

Supporting Information: Chitosan/Zeolite Composite Aerogels for a Fast and Effective Removal of Both Anionic and Cationic Dyes from Water

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S1. FTIR analysis

Fourier Transform Infrared (FTIR) analysis was performed in Attenuated Total Reflectance (ATR) mode with a Perkin Elmer Spectrum 3 Delta. The ATR spectra of chitosan and chitosan-zeolite aerogels were recorded at a resolution of 4 cm^{-1} and 4 scan collections and reported in Figure S1.

The spectrum of CS sample is characterized by stretching vibrations of OH and amine groups (around 3300 cm^{-1}) [1]. Moreover, CH_3 symmetric stretching, C-O-C stretching, and C-OH stretching are visible at around 2920 cm^{-1} , 1150 cm^{-1} and 1065 cm^{-1} , respectively [1]. CS-ZX sample spectrum reflects the composition of the composite, with the compresence of the characteristic bands of zeolite (~ 750 and 680 cm^{-1} : symmetrical stretching vibration of Al-O-Al and Si-O-Si [2]; $\sim 970\text{ cm}^{-1}$: Si-O stretching vibrations [3]) and chitosan.

Crosslinking is induced by Glutaraldehyde in both samples, as proved by the presence of the peaks at 1655 cm^{-1} and at 1562 cm^{-1} , that can be addressed to the formation of imine $\text{N}=\text{C}$ and ethylenic $\text{C}=\text{C}$ bonds, respectively [1]. Moreover, complete crosslinking is ensured by the absence of unreacted GLA, as highlighted by the absence of free aldehydic groups peak at 1720 cm^{-1} [1].

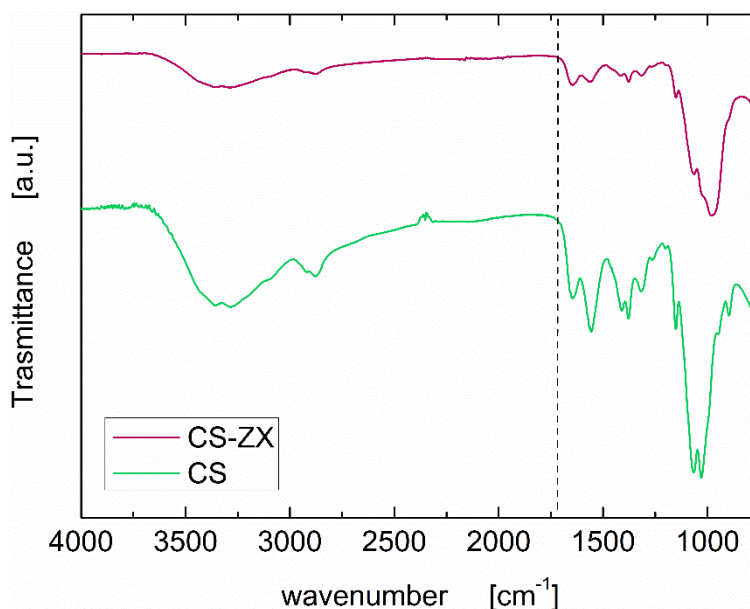


Figure S1. FTIR spectra of CS and CS-ZX aerogels. Baseline correction was applied to the spectra, which are also vertically shifted for the sake of clarity.

S2. Fitting of adsorption isotherms

The adsorption isotherms in Figure 3 of the main text were fitted to the Langmuir and Freundlich models, according to Equation S1 and S2, respectively. The obtained best fitting parameters are reported in Table S1 together with R-squared parameter (RS).

$$q_e = \frac{q_e^{\max} b C_e}{1 + b C_e} \quad (S1)$$

$$q_e = k C_e^{1/n} \quad (S2)$$

Table S1. Langmuir and Freundlich model parameters for all the investigated systems.

		IC		
		CS	CS-ZX	ZX
Langmuir	q_e^{\max} [mg/g]	302.27±8.91	372.83±29.15	3.79·10 ⁵ ±1.66·10 ⁸
	b [L/mg]	0.32±0.06	2.96·10 ⁻³ ±4.41·10 ⁻⁴	2.69·10 ⁻⁷ ±1.18·10 ⁻⁴
	RS	0.99	0.99	0.99
Freundlich	k [L/mg]	110.65±19.32	4.74±1.65	0.07±0.02
	n	5.36±1.02	1.60±1.16	0.93±0.03
	RS	0.93	0.99	0.99
		MB		
		CS	CS-ZX	ZX
Langmuir	q_e^{\max} [mg/g]	9.20±1.90	7058.95±208.39	850.81±304.32
	b [L/mg]	0.47·10 ⁻³ ±0.26·10 ⁻²	2.89·10 ⁻⁴ ±9.74·10 ⁻⁵	3.35·10 ⁻⁴ ±1.39·10 ⁻⁴
	RS	0.86	0.99	0.99
Freundlich	k [L/mg]	0.49±0.30	0.32±0.05	0.51±0.08
	n	1.14±0.03	1.11±0.03	2.44±0.62
	RS	0.99	0.99	0.88

The kinetics in Figure 4 of the main text were fitted to the Pseudo First (equation S3) and Pseudo Second Order (Equation S4) and the obtained best fitting parameters are reported in Table S2 together with R-squared parameter.

$$q_t = q_e \left(1 - e^{-k_1 t}\right) \quad (S3)$$

$$q_t = \frac{q_e^2 k_2 t}{1 + q_e k_2 t} \quad (S4)$$

Table S2. Kinetic plots fitting parameters for CS-ZX aerogels.

		IC	MB
Pseudo First Order	q_e [mg/g]	94.96±1.79	30.77±0.69
	k_1 [s ⁻¹]	0.032±0.002	0.060±0.006
	RS	0.99	0.98
Pseudo Second Order	q_e [mg/g]	107.94±5.37	33.78±0.10
	k_2 [s ⁻¹]	3.54·10 ⁻⁴ ±8.78·10 ⁻⁵	0.002±3.88·10 ⁻⁴
	RS	0.97	0.98

S3. TGA analysis

Thermogravimetric (TG) analyses were carried out using a TGA Q500 (TA Instruments) with a heating rate of 20 °C min⁻¹ in air atmosphere from 25 °C to 700 °C. CS-ZX samples subjected to the three regeneration cycles have been dried overnight at 60 °C under vacuum and then subjected to thermogravimetric analysis. A representative thermogram is reported in Figure S2, together with that of a freshly prepared CS-ZX sample. Apart from the different content of adsorbed water (corresponding to the weight loss up to 200 °C), the two curves are comparable, suggesting that the leaching of zeolite after the regeneration cycles is essentially negligible.

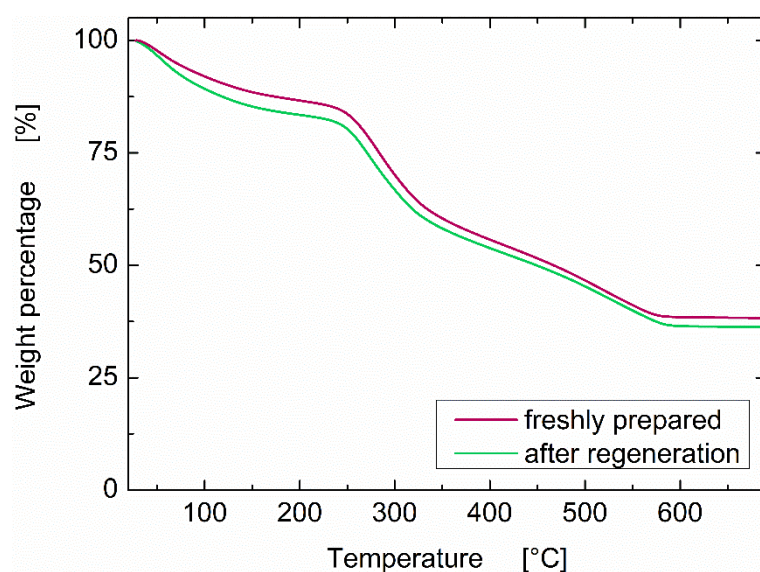


Figure S2. TG curves of CS-ZX aerogels freshly prepared and after three regeneration cycles.

References

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