Supplementary Materials

Table S1. Specification of chemicals used in the study.

Component	CAS Reg. No.	Suppliers	Purity
Graphene oxide dispersion	7440-44-0	Jiangsu Xianfeng Nano Material Technology Co., Ltd. China	0.5mg/ml, solvent: H_2O
Sodium borohydride	16940-66-2	Sigma Aldrich, China	Analytical grade
Methyl blue	28983-56-4	Sigma Aldrich, China	Analytical grade

Table S2. Comparison of maximum adsorption capacity for MB sorption with other adsorbents.

Adsorbent	Adsorption capacity (mgg^{-1})	Time (min)	References
Graphite oxide	351.1	60	[56]
GO	403.3	60	[57]
GO	243.90	300	[58]
Carbon nanotubes	188.68	300	[58]
GO aerogel	480.76	360	[59]
3D GO sponge	397	20	[60]
3D RGO hydrogel	7.85	120	[61]
RGO	204.08	255	[62]
RGO	100	60	[63]
GO	714	100	[64]
Porous RGO	313	180	[65]
APG	821.05	120	This work

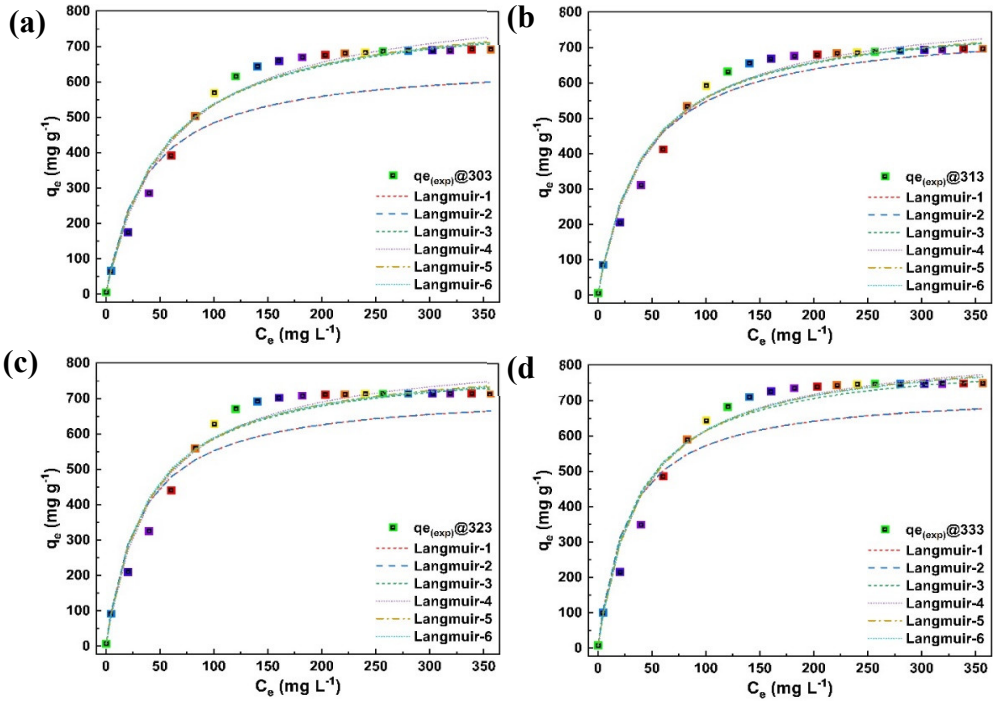

Figure S1. Linear forms of Langmuir isotherm models for sorption of MB on AG at (a) 303, (b)313, (c) 323 and (d) 333 K.

Table S3. Description of error functions.

Function name	Abbreviation	Expression	Interpretation
Sum of Squares of the Errors	SSE	$SSE = \sum_{i=1}^{n} (q_{cal} - q_{\exp})_i^2$	The most widely used error function is SSE. The underlying features of this function is that when liquid-phase

			concentration with time increases, the errors' square also grows results the better fit of the isotherm parameters.
Sum of the Absolute Errors	EABS	$EABS = \sum_{i=1}^{n} \left\| q_{cal} - q_{\exp} \right\|_i$	EABS is similar to the SSE. Thus, the same disadvantage as for SSE, namely better fit at high pressure, is observed.
Average Relative Error	ARE	$ARE = \frac{100}{n} \sum_{i=1}^{n} \left\| \frac{q_{e,cal} - q_{e,\exp}}{q_{e,\exp}} \right\|_i$	ARE is a function minimizing the fractional error distribution across the entire range of independent variables.
Marquardt's Percent Standard Deviation	MPSD	$MPSD = 100 \sqrt{\frac{1}{n-p} \sum_{i=1}^{n} \left(\frac{q_{e,cal} - q_{e,\exp}}{q_{e,\exp}} \right)_i^2}$	MPSD is a function based on error distribution of geometric mean of a system's degree of freedom.
Hybrid Fractional Error	HYBRID	$HYBRID = \frac{100}{n-p} \sum_{i=1}^{n} \left[\frac{\left(q_{e,\exp} - q_{e,cal} \right)^2}{q_{e,\exp}} \right]_i$	In comparison to SSE, the HYBRID enhances the fit for low concentrations. The function features the degrees of freedom of the system namely, the number of defining constraints and the tentative data points.

Method of SNE calculation

1. Calculation of all parameters for a particular isotherm model.
2. Error calculations for each of all desired error functions in separate spreadsheets.
3. The solver add-in minimization (maximization in the case of R^2) of an as-prepared error function.
4. Repeating the above steps (1-3) for all isotherm models and error functions.
5. Orthogonal tabulation of the data obtained for each isotherm model and identifying the maximum value for each data set of a particular error function.
6. Dividing the other error data by the maximum value within the error function.
7. The summation of the obtained residuals for each error function is the normalized error.

Table S4. Error analysis of Langmuir isotherm model at four different temperatures for MB adsorption on AG.

Parameters	**SSE**	**ARE**	**EABS**	**HYBRID**	**MPSD**
303					
q_e	849.368	833.6314	829.4236	874.4191	847.9420731
K_L	0.016863	0.018057	0.01859	0.014807	0.016284335
SSE	**18557.58**	19025.07	19410.34	20147.6	19341.45123
ARE	6.80083	**6.537616**	6.632709	7.307438	6.988912143
EABS	509.0316	493.7912	**489.8041**	544.3506	523.3686072
HYBRID	247.709	278.85	298.6454	**221.2182**	234.8043412
MPSD	10.13197	10.54165	10.88628	10.24976	**9.97822198**
SNE	**4.547023**	4.648115	4.770868	4.682269	4.580671772
313					
q_e	831.9712	799.9976	797.7316	845.5335	816.0993
K_L	0.019751	0.023931	0.024423	0.018143	0.020606
SSE	**17217.88**	20354.33	21048.99	17899.89	18095.86
ARE	6.522333	**5.695414**	5.77478	6.863585	6.385892
EABS	499.7889	462.4673	**459.3656**	519.8633	493.9634
HYBRID	220.826	317.0547	334.7828	**209.9631**	232.0307
MPSD	9.070946	10.24994	10.59157	9.527401	**8.994606**

SNE	**4.245697**	4.601185	4.724993	4.377081	4.282585
323					
q_e	855.0125	807.6129	833.6172	871.4969	834.6808222
K_L	0.021036	0.027297	0.024637	0.018931	0.022168202
SSE	**24662.22**	31237.06	27251.4	25824.18	26254.077
ARE	7.679979	**6.808864**	7.082505	8.047483	7.564665666
EABS	596.9301	571.8395	**567.0843**	621.0133	596.8528199
HYBRID	300.5924	471.08	397.4728	**282.6617**	318.912204
MPSD	10.94389	12.49928	11.65993	11.47366	**10.84555591**
SNE	**4.218725**	4.946067	4.619925	4.539262	4.473254048
333					
q_e	889.2123	847.3478	857.9883	905.1901	864.2978415
K_L	0.021325	0.02835	0.026483	0.019366	0.023086174
SSE	**19373.42**	27536.94	24301.94	20383.52	21274.15803
ARE	7.371104	**6.464843**	6.61592	7.674105	7.247359435
EABS	530.5134	498.1741	**493.0595**	551.5	535.1487938
HYBRID	258.8117	476.7155	404.7786	**243.8294**	289.3381489
MPSD	11.59008	13.31412	12.47409	12.1481	**11.43785203**
SNE	**4.039422**	4.745731	4.424671	4.164125	4.153328708

Table S5. Error analysis of Freundlich isotherm model at four different temperatures for MB adsorption on AG.

Parameters	**SSE**	**ARE**	**EABS**	**HYBRID**	**MPSD**
303					
n	2.793126	1.597954	3.07194	1.949771	1.462359499
K_F	94.51226	22.11086	112.669	40.8784	16.47334329
SSE	**81806.33**	241322.5	85437.3	143125.5	310030.951
ARE	70.75273	**21.23742**	86.6834	29.03088	21.66460189
EABS	1137.862	1831.87	**1131.16**	1408.778	2101.757356
HYBRID	4989.446	2275.059	7472.42	**1615.339**	2925.871234
MPSD	251.0863	29.97046	316.884	75.54127	**25.25598835**
SNE	3.081546	2.294011	3.81377	**1.921403**	2.72118483
313					
n	2.991297	1.557167	3.06844	2.03555	1.482338
K_F	108.8469	20.27082	112.806	46.667	17.5412
SSE	**79604.98**	298719.8	80384.7	148681.8	344689.4
ARE	74.89074	**23.29718**	78.1694	29.87984	23.54674
EABS	1123.275	2078.369	**1117.56**	1418.253	2247.521
HYBRID	5797.732	2907.226	6325.91	**1715.526**	3310.953
MPSD	283.0751	28.96165	297.482	85.65777	**27.80122**
SNE	3.556865	2.646338	3.73045	**2.003758**	2.918078
323					
n	3.077175	1.643806	3.06911	2.08929	1.537889167

K_F	119.0418	25.38938	117.014	51.89661	20.76540525
SSE	**99895.99**	315036.7	101080	174986	374677.6242
ARE	69.33944	**22.73679**	67.9799	28.74965	23.02243688
EABS	1252.027	2119.934	**1245.64**	1545.416	2334.502341
HYBRID	5940.609	2864.969	5727.41	**1878.887**	3398.964704
MPSD	253.5464	29.12627	248.507	77.41679	**27.0159337**
SNE	3.802933	2.673958	3.72799	**2.165256**	3.010734936
333					
n	3.086191	1.677792	3.35669	2.114916	1.566907388
K_F	124.8107	28.43539	143.008	55.93019	23.18762874
SSE	**96792.7**	314512.5	99935.1	173647.1	379063.7475
ARE	64.02076	**21.93811**	74.8469	27.57001	22.23626674
EABS	1236.979	2122.226	**1208.73**	1561.982	2347.214504
HYBRID	5670.709	2771.09	7848.49	**1834.666**	3323.919492
MPSD	232.0343	28.4162	278.736	72.78366	**26.21951188**
SNE	3.192676	2.481982	3.7786	**1.98679**	2.814666663

Table S6. Error analysis of R-P isotherm model at four different temperatures for MB adsorption on AG

Parameters	**SSE**	**ARE**	**EABS**	**HYBRID**	**MPSD**
303					
g	1.44683	0.852003	0.929612	1.390284	0.868743961
B	0.00072	0.044819	0.056599	0.001046	0.039391975
A	8.63858	16.20011	28.93531	9.016035	15.82256303
SSE	**2431.78**	40182.46	53850.26	2616.606	36427.7127
ARE	6.0892	7.348417	15.74949	**5.778427**	7.367660124
EABS	181.911	731.7005	674.7607	**173.1848**	709.7639352
HYBRID	14304.6	236367.4	316766.2	83.82291	214280.6629
MPSD	15.834	9.718796	31.36686	15.11038	**9.678423601**
SNE	1.23036	3.268802	4.922182	**1.13417**	3.099304603
313					
g	1.35869	1.058133	1.119498	1.358691	0.89734
B	0.00144	0.017287	0.008753	0.001443	0.040813
A	10.0662	19.09989	14.36647	10.06578	18.73538
SSE	**4293.98**	24338.72	11097.78	4293.979	29293.74
ARE	6.61127	**5.650831**	6.011117	6.611634	6.643891
EABS	**229.537**	399.8405	321.1165	229.5541	648.7878
HYBRID	25258.7	143169	65281.08	**25258.7**	172316.1
MPSD	16.1855	12.63843	11.02294	16.18627	**8.571826**
SNE	**2.642**	3.909332	2.838402	2.642132	4.529574
323					
g	1.41872	0.944763	1.081141	1.417127	0.856269987

B	0.00102	0.03744	0.017182	0.001032	0.059823152
A	10.3423	22.68129	22.07371	10.36138	22.23571651
SSE	**4803.71**	32376.07	42139.69	4804.205	48592.82589
ARE	7.03242	**6.984165**	7.33145	7.021219	7.74952526
EABS	239.461	651.584	501.4692	**239.1724**	817.3915743
HYBRID	**28257.1**	190447.5	247880.5	28260.03	285840.1523
MPSD	17.9904	11.74353	16.68187	17.96168	**10.01038816**
SNE	2.39814	3.6837	4.221216	**2.394761**	4.556429749
333					
g	1.34612	0.908936	0.814224	1.34663	0.830063478
B	0.00167	0.050375	0.09012	0.001667	0.07639992
A	11.5208	25.60584	27.39183	11.51479	25.35904624
SSE	**3292.91**	31431.22	51140.58	3292.913	48848.88437
ARE	6.15785	6.696776	7.434895	**6.157435**	7.786572445
EABS	165.852	649.3918	854.6108	**165.7566**	841.4419399
HYBRID	**19370.1**	184889.5	300826.9	19370.08	287346.3787
MPSD	17.8393	11.42709	10.36925	17.84705	**10.1535249**
SNE	**2.11324**	3.489397	4.535842	2.113511	4.463886497

Table S7. Error analysis of Toth isotherm model at four different temperatures for MB adsorption on AG.

Parameters	**SSE**	**ARE**	**EABS**	**HYBRID**	**MPSD**
303					
q_{max}	736.7064	858.8074	711.9343	736.7064	845.5942807
n_T	1.604449	0.953368	1.970931	1.604449	0.977921341
K_T	0.020258	0.016462	0.020414	0.020258	0.017256164
SSE	**7548.715**	20909.2	10159.38	7548.715	19795.47795
ARE	11.54109	**6.201768**	12.55593	11.54109	6.383362939
EABS	310.2133	534.702	**259.3109**	310.2133	513.1838542
HYBRID	44404.2	122995.3	59761.05	**44404.2**	116443.988
MPSD	101.121	**98.56942**	101.2192	101.121	98.56999712
SNE	**3.220413**	4.467753	3.456725	**3.220413**	4.335448617
313					
q_{max}	744.8814	818.355	755.7915	744.8814	818.4333
n_T	1.474588	0.98046	1.272532	1.474588	0.98297
K_T	0.022521	0.021249	0.024062	0.022521	0.021217
SSE	**10241.07**	18758.88	12445.33	10241.07	18594.54
ARE	11.07293	**5.723082**	9.597539	11.07293	5.768101
EABS	345.7378	489.0025	369.1215	**345.7378**	488.4367
HYBRID	60241.6	110346.3	73207.84	**60241.6**	109379.6
MPSD	105.0906	102.3927	104.3704	105.0906	**102.3927**
SNE	**3.798891**	4.491181	3.941624	**3.798891**	4.476569
323					

q_{max}	758.9554	838.0697	739.9011	758.9554	837.2281387
n_T	1.597843	0.965954	1.670484	1.597843	0.979057657
K_T	0.023547	0.023695	0.027946	0.023547	0.023638644
SSE	**13633.78**	28123.16	20270.46	13633.78	27182.85329
ARE	11.98523	**6.369412**	11.81512	11.98523	6.729847515
EABS	411.443	585.3742	**389.7503**	411.443	581.6160077
HYBRID	80198.73	165430.4	119238	**80198.73**	159899.137
MPSD	114.9696	**111.7219**	116.8975	114.9696	111.77
SNE	**3.655956**	4.487163	4.09317	**3.655956**	4.444357252
333					
q_{max}	795.4698	873.0415	769.977	795.4698	858.4179843
n_T	1.526445	0.957684	1.965562	1.526445	0.988234696
K_T	0.023959	0.024914	0.02275	0.023959	0.025747524
SSE	**9918.033**	24442.27	14667.51	9918.033	23614.6575
ARE	10.62061	**5.774436**	12.02911	10.62061	6.506572682
EABS	325.3202	515.2066	**279.9498**	325.3202	509.851013
HYBRID	58341.37	143778	86279.44	**58341.37**	138909.75
MPSD	206.853	**203.5973**	209.7743	206.853	203.8
SNE	**3.311967**	4.450593	3.743549	**3.311967**	4.434308315

Table S8. Error analysis of Sips isotherm model at four different temperatures for MB adsorption on AG.

Parameters	**SSE**	**ARE**	**EABS**	**HYBRID**	**MPSD**
303					
q_{max}	832.965	934.086	818.451	832.9653	934.086
1/n	1.00415	1.00415	1.00415	1.004148	1.00415
Ks	0.01815	0.01186	0.01917	0.018148	0.01186
SSE	**19700.8**	29547.4	19857.5	19700.75	29547.3
ARE	6.55676	**5.95835**	6.76151	6.556762	5.95835
EABS	502.579	622.539	**491.252**	502.5785	622.539
HYBRID	115887	173808	116809	**115886.8**	173808
MPSD	10.7853	7.92716	11.4935	10.78528	**7.92716**
SNE	**4.04891**	4.57092	4.13323	**4.048908**	4.57092
313					
q_{max}	821.567	809.665	783.699	821.5669	862.058
1/n	1.00892	1.00892	1.00892	1.008921	1.00892
Ks	0.02097	0.02331	0.02606	0.020969	0.01675
SSE	**18425.5**	19964.5	21881.8	18425.48	22265.1
ARE	5.7801	**5.72443**	6.45235	5.780098	6.01187
EABS	490.547	467.843	**452.067**	490.5469	551.725
HYBRID	108385	117438	128716	**108385.2**	130971
MPSD	9.03993	10.4353	11.828	9.039933	**8.00852**
SNE	**4.20432**	4.41075	4.78494	**4.204315**	4.60882

323					
q_{max}	844.091	850.106	817.169	844.091	909.026
1/n	1.00993	1.00993	1.00993	1.009932	1.00993
Ks	0.02259	0.02297	0.02634	0.022592	0.0162
SSE	**26978.9**	27562.4	28807.5	26978.88	34851.1
ARE	6.68931	**6.38612**	7.08373	6.689311	6.65725
EABS	592.368	588.608	**560.959**	592.3678	679.817
HYBRID	158699	162132	169456	**158699.3**	205006
MPSD	10.606	11.1305	12.6309	10.60598	**8.79076**
SNE	**4.2036**	4.23029	4.47834	**4.203604**	4.63576
333					
q_{max}	884.205	880.626	855.44	884.2045	956.073
1/n	0.99938	0.99938	0.99938	0.999378	0.99938
Ks	0.02257	0.02484	0.02714	0.022572	0.01597
SSE	**22348.7**	25136.6	25793	22348.7	30792.2
ARE	6.15687	**5.78582**	6.37692	6.156882	6.43141
EABS	538.366	512.26	**495.348**	538.3666	661.758
HYBRID	131463	147862	151724	**131463**	181131
MPSD	10.5101	12.2643	13.0707	10.5101	**8.66173**
SNE	**4.02653**	4.24467	4.41536	4.026529	4.66268

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