Supporting Information

Graphene Oxide–Cellulose Nanowhisker Hydrogel Nanocomposite as a Novel Adsorbent for Methylene Blue

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Solvent	T (K)	Region I	Section IIA	Section IIB
		(C	A site)	(Ph site)
Water	308	0.20	0.38	0.33
	318	0.23	0.34	0.31
	328	0.23	0.28	0.35
0.1 M NaCl	318	0.14	0.27	0.47
pH=11	318	0.16	0.29	0.43

Table S1. Relative Magnitude of Region I and Region II (Sections IIA and IIB) for Adsorption ofMB on GO-CNW Nanocomposite in Water, 0.1 M NaCl and Alkaline Solution at 308–328 K

Table S2. TDs and TRAKs for Adsorption of MB on GO-CNW Nanocomposite in Water,

Solvent	Т	$[CR]_0$	rpm	$TRAK_{C_1-C_2}$	t_e	q_{e}
	(K)	(mM)		(min-min)	(min)	$(mg \cdot g^{-1})$
Water	318	0.003	100	_	90	4.2
	318	0.030	100	_	120	23.1
	308	0.054	100	_	120	39.7
	318	0.054	100	_	90	31.3
	328	0.054	100	_	60	29.7
	318	0.054	70	_	120	37.4
	318	0.054	30	_	120	39.4
0.1M NaCl	318	0.030	100	1–3	180	33.5
pH=11	318	0.030	100	1–2	120	35.5

0.1 M NaCl and Alkaline Solutions at 308–328 K

 $\mathit{TRAK}_{C_1-C_2}$ is the TRAK between the first and second kinetic curves. t_e and q_e are

the time and adsorption capacity of starting plateau.

Solvent	Т	$[MB]_0$	rpm	KASRA region 1 (1st curve)		KASRA region 2 (1st curve)			KASRA region 2 (2nd curve)			
	(K)	(mM)		k _{dif}	Ι	TRAK	(t_2, q_2)	k _{dif}	Ι	(t_3, q_3)	k _{dif}	Ι
Corresponding to thermodynamic				ARIAN region I (CA Site)			ARIAN section IIA (CA Site)			ARIAN section IIB (Ph Site)		
Water	318	0.003	100	0.49	-0.18	_	_	_	_	_	_	_
0.1M NaCl	318 ^A	0.030	100	15.31	-0.02	1–3	(3,15.1)*	4.46	7.55	(10,21.6)	1.56	17.85
pH=11	318 ^B	0.030	100	11.50	0.01	1–2	(2,11.6)**	3.80	6.72	(10,18.9)	10.54	2.77
KASRA region 1 (1st curve)					KASRA region 2 (1st curve)							
Corresponding to thermodynamic ARIAN region I and section IIA (CA Site)					ARIAN section IIB (Ph Site)							
Water	318	0.030	100	4.03	-0.72	_	(5,8.5)	1.67	4.11	_	_	_
	308	0.054	100	7.89	-4.16	_	(10,20.3)	2.51	13.28	_	_	_
	318	0.054	100	5.86	-0.95	_	(5,12.9)	2.97	7.06	_	_	_
	328	0.054	100	6.59	-1.21	_	(4,11.5)	3.48	5.20	_	_	_
	318	0.054	70	5.63	-0.69	_	(10,15.9)	2.87	8.10	_	_	_
	318	0.054	30	4.74	0.08	_	(10,14.6)	2.61	6.34	_	_	_

 Table S3. Coefficients of the Intraparticle Equation for Kinetics of MB Adsorption on GO–CNW Nanocomposite at Different

 Temperatures and in Various Shaking Rates and Initial MB Concentrations

Units of k_{dif} and l are in mg·g⁻¹·min^{-0.5}, mg·g⁻¹ and min^{-0.5}. Units of t_1, t_2 and t_3 are in min and those of q_1, q_2 and q_3 are in mg·g⁻¹ and

 $t_1 = q_1 = 0$. Boundary points coordinates of diffusion regions, (t_n, q_n) , are similar to those of the KASRA model, (t_{0n}, q_{0n}) in Table 6. ^A There is a $TRAK_{C1-C2}$ from $t = 1 \min$ and $q_t = 14.4 \text{ mg} \cdot \text{g}^{-1}$ to $t = 3 \min$ and $q_t = 15.1 \text{ mg} \cdot \text{g}^{-1}$. ^B There is a $TRAK_{C1-C2}$ from $t = 1 \min$ and $q_t = 11.0 \text{ mg} \cdot \text{g}^{-1}$ to $t = 2 \min$ and $q_t = 11.6 \text{ mg} \cdot \text{g}^{-1}$. *Here, (t_2, q_2) starts from the end of TRAK and its STC (an abbreviation for Starting TRAK Coordinates) is (0.021 mM, 1 min, 14.4 mg \cdot \text{g}^{-1}). ** The (t_2, q_2) starts from the end of TRAK and its STC is (0.024 mM, 1 min, 11.0 mg \cdot \text{g}^{-1}).

Solvent	Т	$[MB]_0$	rpm		KASRA r	egions 1 and	2 (1st curve)	KASRA region 2 (2nd curve)				
	(K)	(mM)		<i>k</i> ₁₁	(t_{ssr}, q_{ssr})	k _{I2a}	$([MB]_E, t_E, q_E)$	k _{I2a}	(t_{sp}, q_{sp})	k _{I2b}	$([MB]_e, t_e, q_e)$	
Corresponding to thermodynamic				ARIAN	region I (CA	Site)	ARIAN section IIA (CA Site)					
Water	318	0.003	100	1.72×10 ⁴	(40,2.9)	6.02×10 ⁴	_	_	_	_	(3.5×10 ⁻³ ,90,4.2)	
Correspo	sponding to thermodynamic				ARIAN region I and section IIA (CA Site)				ARIAN section IIB (Ph Site)			
0.1M NaCl ^A	318	0.030	100	1.70×10^5 (3,15.1)* 1.42×10^4 (0.016,10,21.6)				1.99×10 ³	(50,29.4)	4.65×10 ³	(0.009,120,33.5)	
рН=11 ^в	318	0.030	100	1.82×10^{4}	(2,11.6)**	6.46×10 ³	(0.027,10,18.9)	1.88×10 ³	(50,30.9)	3.41×10 ³	(0.014,90,35.5)	
					KASRA	regions 1 and	d 2 (1st curve)	KASRA region 2 (1st curve)				
Corresponding to thermodynamic			ARIAN region I and section IIA (CA Site)									
Correspo	nding to	thermody	mamic	A	RIAN region	I and section	IIA (CA Site)		ARIAN	section IIB (I	Ph Site)	
Correspon Water	nding to	0.030	namic 100	A 1.84×10 ⁴	RIAN region	I and section	IIA (CA Site) (0.025,5,8.5)	9.00×10 ²	ARIAN (90,20.2)	section IIB (F 1.29×10^4	Ph Site) (0.016,120,23.1)	
Correspon Water	nding to 318 308	0.030 0.054	2000 2000 2000 2000 2000 2000 2000 200	A 1.84×10 ⁴ 5.18×10 ³	RIAN region 7	I and section	IIA (CA Site) (0.025,5,8.5) (0.041,10,20.3)	9.00×10 ² 6.16×10 ²	ARIAN (90,20.2) (60,33.6)	section IIB (F 1.29×10 ⁴ 9.25×10 ²	Ph Site) (0.016,120,23.1) (0.029,120,39.7)	
Correspo Water	nding to 318 308 318	0.030 0.054 0.054	vnamic 100 100 100		RIAN region 7 — — —	I and section - - -	IIA (CA Site) (0.025,5,8.5) (0.041,10,20.3) (0.046,5,12.9)	9.00×10 ² 6.16×10 ² 9.01×10 ²	ARIAN (90,20.2) (60,33.6) (40,26.5)	section IIB (F 1.29×10^4 9.25×10^2 9.88×10^2	Ph Site) (0.016,120,23.1) (0.029,120,39.7) (0.034,90,31.3)	
Correspo Water	nding to 318 308 318 328	0.030 0.054 0.054 0.054	/namic 100 100 100 100	$\begin{tabular}{c} \hline & A \\ \hline 1.84{\times}10^4 \\ 5.18{\times}10^3 \\ 8.69{\times}10^3 \\ 1.62{\times}10^4 \end{tabular}$	RIAN region 7 - - (2,8.9)	I and section 7 - - 3.06×10 ⁴	IIA (CA Site) (0.025,5,8.5) (0.041,10,20.3) (0.046,5,12.9) (0.047,4,11.5)	9.00×10^{2} 6.16×10^{2} 9.01×10^{2} 1.10×10^{3}	ARIAN (90,20.2) (60,33.6) (40,26.5) (30,24.3)	section IIB (F 1.29×10^4 9.25×10^2 9.88×10^2 2.51×10^3	Ph Site) (0.016,120,23.1) (0.029,120,39.7) (0.034,90,31.3) (0.025,60,29.7)	
Correspo Water	nding to 318 308 318 328 318	0.030 0.054 0.054 0.054 0.054 0.054	vnamic 100 100 100 100 70	$\begin{tabular}{ c c c c c }\hline & A \\ \hline 1.84×10^4 \\ 5.18×10^3 \\ 8.69×10^3 \\ 1.62×10^4 \\ 6.16×10^3 \\ \hline \end{tabular}$	RIAN region 7 - - (2,8.9) (3,9.5)	I and section - - 3.06×10 ⁴ 9.48×10 ³	IIA (CA Site) (0.025,5,8.5) (0.041,10,20.3) (0.046,5,12.9) (0.047,4,11.5) (0.044,10,15.9)	9.00×10^{2} 6.16×10^{2} 9.01×10^{2} 1.10×10^{3} 5.58×10^{2}	ARIAN : (90,20.2) (60,33.6) (40,26.5) (30,24.3) (50,29.8)	section IIB (F 1.29×10^4 9.25×10^2 9.88×10^2 2.51×10^3 1.14×10^3	Ph Site) (0.016,120,23.1) (0.029,120,39.7) (0.034,90,31.3) (0.025,60,29.7) (0.031,120,37.4)	

Table S4. Coefficients of Region 1 and Region 2 (parts 2a and 2b) of the ISO Equation for Kinetics of MB Adsorption on Different Sites ofGO-CNW Nanocomposite at 308–328 K

 $[MB]_E$, t_E and q_E are MB concentration, time and adsorption capacity at the end of adsorption on a type of adsorption site, respectively (corresponding to $[MB]_e$, t_e and q_e in the last curve). $[MB]_e$, t_e and q_e are MB concentration, time and adsorption capacity at the beginning of the plateau. Units of k_{I1} , k_{I2a} and k_{I2b} , are in M⁻¹·min⁻¹. Units of t_{ssr} , t_S , t_{sp} and t_e are in min⁻¹. Units of q_{ssr} , q_S , q_{sp} and q_e are in mg·g⁻¹. $[MB]_E$ and $[MB]_e$ are in mM. ^{A,B} Due to existence of TRAK, the first curve was divided into two curves and k_{I1} and k_{I2a} belong to the first and second resultant curves, respectively. *Here, the second part starts from the end of TRAK and its STC (an abbreviation for <u>Starting TRAK C</u>oordinates) is (0.021 mM, 1 min, 14.4 mg·g⁻¹). ** The second part starts from the end of TRAK and its STC is (0.024 mM, 1 min, 11.0 mg·g⁻¹).

Size Distribution by Intensity



Figure S1. Hydrodynamic size distribution of GO–CNW measured by DLS.



Figure S2. EDS spectrum of recycled GO–CNW (after three times recycling)



Figure S3. SEM images of recycled GO–CNW (after three times recycling). The scale bars are (a) 500 nm, (b) 1 μ m and (c) 20 μ m