Anthraquinone and its derivatives as a recyclable photocatalyst for Efficient Photocatalytic Degradation of Rhodamine B under visible light

Dabo Jiang [a, c], Mayin Zhang [c], Wenyi Meng [c], Junzuo Zhou [c], Shuting Liang [c], Tao Yang [c], Cheng Yang [c], Anqun Su[b, *], Guanghui Zhang [d, *], Longjun Xu [a]

[a] State Key Laboratory of Coal Mine Disaster Dynamics and Control, Chongqing University, Chongqing 400044, PR China

[b] Hunan University of Medicine, Huaihua, 418000, PR China.

[c] Chongqing Key Laboratory for Resource Utilization of Heavy Metal Wastewater, Aquatic Ecosystems in the Three Gorges Reservoir Region of Chongqing Observation and Research Station, Chongqing University of Arts and Sciences, Yongchuan 402160, PR China

[d] State Key Laboratory of Fine Chemicals, Frontier Science Center for Smart Materials, PSU-DUT Joint Center for Energy Research, School of Chemical Engineering, Dalian University of Technology, Dalian 116024, PR China.

E-mail: *sueanqun@126.com (A. Su)*, *gzhang@dlut.edu.cn (G. Zhang)*

Supporting information:

1.The self-assembly photo-reactor

Figure S1 shows a self-assembled photo-reactor used in this study, 35 W tungsten-bromine lamp as a built-in light source.

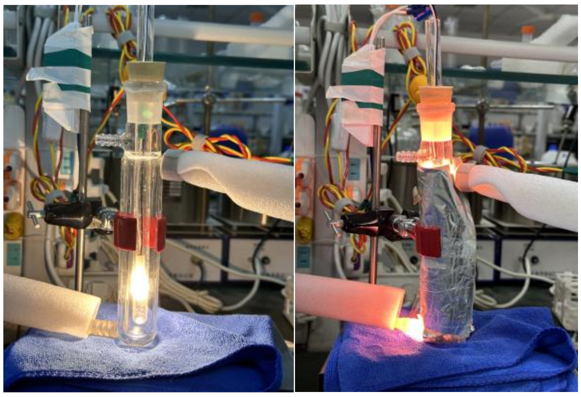

Figure S1. The self-assembled photo-reactor used this work

2.The tungsten-bromine lamp's emission spectrum

Figure S2 displays the emission spectra of the tungsten–bromine lamp. It can be seen from the emission spectra that the lamp used this work may emit a broad visible light from 380 to 940 nm and its emission light about 400 nm can overlap with absorption of photo-catalyst AQ.

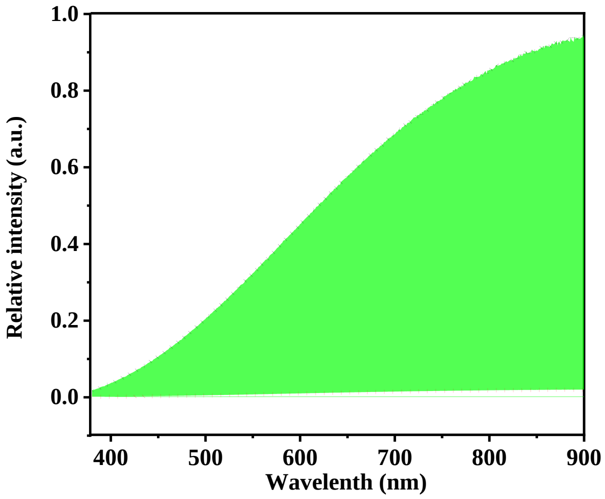

Figure S2. The tungsten-bromine lamp's emission spectrum

3. The reaction solution of RhB at different times

Figure S3 shows photos of the reaction solutions at different AN dosage under standard conditions. It can be clearly found from Figure S3 that the yellow solid (mainly AQ) generated during the reaction gradually increases with the increase in the AN dosage, which leads to the turbidity of the reaction solution and seriously affects the transmittance of visible light.

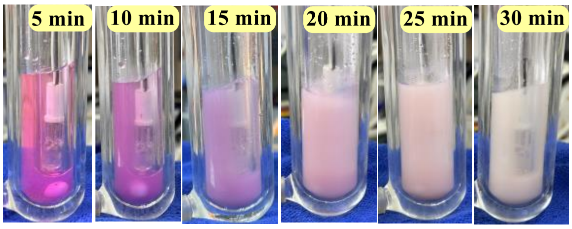

Figure S3. The reaction solution in the reactor at different AN dosage

4. The dispersion diagram of AQ-NH_2 and AQ-COOH in water

Figure S4 shows that AQ-NH_2 in water results in a highly concentrated color, AQ-COOH in water exhibits a light color. AQ-NH_2 can significantly impact the transmission of visible light and thus reduce its photocatalytic efficiency.

Figure S4. The dispersion diagram of AQ-NH_2 and AQ-COOH in water

5. The pH value of AQs in water

In order to prove that the H^+ produced by ionization of AQ-COOH can promote the photodegradation of RhB, the pH value of AQs in water was tested and the results are shown in Figure S5. The results showed that AQ-COOH has the lowest pH value and can be ionized to produce H^+, and the generated H^+ has a significant effect on the photodegradation of RhB.

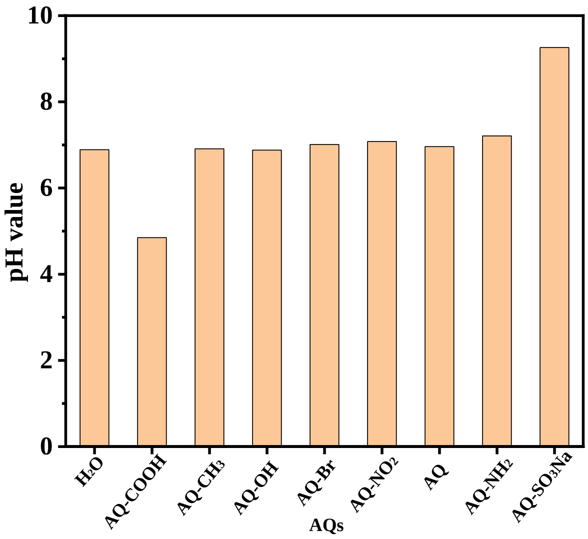

Figure S5. The pH value of AQs in water

6. The kinetic rate constant (k) of AQs in the presence or absence of 0.1 mmol·L^{-1} hydrochloric acid solution

The kinetic rate constant (k) of AQs in the presence or absence of 0.1 mmol·L^{-1} hydrochloric acid solution is shown in Table S1. The findings indicate that AQ-COOH demonstrates exceptional catalytic performance for the photodegradation of RhB, and its performance is significantly improved in an acidic environment.

Table S1. The kinetic rate constant (k) of AQs in the presence or absence of 0.1 mmol·L^{-1} hydrochloric acid solution

AQs	Without HCl		With HCl	
	k/min^{-1}	R^2	k/min^{-1}	R^2
AQ	0.0263	0.988	0.0554	0.996
AQ-OH	0.0095	0.964	0.0214	0.943
AQ-CH_3	0.0355	0.991	0.0750	0.998
AQ-SO_3Na	0.0038	0.969	0.0129	0.933
AQ-COOH	0.1509	0.987	0.4772	0.987
AQ-NO_2	0.0628	0.925	0.1631	0.917
AQ-Br	0.0055	0.967	0.2016	0.935
AQ-NH_2	0.0012	0.966	0.0362	0.982