Electronic Supplementary Material (ESI) for RSC Advances.

Reduced graphene oxide as high efficient adsorbent for 1-naphthol and the mechanism thereof

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Supplementary detail

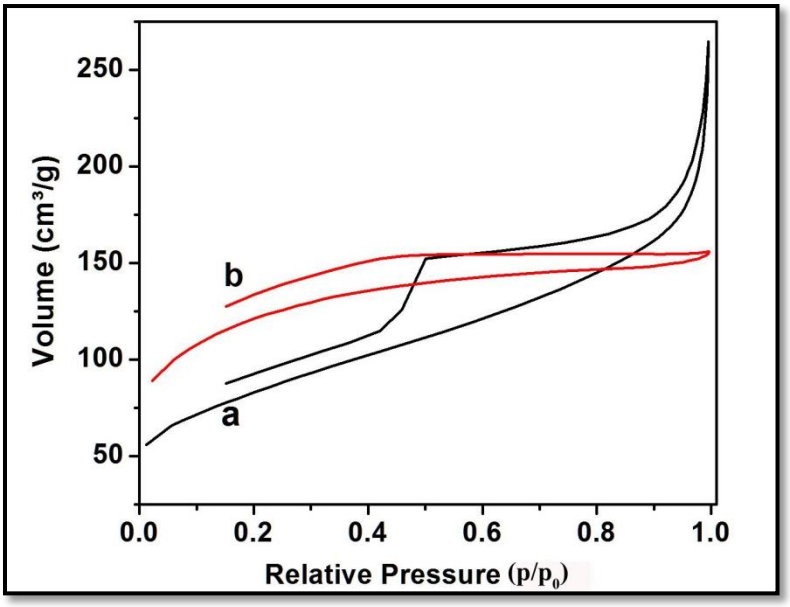

Figure S1. N_2 adsorption isotherms of (a): l-rGO and (b): h-rGO

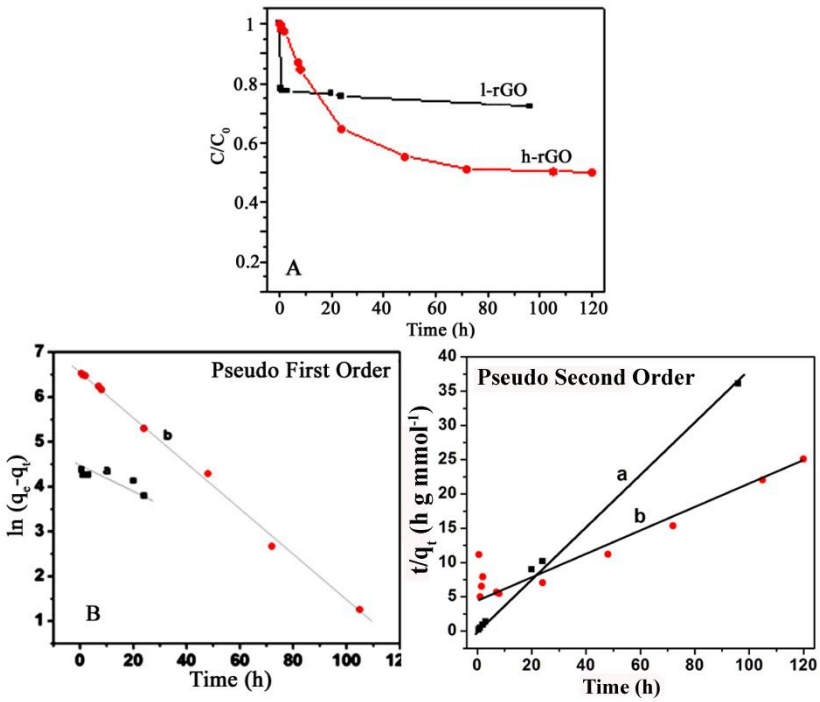

Figure S2. Effect of contact time on the adsorption of 1-naphthol by l-rGO and h-rGO. Linear fits of pseudo first order and pseudo second order kinetics model for (a) l-rGO and (b) h-rGO. The concentration of 1-naphthol is 1 mmol L^{-1} and rGO is 0.1 mg mL^{-1}.

The result shows that 1-rGO reaches equilibrium faster than that of the h-rGO. The linear fitting of the l-rGO fits well to the pseudo second order kinetics while that of the h-rGO fits well with the pseudo first order. This may be due to the difference in the pore sizes of l-rGO and h-rGO. The average pore size of h-rGO (2.7 nm) is lower than that of the l-rGO (4.8 nm). During adsorption, overcome of surface barriers may be necessary for entering micropores (M. Bulow, Z. Chem. Leipzig, 25, 1985, 81). The total rate of the kinetic process is determined by the rate of the slowest process. Therefore it can be assumed that the comparatively smaller pores of h-rGO are possibly slowing down the process.

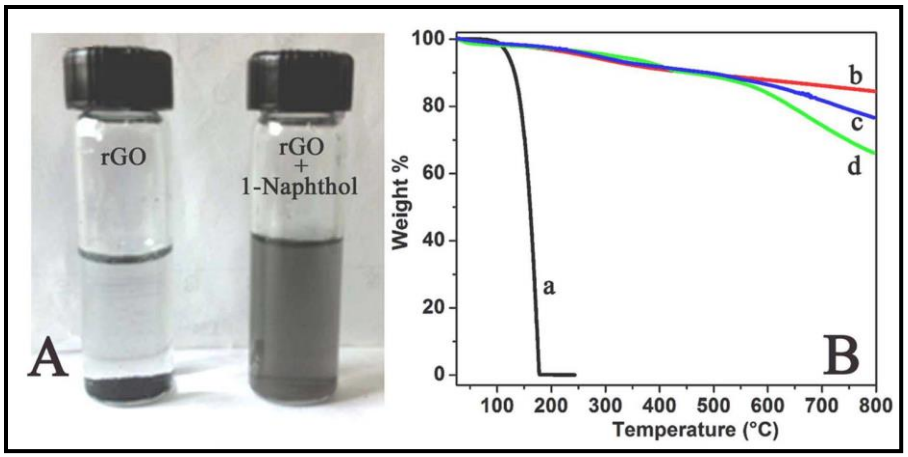

Figure S3. (A): Digital images of l-rGO in water in the absence and presence of 1-naphthol (1 mmol L^{-1}); (B): Thermograms of (a) 1-naphthol; (b) l-rGO; (c) l-rGO-naphthol obtained from a 1 mmol L^{-1}1-naphthol solution and 0.1 mg mL^{-1} rGO with a contact time of 1 h and (d) l-rGO-naphthol obtained from a 3 mmol L^{-1} 1-naphthol solution and 0.1 mg mL^{-1} rGO with a contact time of 1 h.

The thermogram of 1-naphthol shows a 100 % weight loss from 140-170 °C and is attributed to the sublimation of 1-naphthol. The l-rGO shows a ~15 % weight loss at 800 °C which is due to residual oxygen functional groups such as carboxylic acid. Interestingly, thermogram of l-rGO-naphthols, do not show any weight loss between 140 -170 °C, however, the residual weights at 800 °C shows a decrease (65 and 70 %) indicating the presence of 1-naphthol.

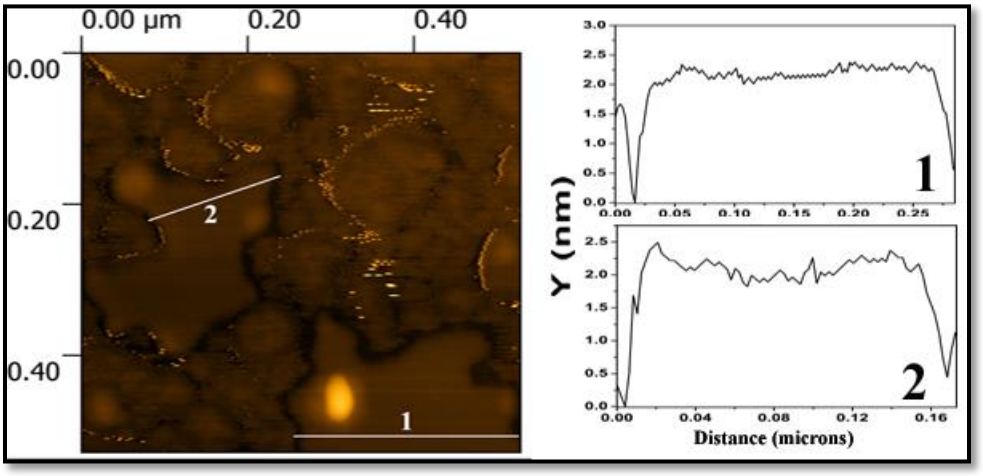

Figure S4. AFM images and height profile of rGO adsorbed with 1-naphthol showing the few layeredgraphenenanosheets with thickness of ~2 nm.

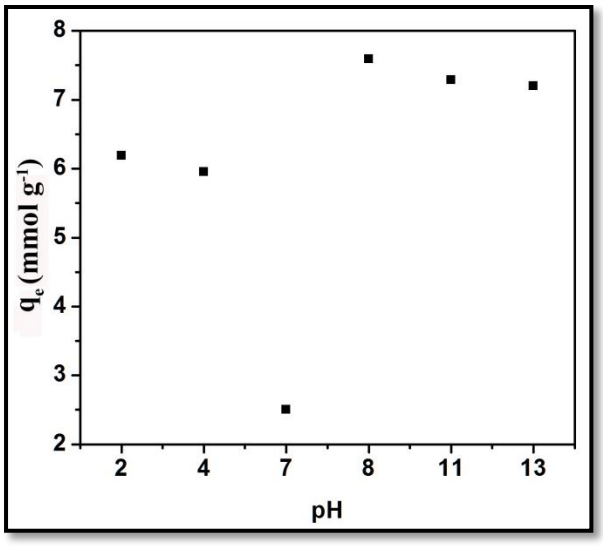

Figure S5. Effect of pH on the adsorption of 1-naphthol (1mmol L^{-1}) byl-rGO (0.1mg mL^{-1}) at room temperature

Table S1. BET SA analyses results of l-rGO and h-rGO

S. No.	Materials	BET SA ($m^2 g^{-1}$)	Average pore size* (nm)
1.	l-rGO	287	4.8
2.	h-rGO	418	2.7

*Average pore size values are calculated based on Barrett-Joyner-Halenda (BJH) adsorption method.

Table S2. Kinetic parameters for the adsorption of 1-naphthol (1 mmol L^{-1}) on l-rGO and h-rGO at 298 K

Adsorbent	$q_{e,\,exp}$ (mmol g^{-1})	Pseudo first order			Pseudo second order			
		$q_{e,\,cal}$ (mmol g^{-1})	k_1 (h^{-1})	R^2	$q_{e,\,cal}$ (mmol g^{-1})	k_2 (g $mmol^{-1}$ h^{-1})	h (mmol g^{-1} h^{-1})	R^2
l-rGO	2.65	0.53	0.017	0.7465	2.66	0.29	2.07	0.9974
h-rGO	4.78	4.95	0.051	0.9969	6.8	0.003	0.168	0.8884

Table S3. The amount of 1-naphthol in water at lower pH values for a 1 mmol L^{-1} 1-naphthol solution

S. No.	pH	Solubility (mg mL^{-1})
1	4	0.134
2	3	0.136
3	2	0.135

Decrease in the solubility of 1-naphthol in water at lower pH values at 298 K is demonstrated using a 1 mmol L^{-1} 1-naphthol solution. The amount of 1-naphthol in water (for pH 7) is 0.144 mg mL^{-1}.