Supplementary Material

Developing new sustainable eco-adsorbent film from Flexographic printing plates waste to remove cationic organic and inorganic pollutants

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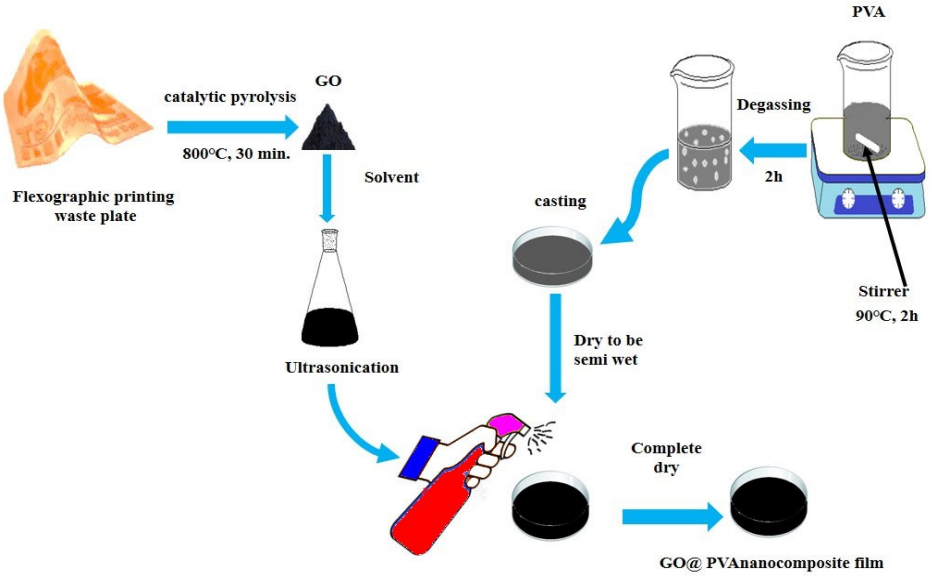
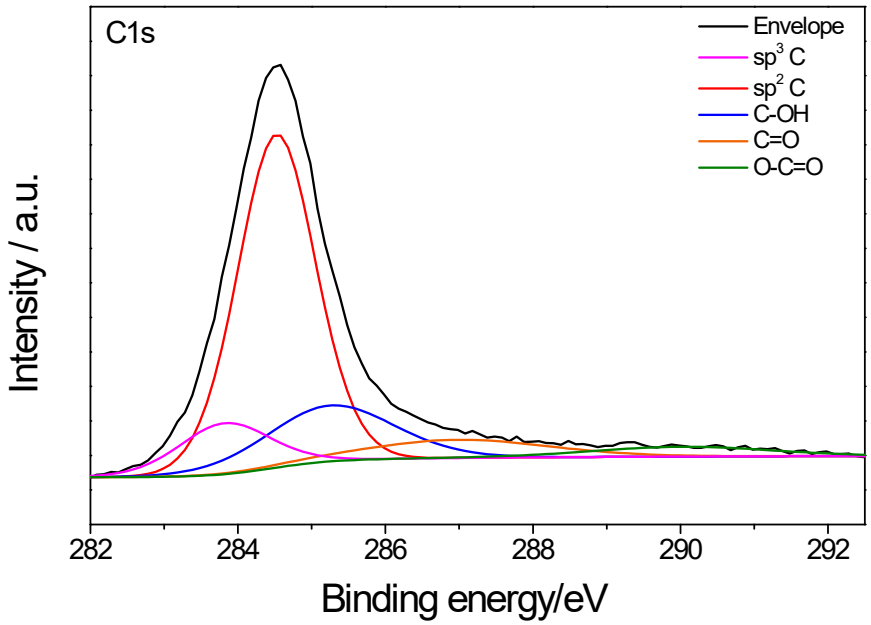
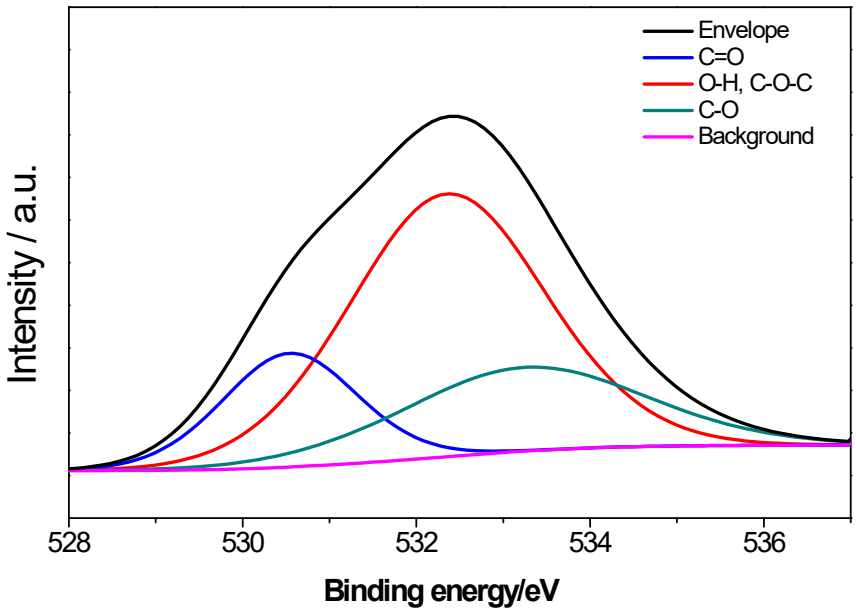


Figure S1: A schematic illustration of the steps taken in producing GO@PVA coated film.

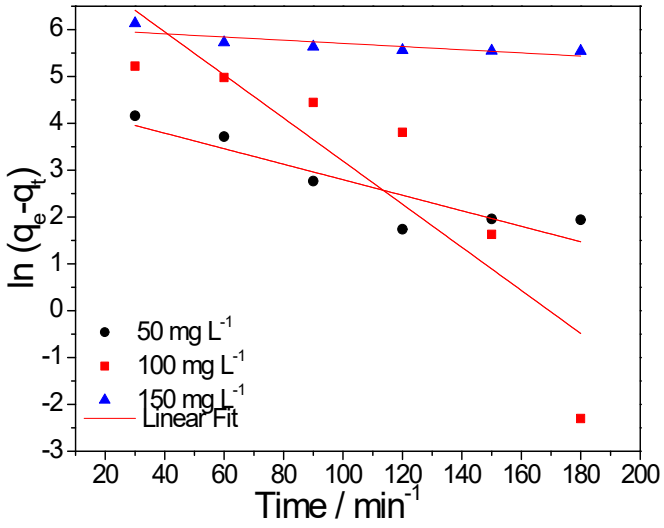


(a)



(b)

Figure S2: (a) C1s, (b) O1s high-resolution XPS spectrum for prepared GO nanoparticles.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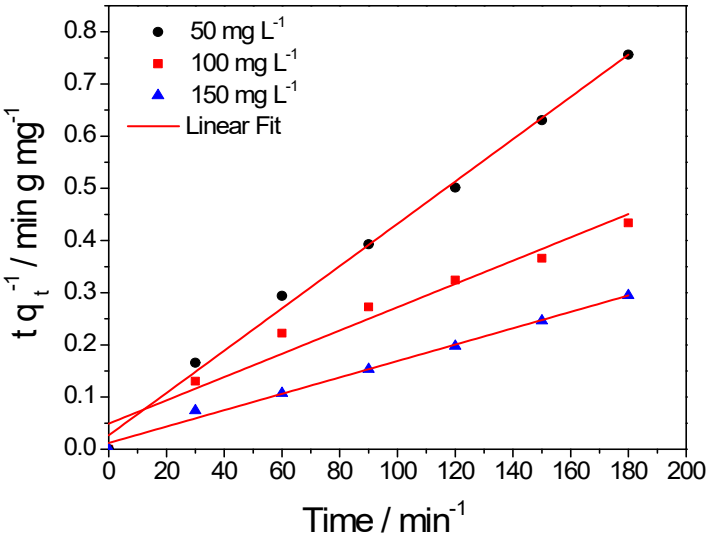
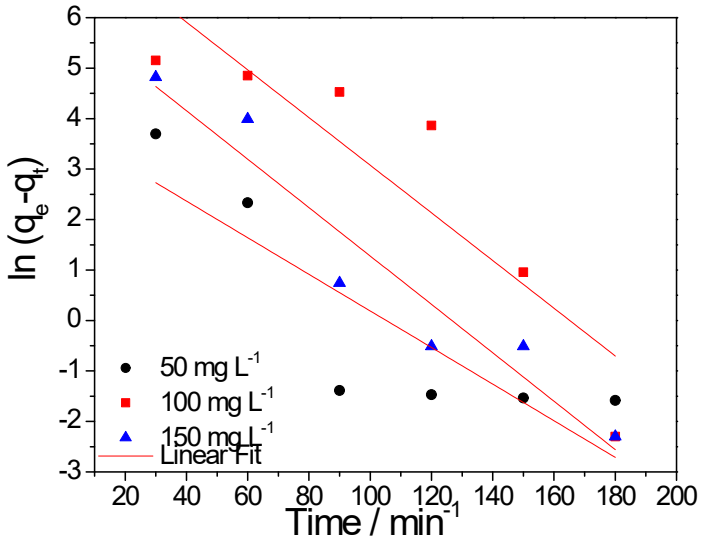
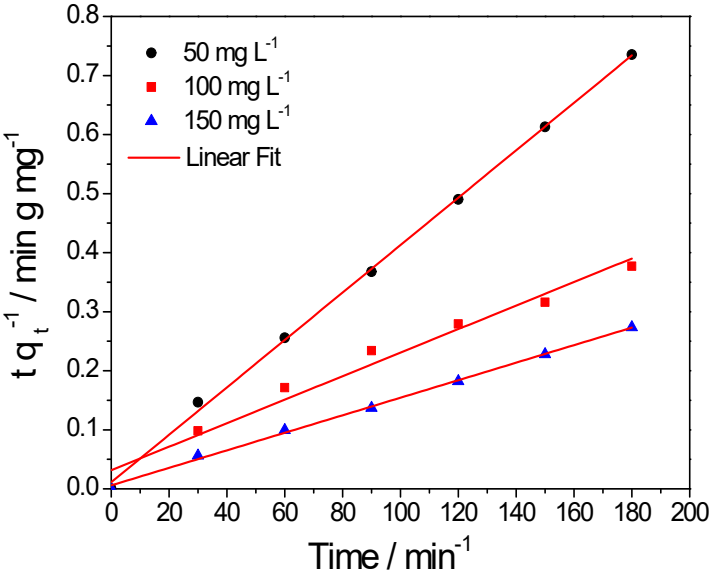
Time / min-1
50 mg L-1
100 mg L-1
150 mg L-1
Linear Fit


t qt-1 / min g mg-1
Time / min-1
50 mg L-1
100 mg L-1
150 mg L-1
Linear Fit

(a)


ln (qe-qt)
Time / min-1
50 mg L-1
100 mg L-1
150 mg L-1
Linear Fit


t qt-1 / min g mg-1
Time / min-1
50 mg L-1
100 mg L-1
150 mg L-1
Linear Fit

(b)

Figure S3: Pseudo-first-order & Pseudo-second-order kinetic model for (a) MB and (b) Pb^{+2} adsorption process onto the prepared GO_3@PVA coated film.

Table S1: The contact angle of the prepared films.

Film	Thickness / µm	Contact angle/ º
PVA	85	85±1
GO_1@PVA	98	65±1
GO_2@PVA	105	61±1
GO_3@PVA	112	60±1

*the measurements were replicated three times for the same prepared membranes and the standard deviation was evaluated accordingly for all tests.

Table S2: The Box-Behnken design matrix and results for the three variables that influenced on removal (%) of experimental and predicted values for MB dye and Pb^{+2} ions using prepared GO_3@PVA coated film.

Trial	Time (A; min)	initial concentration (B; mg L^{-1})	Solution pH (C)	Removal (%)			
				Measured		Predicted	
				MB	Pb^{+2}	MB	Pb^{+2}
1	60	100	7	53.6	87.9	52.8	87.6
2	120	150	7	68.7	95.3	68.7	95.3
3	120	150	7	68.7	95.3	68.7	95.3
4	60	200	7	61.2	91.5	63.1	92.1
5	120	200	2	20.1	41.1	23.9	45.6
6	120	150	7	68.7	95.3	68.7	95.3
7	120	100	2	18.8	35	25.3	40.4
8	120	200	12	98.1	9.8	91.6	4.4
9	120	150	7	68.7	95.3	68.7	95.3
10	120	150	7	68.7	95.3	68.7	95.3
11	180	150	12	97.8	10.2	103.5	15.3
12	60	150	2	16.5	49.3	10.8	44.2
13	180	150	2	28.4	63.2	23.8	58.4

14	180	100	7	91.5	99.8	89.6	99.2
15	180	200	7	76.3	98.6	77.1	98.9
16	60	150	12	61.3	6.2	65.9	11
17	120	100	12	96.3	10	92.5	5.5

Table S3: Regression Statistics of MB removal

Std. Dev.	5.73	**R^2**	0.9807
Mean	62.55	**Adjusted R^2**	0.9560
C.V. %	9.17	**Predicted R^2**	0.6918
		Adeq Precision	21.0951

- The Predicted R^2 of 0.6918 is not as close to the Adjusted R^2 of 0.9560 as one might normally expect; i.e. the difference is more than 0.2. This may indicate a large block effect.
- Adeq Precision measures the signal to noise ratio. A ratio greater than 4 is desirable. The obtained ratio of 21.095 indicates an adequate signal. This model can be used to navigate the design space.

Table S4: ANOVA for Quadratic model of MB removal

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	11717.91	9	1301.99	39.60	< 0.0001	significant
A-time	1285.25	1	1285.25	39.09	0.0004	
B-MBinitial concentration	2.53	1	2.53	0.0770	0.7894	
C-solution pH	9092.26	1	9092.26	276.52	< 0.0001	
AB	129.96	1	129.96	3.95	0.0871	
AC	151.29	1	151.29	4.60	0.0691	
BC	0.0625	1	0.0625	0.0019	0.9664	
A^2	30.41	1	30.41	0.9249	0.3682	
B^2	90.55	1	90.55	2.75	0.1410	
C^2	948.95	1	948.95	28.86	0.0010	
Residual	230.17	7	32.88			
Lack of Fit	230.17	3	76.72			
Pure Error	0.0000	4	0.0000			

Cor Total	11948.08	16

Sum of squares is Type III - Partial

The Model F-value of 39.60 implies the model is significant. There is only a 0.01% chance that an F-value this large could occur due to noise. P-values less than 0.0500 indicate model terms are significant. In this case A, C, C^2 are significant model terms.

Table S5: Regression Statistics of Pb^{+2} removal

Std. Dev.	5.34	**R^2**	0.9911
Mean	63.48	**Adjusted R^2**	0.9796
C.V. %	8.41	**Predicted R^2**	0.8572
		Adeq Precision	23.1514

- The Predicted R^2 of 0.8572 is in reasonable agreement with the Adjusted R^2 of 0.9796; i.e. the difference is less than 0.2.
- Adeq Precision measures the signal to noise ratio. A ratio greater than 4 is desirable. The obtained ratio of 23.151 indicates an adequate signal. This model can be used to navigate the design space.

Table S6: ANOVA for Quadratic model of Pb^{+2} removal

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	22171.42	9	2463.49	86.36	< 0.0001	significant
A-light intensity	170.20	1	170.20	5.97	0.0446	
B-initial concentration	8.61	1	8.61	0.3019	0.5998	
C-film weight	2903.22	1	2903.22	101.77	< 0.0001	
AB	5.76	1	5.76	0.2019	0.6668	
AC	24.50	1	24.50	0.8589	0.3849	
BC	9.92	1	9.92	0.3478	0.5739	
A^2	57.64	1	57.64	2.02	0.1982	
B^2	87.17	1	87.17	3.06	0.1239	
C^2	18774.32	1	18774.32	658.13	< 0.0001	
Residual	199.69	7	28.53			
Lack of Fit	199.69	3	66.56			
Pure Error	0.0000	4	0.0000			
Cor Total	22371.11	16				

Sum of squares is Type III - Partial

The Model F-value of 86.36 implies the model is significant. There is only a 0.01% chance that an F-value this large could occur due to noise. P-values less than 0.0500 indicate model terms are significant. In this case A, C, C^2 are significant model terms.