Supplementary materials

Facile synthesis of Zn(Al)O/C for effective adsorption of organic dye and waste resource utilization

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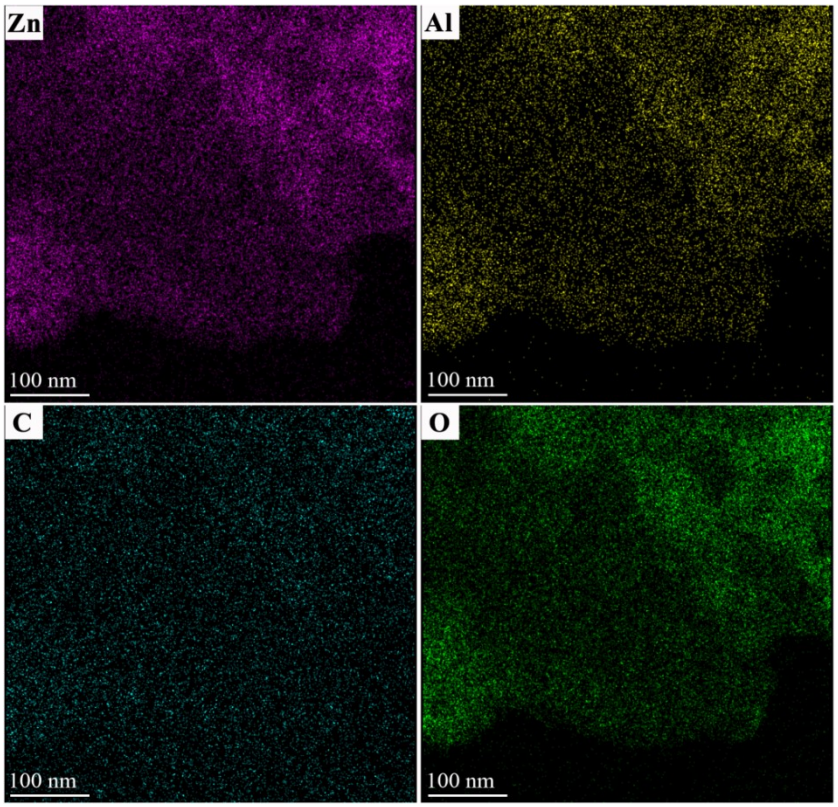

Fig.S1. Elemental mapping images of Zn(Al)O/C.

Table S1 Surface parameters of Zn(Al)O/C and Zn(Al)O.

Sample	**SBET** ($m^2 \cdot g^{-1}$)	**Vp** ($cm^3 \cdot g^{-1}$)	**P** (nm)
Zn(Al)O/C	135.9	0.40	3.57
Zn(Al)O	107.9	0.53	7.19

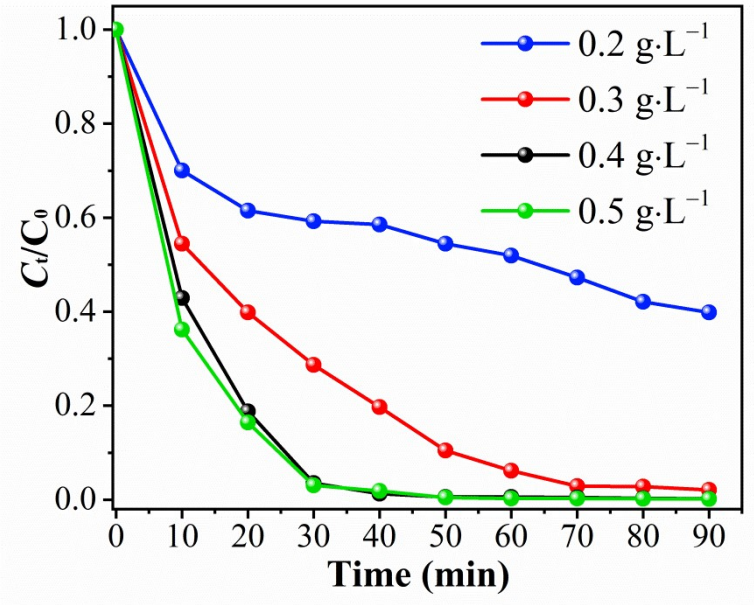

Fig. S2. Effect of adsorbent dosage on removal of CR.

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Table S2 Kinetic parameters for the CR adsorption by prepared Zn(Al)O/C and Zn(Al)O.

Adsorbents	$q_{e,exp}$ (mg·L^{-1})	pseudo-first-order kinetic model			pseudo-second-order kinetic model		
		$q_{e,calc1}$ (mg·g^{-1})	k_1(min^{-1})	R^2	$q_{e,calc2}$ (mg·g^{-1})	k_2 (×10^{-5}g·mg^{-1}·min^{-1})	R^2
Zn(Al)O/C	1244.5	1694.4	0.0422	0.9763	1448.1	2.84	0.9920
Zn(Al)O	1244.0	1881.7	0.0370	0.9696	1550.4	1.70	0.9767

■

Adsorption isothermal models

$$\frac{C_e}{q_e} = \frac{1}{K_L q_m} + \frac{C_e}{q_m} \qquad \text{Eq. (S1)}$$

$$lgq_e = \lg K_F + \frac{1}{n} lgC_e \qquad \text{Eq. (S2)}$$

where, C_e (mg·L^{-1}) is the equilibrium concenratin; q_e (mg·g^{-1}) and q_m (mg·g^{-1}) represent the equilibrium capacity and maximum adsorption capacity, respectively; K_L (L· mg $^{-1}$) and K_F[(mg·g $^{-1}$)·(L· mg $^{-1}$) 1/n] are the constants, and 1/n is the heterogeneity factor.

Table S3 Isotherm parameters for CR removal of the Zn(Al)O/C and Zn(Al)O.

Adsorbents	Langmuir model			Freundlich model		
	q_{max}	K_L	R_L^2	K_F	n	R_F^2

	($mg \cdot g^{-1}$)	($L \cdot mg^{-1}$)		($mg \cdot g^{-1}$)		
Zn(Al)O/C	2240.4	0.432	0.9998	1335	10.16	0.9876
Zn(Al)O	1776.4	0.664	0.9992	1201	13.50	0.9805

Table S4 The dissolved concentration of metal ions during the adsorption.

Total Zn ($mg \cdot L^{-1}$)	Total Al ($mg \cdot L^{-1}$)
0.897	0.033

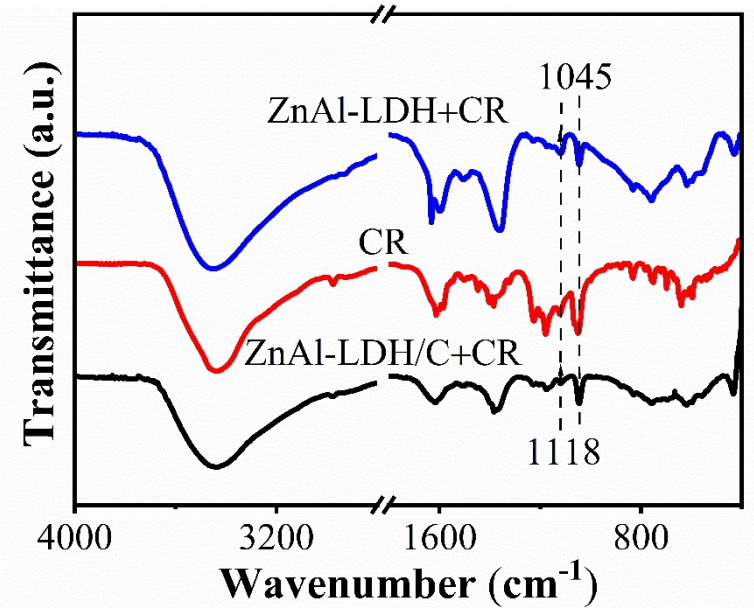

Fig. S3. FTIR spectra of CR dye and the adsorbents after adsorption.

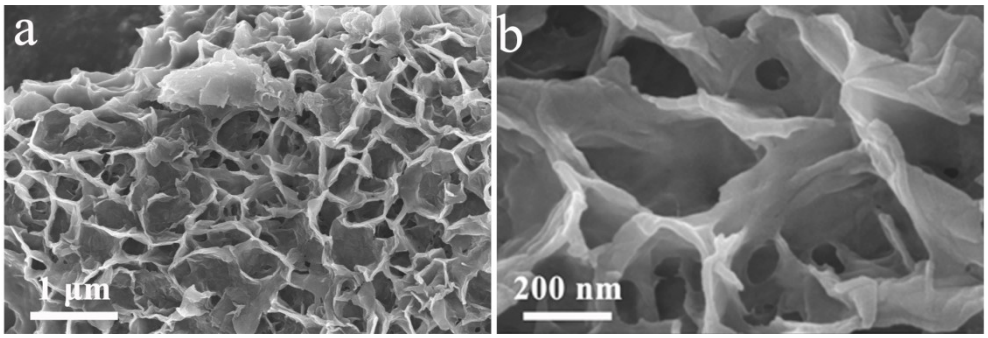

Fig. S4. SEM images of the adsorbent after adsorption of CR dye.

Table S5. Physicochemical properties of lake water

Chemical oxygen demand (COD) ($mg \cdot L^{-1}$)	Total organic carbon (TOC) ($mg \cdot L^{-1}$)	Total nitrogen (TN) ($mg \cdot L^{-1}$)	Total phosphorus (TP) ($mg \cdot L^{-1}$)	Conductivity
13.36	12.04	1.19	0.22	565

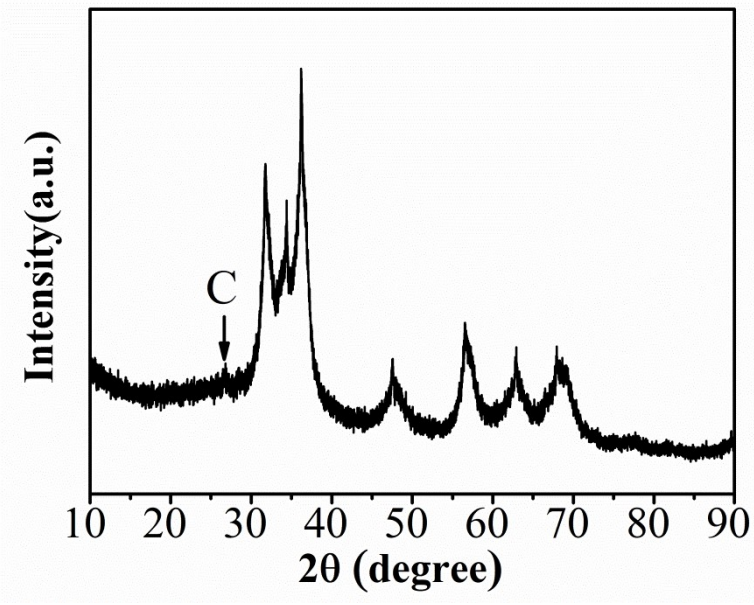

Fig. S5. XRD pattern of product annealed at 600°C after adsorption of CR dye.

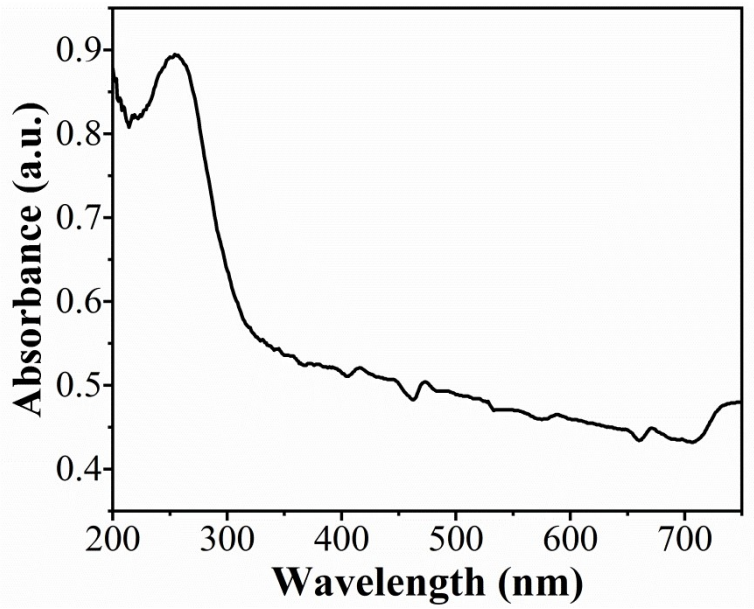

Fig. S6. UV–vis DRS of N/S co-doped porous carbon.

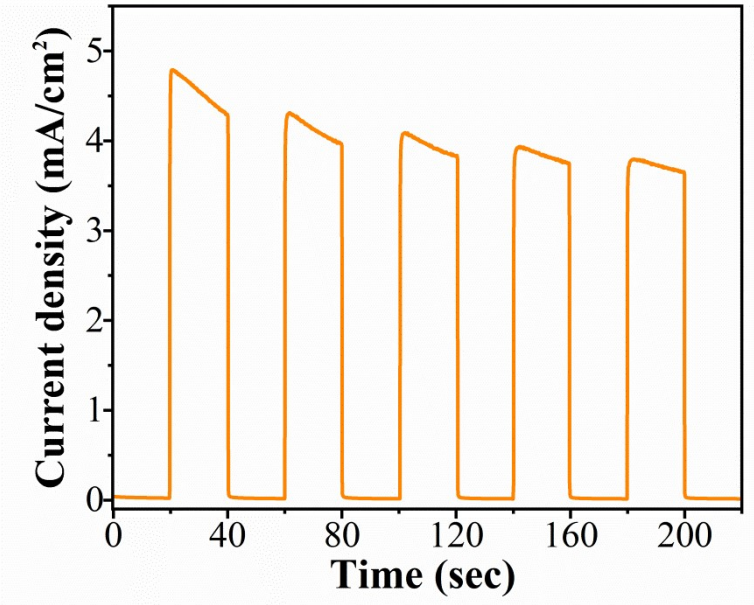

Fig. S7. Photocurrent responses of N/S co-doped porous carbon obtained under dark and visible light irradiation.