## **Electronic Supplementary Information (ESI)**

Syntheses and structures of two gold(I) coordination compounds derived from P-S hybrid ligands and their efficient catalytic performance in the photodegradation of nitroaromatics in water

Hai-Xiao Qi,<sup>a</sup> Jian-Feng Wang,<sup>a</sup> Zhi-Gang Ren,<sup>\*, a</sup> Jin-Jiao Ning,<sup>a</sup> and Jian-Ping Lang<sup>\*, a,b</sup>

<sup>a</sup> College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou 215123, P. R. China

<sup>b</sup> State Key Laboratory of Organometallic Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, Shanghai 200032, P. R. China

\*E-mail: jplang@suda.edu.cn

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Fig. S1 Equipment used to collect the released CO<sub>2</sub> in the degradation reactions.



**Fig. S2** PXRD patterns for **1**: simulated from single crystal data; single-phase polycrystalline sample; samples after catalyzed the photodegradation of NB, PNP, DNP after the first cycle (NB-1, PNP-1, DNP-1) and the fifth cycle (NB-5, PNP-5 DNP-5).



**Fig. S3** PXRD patterns for **2**: simulated from single crystal data; single-phase polycrystalline sample; samples after catalyzed the photodegradation of NB, PNP, DNP after the first cycle (NB-1, PNP-1, DNP-1) and the fifth cycle (NB-5, PNP-5 DNP-5).



Fig. S4 The TGA curves for complexes 1 and 2.



Fig. S5 Solid-state UV-vis absorption spectra of compounds 1 and 2.



Fig. S6 UV-Vis spectra of the aqueous solution of NB(a), PNP(b) and DNP(c) with 1 in dark. Black: only mixed, red: stirred for 3.5 to 4 hours. Catalyst loading: 20 mg (1); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; in dark.



Fig. S7 UV-Vis spectra of the aqueous solutions of NB(a), PNP(b) and DNP(c) with 2 in dark. Black: just mixed, red: stirred for 4 to 6 hours. Catalyst loading: 12 mg (2); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; in dark.



Fig. S8 UV-Vis spectra of the aqueous solution of NB(a), PNP(b) and DNP(c) without catalyst. Black: before irradiation, red: after irradiation. Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Fig. S9 UV-Vis spectra of the solutions of NB(a), PNP(b), DNP(c) after irradiation at different time intervals in the presence of 2. Catalyst loading: 12 mg (2); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



**Fig. S10** PXRD patterns for [Au<sub>2</sub>(dppm)<sub>2</sub>]Cl<sub>2</sub>: experimental (black); samples after catalyzed the photo-degradation of NB, PNP, DNP (NB: green; PNP: red; DNP: blue)



**Fig. S11** UV-Vis spectra of the solutions of NB(a), PNP(b), DNP(c) after UV irradiation for different time intervals in the presence of [Au<sub>2</sub>(dppm)<sub>2</sub>]Cl<sub>2</sub>.

**Table S1**Degradation time in control experiments by using 1 and 2 with smaller surface areas.

catalyst	NB	PNP	DNP
1	9h	7.5h	10h
2	11h	8h	13h

**Table S2** The concentrations of gold ion left in the residual solutions after the UV irradiationusing ICP method.

catalyst	substrate	Gold ion (mg/L)	Au mol%
1	NB	0.0293	0.016
	PNP	0.0266	0.015
	DNP	0.0261	0.014
2	NB	0.0270	0.015
	PNP	0.0284	0.015
	DNP	0.0255	0.014

 Table S3 Elemental analysis before and after catalysis for 1 and 2.

EA	С	Н	Ν
1: before	45.27	3.92	6.01
1: after	45.24	3.89	5.97
2: before	36.79	3.13	
<b>2</b> : after	36.67	3.01	



**Fig. S12** The <sup>1</sup>H NMR spectra of **1** and **2** in DMSO-d<sub>6</sub>: a: before catalyzed the photodegradation of NB; b: after catalyzed the photodegradation of NB.



**Fig. S13** The <sup>31</sup>P NMR spectra of **1** and **2** in DMSO-d<sub>6</sub>: a: before catalyzed the photodegradation of NB; b: after catalyzed the photodegradation of NB.



**Fig. S14** Recycling experiments using **1** as a catalyst for the photodegradation of PNP (a) and DNP (b) and using **2** as a catalyst for the photodegradation of NB(c), PNP (d) and DNP (e) under UV light. The black squares and the lines are the experimental data and the fitted least-square line, respectively.



**Fig. S15** The SEM images of **2** before (a, c) and after (b, d) irradiation in the catalytic photodegradation of NB.



Fig. S16 UV-Vis spectra of the aqueous NB(a), PNP(b) and DNP(c) solutions which were re-adjusted to  $5 \times 10^{-4}$  M by adding the substrates into the centrifugalized solutions after the degradations catalyzed by 1. Black: before irradiation, red: after irradiation. Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Fig. S17 UV-Vis spectra of the aqueous NB(a), PNP(b) and DNP(c) solutions which were re-adjusted to  $5 \times 10^{-4}$  M by adding the substrates into the centrifugalized solutions after the degradations catalyzed by 2. Black: before irradiation, red: after irradiation. Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Fig. S18 UV-Vis spectra of the filtrates after stirring the mixture of 1 and NB(a), PNP(b) or DNP(c) for 2 hours. Black: before irradiation, red: after irradiation. Catalyst loading: 20 mg (1); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Fig. S19 UV-Vis spectra of the filtrates after stirring the mixture of 2 and NB(a), PNP(b) or DNP(c) for 2 hours. Black: before irradiation, red: after irradiation. Catalyst loading: 12 mg (2); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Fig. S20 UV-Vis spectra of the aqueous solution of NB(a), PNP(b) and DNP(c) in the presence of HAuCl<sub>4</sub>·4H<sub>2</sub>O under UV irradiation. Black: before irradiation, red: after irradiation. Catalyst loading: 6 mg (HAuCl<sub>4</sub>·4H<sub>2</sub>O); Substrates: 5 × 10<sup>-4</sup> M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Fig. S21 UV-Vis spectra of the aqueous solution of NB(a), PNP(b) and DNP(c) in the presence of dppatc under UV irradiation. Black: before irradiation, red: after irradiation. Catalyst loading: 7 mg (dppatc); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.



Scheme S1 Proposed mechanism of the catalytic photodegradation reactions.



Fig. S22 UV-Vis spectra of the aqueous solution of NB with 1 (a) and 2 (b) in the presence of *t*-BuOH under experimental conditions. Black: before irradiation, red and blue: after irradiation. Catalyst loading: 20 mg (1) and 12mg (2); Substrates:  $5 \times 10^{-4}$  M in 30 mL H<sub>2</sub>O; UV light-power density: 25 mW/cm<sup>2</sup>.