## **Supporting Information**

## Mg-Al layered double hydroxide (LDH) modified diatoms for highly efficient removal of Congo Red from aqueous solution

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Figure S1. Structure of Congo Red.



Figure S2. FTIR spectra of after CR adsorption for DE and DE-LDH.

	50	Kint		С		$\mathbb{R}^2$	
	mg/L	-0.201		4.50		0.939	
DE	100	K <sub>int1</sub>	K <sub>int2</sub>	C <sub>1</sub>	C <sub>2</sub>	$\mathbb{R}^{2}_{1}$	$\mathbb{R}^{2}_{2}$
	mg/L	-0.414	-0.067	8.46	5.70	0.952	0.944
	250	K <sub>int1</sub>	K <sub>int2</sub>	<b>C</b> <sub>1</sub>	C <sub>2</sub>	$R^2_1$	$\mathbb{R}^{2}_{2}$
	mg/L	-1.483	-0.233	24.42	17.56	0.488	0.928
	50	Kint1	Kint2	C1	$C_2$	$\mathbb{R}^{2}$	$\mathbb{R}^{2}_{2}$
DE-LDH	mg/L	0.657	0.042	26.22	30.16	0.386	0.999
	100	K <sub>int1</sub>	K <sub>int2</sub>	C1	C <sub>2</sub>	$\mathbf{R}^{2}_{1}$	$\mathbb{R}^{2}_{2}$
	mg/L	1.61	0.154	50.64	59.26	0.558	0.857
	250	K <sub>int1</sub>	K <sub>int2</sub>	<b>C</b> <sub>1</sub>	C <sub>2</sub>	$\mathbb{R}^{2}_{1}$	$\mathbb{R}^{2}_{2}$
	mg/L	14.01	0.19	67.43	147.68	0.991	0.916

Table S1. Intraparticle diffusion constants of Congo red adsorption onto DE and DE-LDH.

Adsorption Isotherms. Interaction of dye with absorbent can be determined by adsorption isotherms i.e. Langmuir and Freundlich isotherm. If the interaction of absorbate on adsorbent sites is monolayer, known as Langmuir isotherm. The interaction of adsorbate on adsorbent sites is multilayer, known as Freundlich isotherm [1]. After dye adsorption, the materials were isolated and characterized by various techniques to understand the nature of the adsorption process.

The following linearized equations can be used to perform the isotherm model for the experiment:

For Langmuir isotherm,

$$\frac{C_e}{q_e} = \frac{1}{q_m K_L} + \frac{C_e}{q_m}$$
(S1)

Where  $q_m (mgg^{-1})$  denotes the maximum adsorption capacity of adsorbent and  $K_L (L. mg^{-1})$  denotes Langmuir constant related to the affinity of binding sites and adsorption energy. The Langmuir isotherm can be stated dimensionless separation factor [2],  $R_L$  which can describes the type of isotherm process either favorable ( $0 < R_L < 1$ ), unfavorable ( $R_L > 1$ ), linear ( $R_L = 1$ ) or irreversible process ( $R_L = 0$ ), which can be expressed in Eqn. (4):

$$R_{L} = \frac{1}{1 + K_{L}C_{0}}$$
(S2)

For Freundlich isotherm,

$$\ln q_e = \ln K_F + \frac{\ln C_e}{n}$$
(S3)

Where " $K_F$ " (mgg<sup>-1</sup>) and "n" are the Freundlich constants of adsorption capacity and adsorption tendency respectively. " $K_F$ " denotes an adsorption or distribution coefficient i.e. the amount of adsorbate adsorbed on adsorbent. The *n* can be expressed favorable adsorption process. The "1/n" value expressed energy distribution on adsorbent sites i.e. a value between 0 and 1 is adsorbent surface is heterogeneity. The surface become more heterogeneous if the value is nearly zero.

**Batch Kinetic Studies.** For the adsorption process, it is a very essential parameter to determine the time required for the adsorbate in aqueous media to get adsorbed on the surface of unit mass of absorbent. The concentration of adsorbate in aqueous media can be measured at certain time,  $q_t$  (mgg<sup>-1</sup>), was determined by Eq. (6):

$$q_t = \frac{C_0 - C_t}{M} \times V \tag{S4}$$

Where  $C_t$  (mgL<sup>-1</sup>) is concentration of adsorbate in aqueous solution at a certain time t (h).

The kinetic models pseudo-first-order, pseudo-second-order and intra-particle diffusion were used to determine the adsorption kinetics of adsorbate onto adsorbent sites. The following equations were used for fitting the adsorption kinetics [3]:

For pseudo-first-order kinetic model,

$$\log(q_{e} - q_{t}) = \log q_{e} - \frac{K_{1}}{2.303}t$$
(S5)

For pseudo-second-order kinetic model,

$$\frac{t}{q_t} = \frac{1}{K_2 q_e^2} + \frac{t}{q_e}$$
(S6)

For intra-particle diffusion,

$$q_t = K_{int} t^{1/2} + C \tag{S7}$$

Where  $K_1 \text{ (min}^{-1}\text{)}$  and  $K_2 \text{ (g}^{-1}\text{mg}^{-1}\text{min}^{-1}\text{)}$  are the adsorption rate constant of pseudo-first-order and pseudo-second-order adsorption kinetics respectively.  $q_e \text{ (mgg}^{-1}\text{)}$  and  $q_t \text{ (mgg}^{-1}\text{)}$  are the amounts of adsorbate adsorbed at equilibrium and time 't' respectively.  $K_{int} \text{ (mgg}^{-1}\text{min}^{-1/2}\text{)}$  denotes intra-

particle diffusion rate constant and C (mgg<sup>-1</sup>) was the thickness of the boundary layer of adsorbate on adsorbent sites. Here,  $K_{int}$  is slope and C is the intercept which are obtained from linearized plot of 'q<sub>t</sub> vs t<sup>1/2</sup>'.

## References

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