toward the Oxygen-Reduction Reaction. *Adv. Energy Mater.* **2012**, *2* (7), 884–888. <https://doi.org/10.1002/aenm.201200038>.

- (6) Liao, Y.; Gao, Y.; Zhu, S.; Zheng, J.; Chen, Z.; Yin, C.; Lou, X.; Zhang, D. Facile Fabrication of N-Doped Graphene as Efficient Electrocatalyst for Oxygen Reduction Reaction. *ACS Appl. Mater. Interfaces* **2015**, *7* (35), 19619–19625. <https://doi.org/10.1021/acsami.5b05649>.
- (7) Xiang, Q.; Liu, Y.; Zou, X.; Hu, B.; Qiang, Y.; Yu, D.; Yin, W.; Chen, C. Hydrothermal Synthesis of a New Kind of N-Doped Graphene Gel-like Hybrid As an Enhanced ORR Electrocatalyst. *ACS Appl. Mater. Interfaces* **2018**, *10* (13), 10842–10850. <https://doi.org/10.1021/acsami.7b19122>.
- (8) Wu, Z.-S.; Yang, S.; Sun, Y.; Parvez, K.; Feng, X.; Müllen, K. 3D Nitrogen-Doped Graphene Aerogel-Supported Fe₃O₄ Nanoparticles as Efficient Electrocatalysts for the Oxygen Reduction Reaction. *J. Am. Chem. Soc.* **2012**, *134* (22), 9082–9085. <https://doi.org/10.1021/ja3030565>.