Electronic Supplementary Information

A novel synthesis of ultra thin graphene sheets for energy storage applications using malonic acid as a reducing agent

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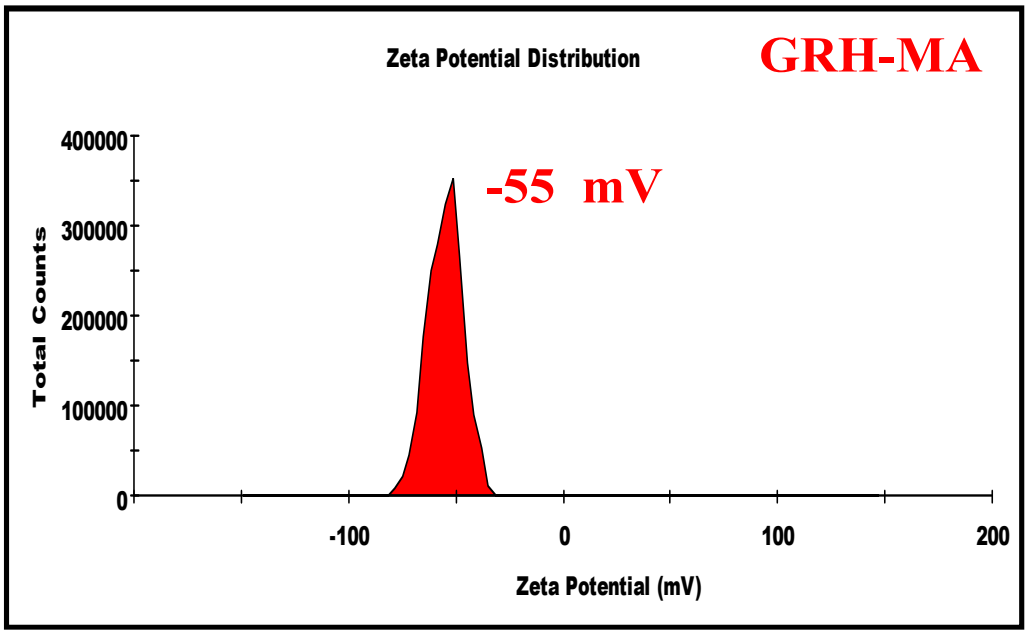

Fig. S1 Zeta- potential of GRH-MA.

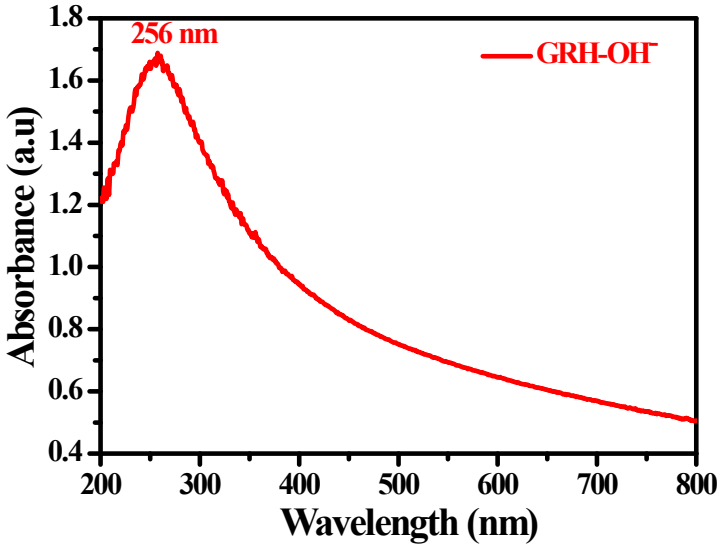

Fig. S2 Optical absorption spectrum of GRH-OH$^-$ after 6 h of reaction.

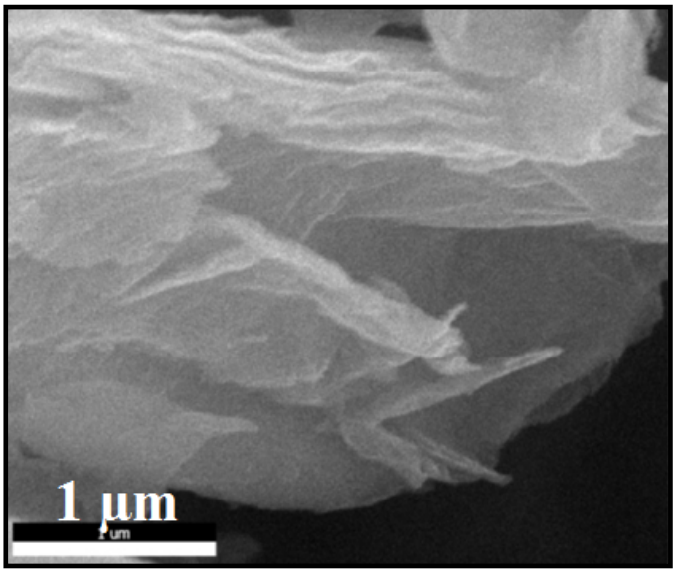

Fig. S3 FE-SEM image of GRH-MA used for elemental mapping shown in Fig. 6 b'' and b''' at higher magnification.

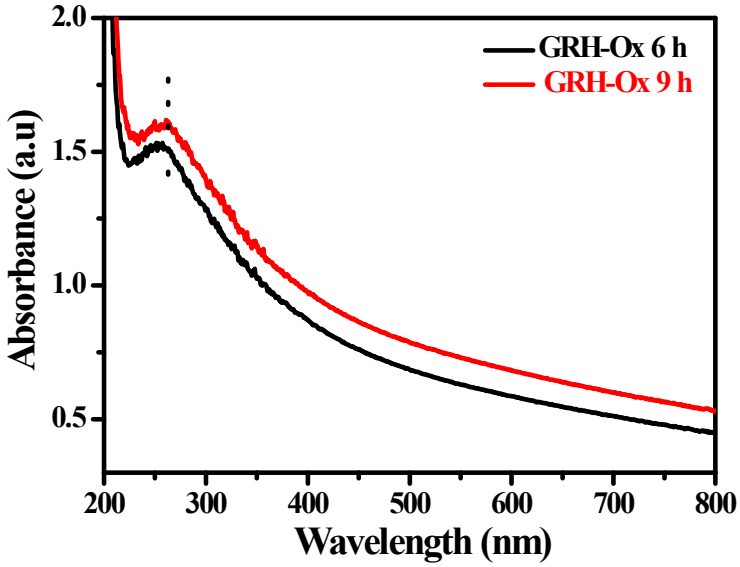

Fig. S4 Optical absorption spectrum of GRH-Ox after 6 and 9 h of reaction, respectively.

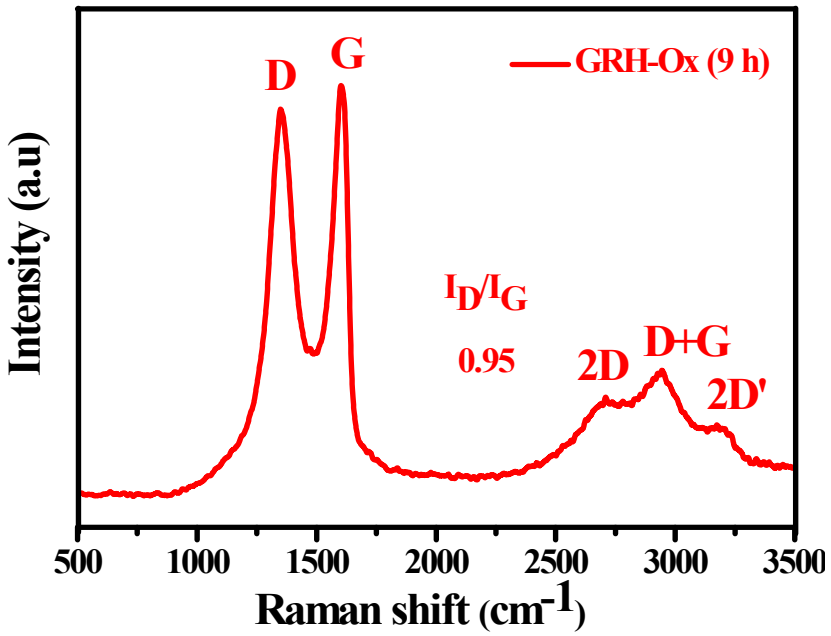

Fig. S5 Raman spectrum of GRH-Ox after 9 h of reaction.

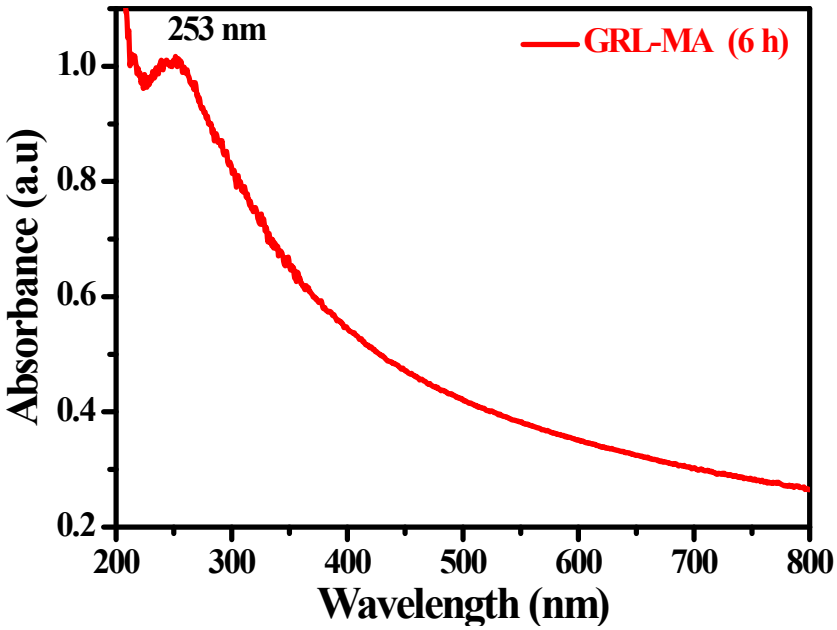

Fig. S6 Optical absorption spectrum of GRL-MA after 6 h of reaction.

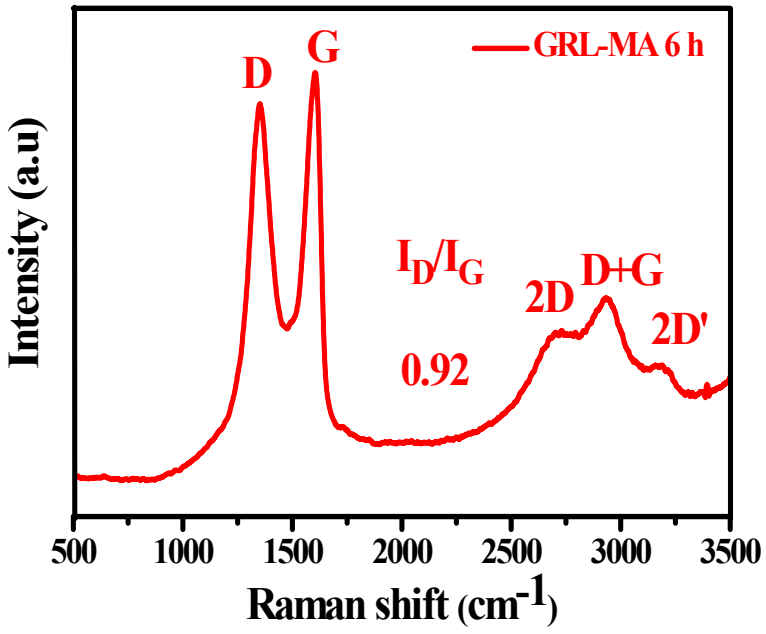

Fig. S7 Raman spectrum of GRL-MA after 6 h of reaction.

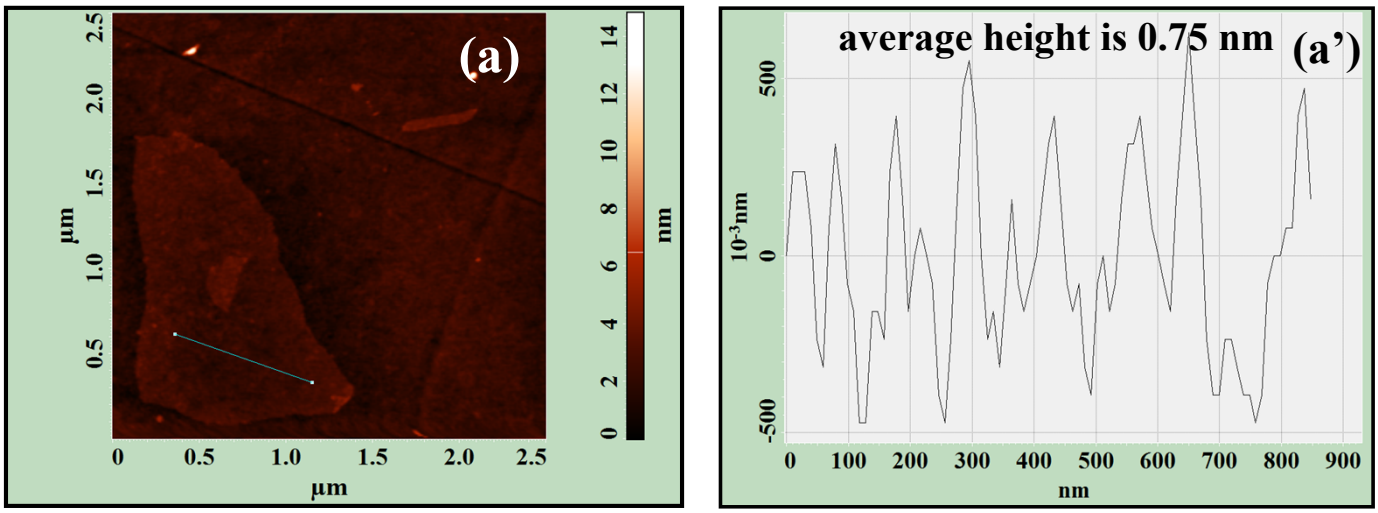

Fig. S8 AFM image and its height profile along a particular line of GRH-Ox (a,a′).

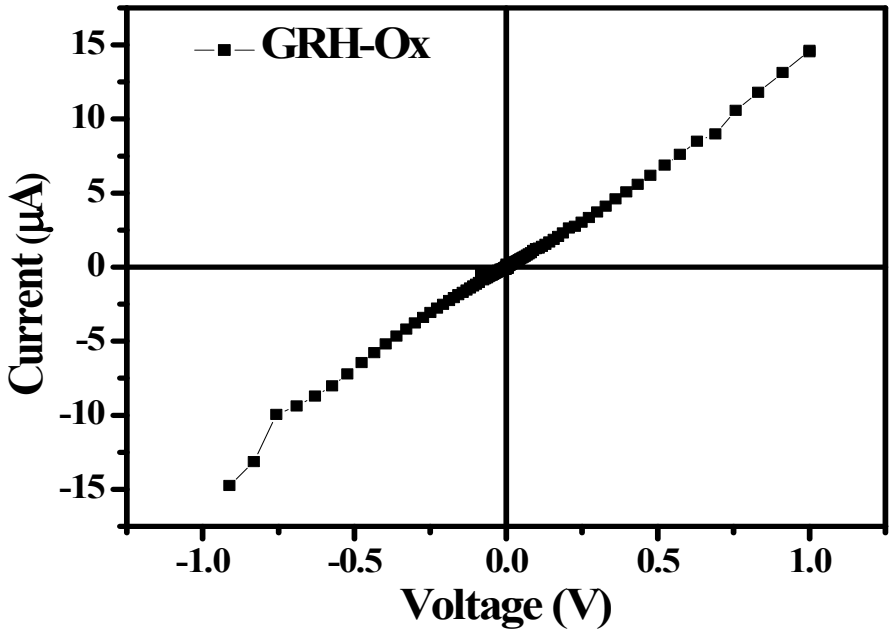

Fig. S9 I-V curve of GRH-Ox.

Table S1 Raman spectral data of graphite, GO, GRH-MA and GRH-MA300.

Raman shift	D band (cm^{-1})	G band (cm^{-1})	I_D/I_G
Graphite	1359	1583	-
GO	1356	1606	0.86
GRH-MA	1353	1604	0.97
GRH-MA300	1354	1596	0.93

Table S2 A comparison of the specific capacitance (C_s) value of GRH-MA with the previously reported chemically reduced graphene(s) and some of the N-doped graphene(s).

Reducing agents	Specific Capacitance (CV and GCD)	Ref.
Malonic acid reduced GO	***254 F/g at 1 A/g 173 F/g at 100 mV/s***	***Present study***
Microbial reduction of GO by Shewanella	117 F g^{-1} at 1 A g^{-1}	**S1**
Trigol reduced GO	130 F g^{-1} at 1 A /g 106.3 at 100 mV/s	**S2**
Caffeic acid reduced GO	136 F/g at 1 A/g 96 F/g at 100 mV/s	**S3**
Double microwave assisted exfoliations of expandable graphite	189 F/g at 1 A/g 164 F/g at 100 mV/s	**S4**
Dimethyl ketoxime reduced GO	131 F/g at 100 mV/s	**S5**
Solvothermal process for the reduction of GO and introduction of primary amine	87.1 F/g at 100 mV/s	**S6**
Hydrazine monohydrate reduced GO	133 F g^{-1} at 1 A g^{-1}	**S7**
Exfoliation of graphite flakes with the addition of melamine producing N- doped FLG	227 F/g at 1 A/g	**S7**

References:

S1. G. Wang, F. Qian, C. W. Saltikov, Y. Jiao and Y. Li, *Nano Res*., 2011, **4**, 563.

S2. D. Mhamane, S. M. Unni, A. Suryawanshi, O. Game, C. Rode, B. Hannoyer, S. Kurungot and S. Ogale, *J. Mater. Chem*., 2012, **22**, 11140.

S3. Z. Bo, X. Shuai, S. Mao, H. Yang, J. Qian, J. Chen, J. Yan and K. Cen, *Sci. Rep.*, 2014, **4**, 4684.

S4. X. Liu, D. Zhan, D. Chao, B. Cao, J. Yin, J. Zhao, Y. Li, J. Lin and Z. Shen, *J. Mater. Chem. A*, 2014, **2**, 12166.

S5. P. Su, H.-L. Guo, L. Tian and S.-K. Ning, *Carbon*, 2012, **50**, 5351.

S6. L. Lai, L. Chen, D. Zhan, L. Sun, J. Liu, S. H. Lim, C. K. Poh, Z. Shen and J. Lin, *Carbon*, 2011, **49**, 3250.

S7. N. Xiao, D. Lau, W. Shi, J. Zhu, X. Dong, H. H. Hng and Q. Yan, *Carbon*, 2013, **57**, 184.