Supplementary Materials

The first study of adsorption of methylene blue by Black Titania ($B-TiO_2$) nanoparticle in aqueous solution

Adsorption studies

A 500 mg. g^{-1} concentration standard solution of MB was prepared. The stock solution was diluted to prepare the initial MB concentrations to range 10 to 210 mg. g^{-1}. Afterward, batch mode adsorption equilibrium tests were used to examine MB adsorption on black titania. The experiments were done as follows: A few beakers with 10 mL MB at various concentrations were placed in an ultrasonic bath for 15 min. To each beaker, a constant quantity of $B-TiO_2$ was added, and they were covered to prevent evaporation. For determining the MB concentration at λ_{max}=665 nm in the aqueous solution, UV–Vis spectrophotometer was implemented according to the standard calibration curve method. The adsorbed MB on $B-TiO_2$ per unit weight of adsorbent (milligram MB per gram of adsorbent) called q_e, was calculated by the eqs (1), (2) and the removal efficiency (R%) of MB by eq (3).

$$q_e = \frac{(C_0 - C_e)V}{m} \quad (1)$$

$$q_e = \frac{(C_0 - C_t)V}{m} \quad (2)$$

$$R\% = \frac{(C_0 - C_e)}{C_0} \times 100 \quad (3)$$

where C_0 is the initial concentration (mg L^{-1}), C_e is the concentration at the equilibrium (mg L^{-1}), V is the dye solution volume (L), m is the adsorbent weight (g). For implementing adsorption isotherms, different MB concentrations (60, 110 and 210 mg L^{-1}), a fixed amount of sorbent (26 mg), at a constant pH = 6 (the weight of sorbent and also pH, were optimized throught a lot of tests under variable conditions), at room temperature for 60 min were performed. For analyzing and derive the empirical data and mechanism, it was required to evaluate different models such as Freundlich, Langmuir, and Temkin adsorption isotherms to identify the best one. For kinetic experiments, 26 mg of the adsorbent and 10 mL of MB solution with a constant concentration (10 mg L^{-1}) were placed in some beakers with pH = 6, which balanced by using either HCl (0.1 M) or NaOH (0.1 M).

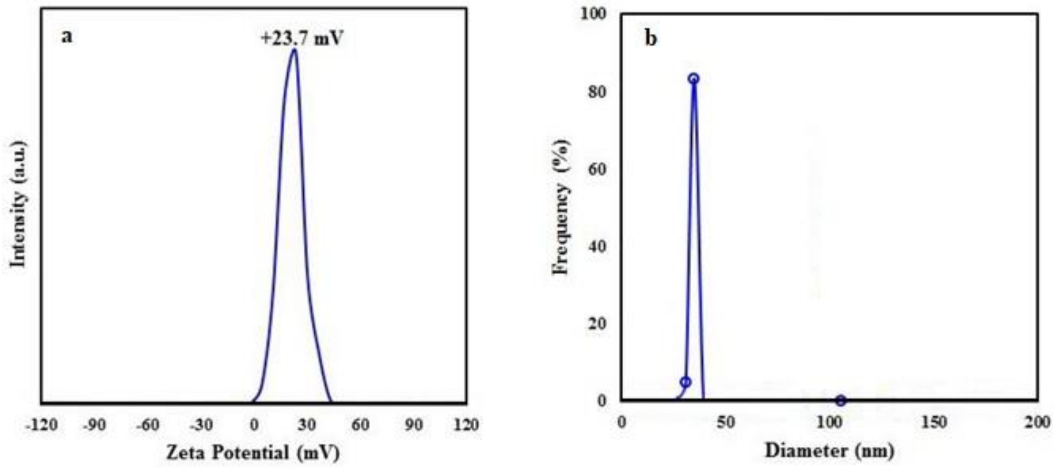

Figure S1. (a) Zeta potential and (b) DLS graph of B-TiO_2.

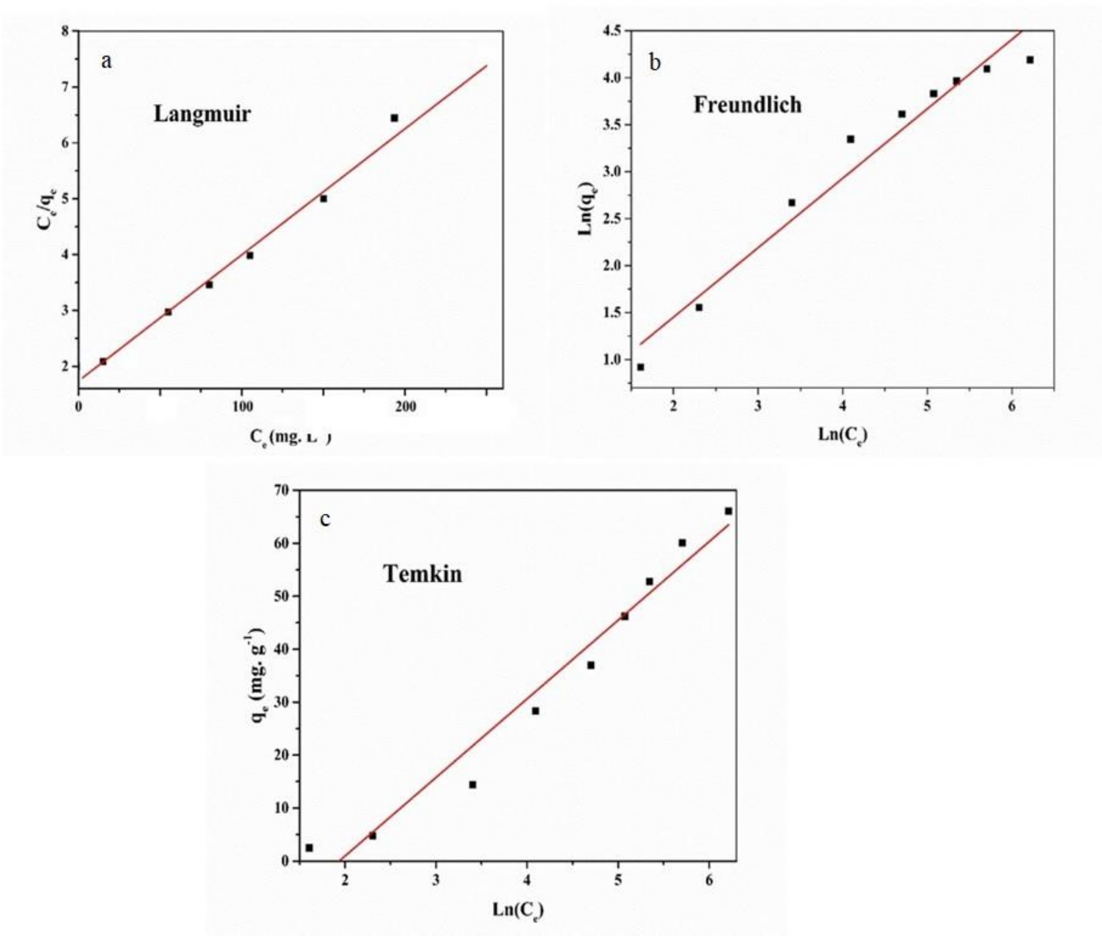

Figure S2. Plots of Langmuir (a), Freundlich (b) and Temkin (c) isotherm models for MB adsorption onto B-TiO_2. [pH = 6, RT]

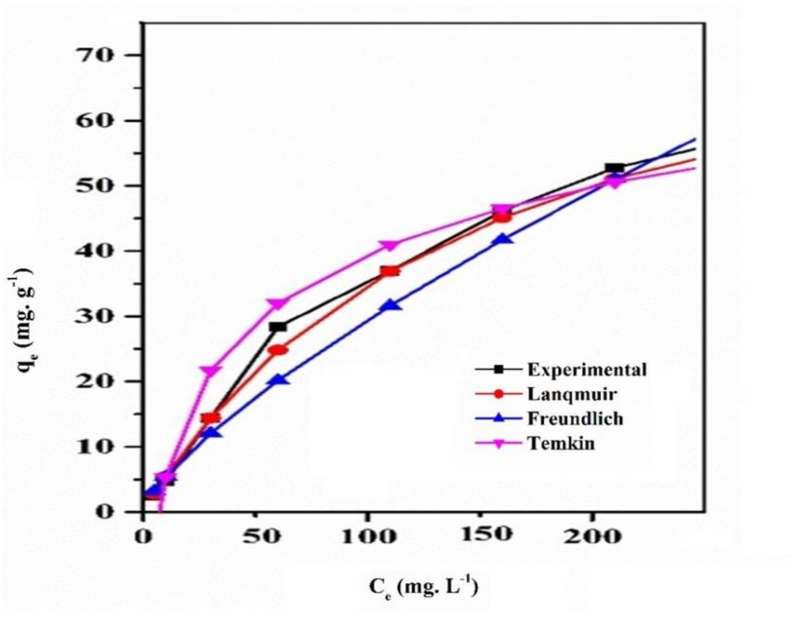

Figure S3. q_e versus C_e *for* different isotherm models. [pH = 6, RT]

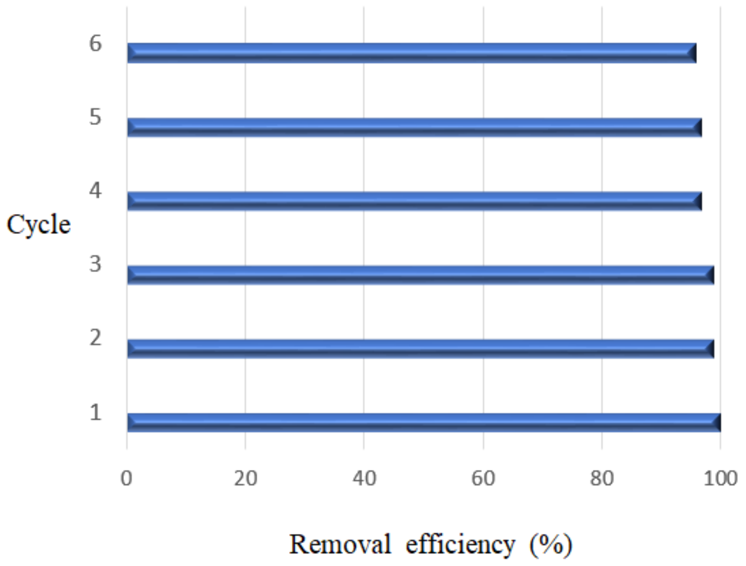

Figure S4. Reusability of B-TiO_2. [pH = 6, RT]

Table S1. Comparison of the isotherm parameters for MB adsorption by B-TiO_2. [pH = 6, RT]

Isotherm model	Parameter	
Langmuir	Q_m(mg g^{-1})	88.65
	K_a (L mg^{-1})	6.48 ×10^{-3}
	R^2	0.989
Freundlich	n_F	1.35
	K_F(L g^{-1})	0.972
	R^2	0.957
Temkin	A_T	0.144
	b_T	14.84
	R^2	0.957

Table S2. Comparison of kinetic model parameters. [pH = 6, RT]

		60 mg. L^{-1}	110 mg. L^{-1}	210 mg. L^{-1}
Experimental	q_e (exp.)	28.14	35.64	39.14

Pseudo 1th order	q_e (calc.)	5.34	2.21	6.71
	K_1	-0.29	-0.17	-0.20
	R^2	0.916	0.943	0.940
Pseudo 2nd order	q_e (calc.)	28.35	36.18	39.97
	K_2	0.21	0.08	0.13
	R^2	0.99999	0.99995	0.99999
Intraparticle diffusion	K_{dif}	1.438	1.128	2.298
	C	23.624	32.056	31.919
	R^2	0.983	0.991	0.986