

## Supplementary Materials

### A novel organic/inorganic dual Z-scheme photocatalyst with visible-light response for organic pollutants degradation

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#### Kinetic model analysis

The photodegradation kinetics study for the composite membrane were identified with the Langmuir–Hinshelwood (L–H) model and expressed as Equation (1):

$$r = -\frac{dC}{dt} = \frac{kKC}{1+KC} \quad (1)$$

where  $r$  was the degradation rate,  $C$  ( $\text{mg L}^{-1}$ ) was the concentration of RhB,  $t$  (min) was the running time of the simulated sunlight irradiation,  $k$  ( $\text{mg L}^{-1} \text{min}^{-1}$ ) was the reaction rate constant, and  $K$  ( $\text{L mg}^{-1}$ ) was the equilibrium constant. The term  $kK$  could be regarded as an apparent rate constant  $k_{app}(\text{min}^{-1})$ . Therefore, Equation (1) was expressed as Equation (2):

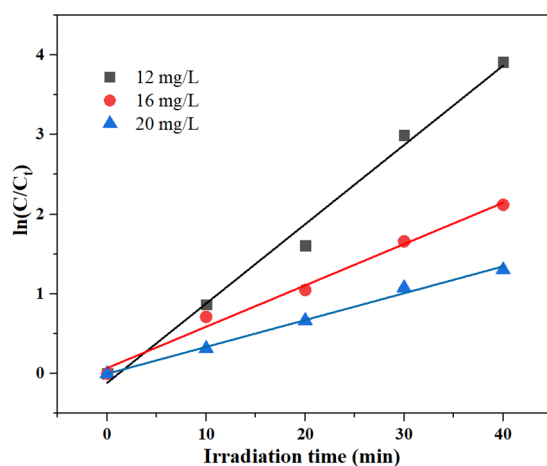
$$r = -\frac{dC}{dt} = \frac{k_{app}C}{1+KC} \quad (2)$$

where  $KC \ll 1$  in lower-concentration solutions of RhB. The above equation could be simplified to the first-order equation and expressed as Equation (3):

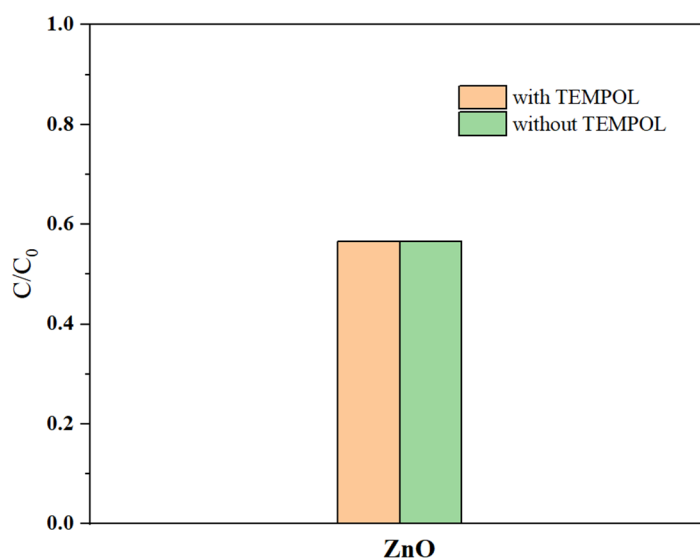
$$r = -\frac{dC}{dt} = k_{app}C \quad (4)$$

#### Treatment cost analysis

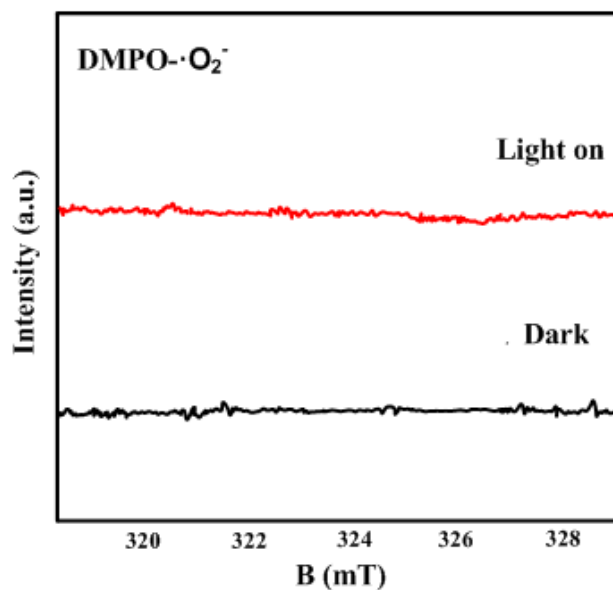
To synthesize 20 g PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO, 20 g PAN, 10 g PANI, 15.2 g SbCl<sub>3</sub>, 24 g Na<sub>2</sub>S and 500 ml of HCl were required. Electricity was required for ultrasonic, high-voltage power supply, magnetic stirring and oven. This brought the cost of 20 g PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO to 150 CNY (20.54 USD) and the rate to 7.5 CNY (1.027 USD) per gram. To treat the 10,000 L of RhB (12 mg/L), 33.4 g PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO were required. Electricity was required for UV light and magnetic stirring of the solution. The cost of treatment of 10,000 L of RhB was 250 CNY (34.23 USD).



**Figure S1** Corresponding reaction rate diagram of RhB with different initial concentrations by PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO.



**Figure S2** The degradation of RhB by ZnO with or without TEMPOL. [Experimental conditions: Initial concentration = 12 mg/L, photocatalyst = 0.2 g, TEMPOL concentration=10Mm, pH value for RhB solutions = 10, t = 40 min, UV light irradiation]



**Figure S3** ESR spectra of radical adducts trapped by DMPO in ZnO for superoxide radical.

**Table S1** The pseudo-first order kinetic model kinetic parameters of RhB photocatalytic experiments.

Photocatalyst	$k_{app}$ ( $10^{-3} \text{ min}^{-1}$ )	$t_{1/2}$ (min)	$R^2$
PAN/PANI	32.3	21.4	0.99
PAN/PANI-Sb <sub>2</sub> S <sub>3</sub>	42.9	16.1	0.998
PAN/PANI-Sb <sub>2</sub> S <sub>3</sub> -ZnO	59.8	11.6	0.997

**Table S2** The pseudo-first order kinetic model kinetic parameters of RhB, MB, CR and MO photocatalytic experiments by PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO.

dyes	$k_{app}$ ( $10^{-3} \text{ min}^{-1}$ )	$t_{1/2}$ (min)	$R^2$
RhB	59.8	11.6	0.997
MB	45.1	15.3	0.988
CR	38.4	18.1	0.992
MO	36.7	18.9	0.994

**Table S3** Comparison of degradation rate of PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO with other photocatalysts toward RhB and MB.

Photocatalyst	Pollutants	degradation rate	Ref.
AgInS <sub>2</sub> /CN/PAN	RhB	94.48%	[1]
P <sub>2</sub> Mo <sub>5</sub>	RhB	89.57%	[2]
TiO <sub>2</sub> /BP/g-C <sub>3</sub> N <sub>4</sub>	RhB	87.39%	[3]
In <sub>2</sub> O <sub>3</sub> /SnO <sub>2</sub>	MB	50.9%	[4]
Eu:GO/KSrPO <sub>4</sub>	MB	82.75%	[5]
MDTS	MB	83%	[6]
PAN/PANI-Sb <sub>2</sub> S <sub>3</sub> -ZnO	RhB	99.2%	This work
	MB	96.42%	

**Table S4** L-H model kinetic parameters for different initial concentrations of RhB by PAN/PANI-Sb<sub>2</sub>S<sub>3</sub>-ZnO.

Photocatalyst	initial concentrations of RhB	$k_{app}(\text{min}^{-1})$	$R^2$
PAN/PANI-Sb <sub>2</sub> S <sub>3</sub> -ZnO	12 mg/L	0.0995	0.986
	16 mg/L	0.0518	0.987
	20 mg/L	0.0337	0.991