**Supplementary Material**

**Synergistic improvement of Cr (VI) reduction and RhB degradation using**

**RP/g-C3N4 photocatalyst under visible light irradiation**

Enzhou Liua, \*, Yanyan Dua, Xue Baia, Jun Fana, \*, Xiaoyun Hub

aSchool of Chemical Engineering, Northwest University, Xi’an 710069, P. R. China.

bSchool of Physics, Northwest University, Xi’an 710069, P. R. China.

\*e-mail address: liuenzhou@nwu.edu.cn and fanjun@nwu.edu.cn

**Characterization methods**

X-ray diffraction (XRD) of the samples was investigated by a Shimadzu XRD-6000 powder diffractometer. Fourier transform infrared spectra (FT-IR) were tested with a Perkin-Elmer Frontier FT-IR spectrometer with KBr pellets in the region of 4000-500cm−1. Scanning electron microscopy (SEM, Carl Zeiss SIGMA) and transmission electron microscopy (TEM, JEOL JEM-2100) were applied to survey the morphology and elemental composition of the samples. X-ray photoelectron spectroscopy (XPS) was performed with a Kratos AXIS NOVA spectrometer. Ultraviolet visible diffuse reflection (UV-vis) and Photoluminescence (PL) spectra were carried out with a Perkin Elmer Lambda 950 spectrometer in the region of 200-1000 nm and a Hitachi-F7000 florescence spectrophotometer, respectively. Quantachrome Instrument was applied to measure the specific surface area (BET) of samples by N2 adsorption-desorption.



**Fig. S1** The change in UV-vis absorption spectra and removal efficiencies of Cr (VI) and RhB by (a, b) 20%-RP/g-C3N4, (c d) 33%-RP/g-C3N4.



**Fig. S2** The change in UV-vis absorption spectra and removal efficiencies of Cr(VI) and RhB by (a, b)50%-RP/g-C3N4, (c d) 60%-RP/g-C3N4 and (e) The removal efficiencies comparison of composite samples for Cr (VI) and RhB.



**Fig. S3** (a) The change in UV-vis absorption spectra. (b) Removal efficiencies of Cr (VI) and RhB over 50%-RP/g-C3N4 by physical mixing of two materials.

**Fig. S4** Comparison of XRD (a) and XPS (b, c, d) spectra of catalysts before and after photocatalytic reaction.



**Fig. S5** The adsorption capacity test of RhB and MB by 50%-RP/g-C3N4.



**Fig. S6** The change in UV-vis absorption spectra and (b) removal efficiencies

of Cr(VI) and Phenol mixture by 50%-RP/g-C3N4.



**Fig. S7** Pore size distribution of the samples.

**Table S1** The specific surface area, pore diameter and pore volume of the samples.

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **SBET(m2/g)** | **Pore size(nm)** | **Pore volume(cm3/g)** |
| **g-C3N4** | **83.987** | **3.368** | **0.660** |
| **RP** | **53.111** | **3.742** | **0.216** |
| **50%-RP/g-C3N4** | **79.253** | **3.761** | **0.586** |

**Table S2** The RP-related photocatalysts reported in the literatures.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Materials** | **Morphology** | **Precursor** | **Preparation method** | **Application** | **Weight of samples** | **Light source** | **Result (optimum sample)** | **Ref. in the manuscript** |
| **RP/MoS2** | Nanoparticles/  Nanosheets | RP H2NCSNH2  (NH4)6Mo7O24 | Hydrothermal | Removal of RhB and Cr(VI) | 20mg | 300 W xenon lamp  λ>420nm | 72.7% Cr(VI) and 97.5% RhB were removed within 80 min. | Bai et al., 2018 |
| **RP/MoS2**  **/rGO** | Nanoparticles/  Nanosheets | RP H2NCSNH2  (NH4)6Mo7O24 GO | Hydrothermal | Removal of RhB and Cr(VI) | 20mg | 300 W xenon lamp  λ>420nm | 98.0% Cr(VI) and 99.3% RhB wre removed within 30 min. | Bai et al., 2018 |
| **RP** | Nanoparticles | Commercial RP | Hydrothermal | Reduction of Cr (VI) | ￣ | 300 W xenon lamp  λ>420nm | Cr (VI) with initial concentration of 20 mg/L can be completely converted within 36 min at pH of 2.0. | Li et al., 2018 |
| **Crystalline RP** | Microparticles | Commercial RP | Hydrothermal and  calcination | H2 evolution | 50 mg | 300 W xenon lamp  λ>400nm | The H2 evolution rate is 2 times higher than that of amorphous RP. | Wang et al., 2012 |
| **P/YPO4** | Microspheres | RP  YCl3·6CO2 | Hydrothermal | H2 evolution | 50 mg | 300 W xenon lamp  λ>400nm | The H2 evolution rate is 6 times higher than that of RP. | Wang et al., 2012 |
| **RP/g-C3N4** | Particles | RP  Urea | Grinding and  calcination | H2 evolution  CO2 conversion into CH4 | 10mg  20mg | 300 W xenon lamp  λ>420nm  500W xenon arc lamp | The H2 evolution rate is ten times higher than that of pure g-C3N4; CH4 production yield is 3 times higher than pure g-C3N4. | Yuan et al., 2013 |
| **RP** | Microparticles | Commercial RP | Hydrothermal | Inactivate of escherichia coli | ￣ | 300 W xenon lamp  λ<400nm | Complete inactivation was obtained within 60 min. | Xia et al., 2015 |
| **P/BiPO4** | Nanoparticles | RP  Bi(NO3)3 | Hydrothermal | Degradation of MB | 100mg | 100 W xenon lamp  λ>400nm | 95% MB was degraded within 2.5h. | Zong et al., 2015 |
| **RP/BP** | Microparticles | Commercial RP | Ball milling | Degradation of RhB | ￣ | λ>420 nm | 95% RhB was degraded after 2h. | Shen et al., 2015 |
| **Ni(OH)2/P** | Microparticles | RP Ni(OH)2 | Precipitation | H2 evolution | 50 mg | λ> 400 nm | The H2 evolution rate exceeded 1.12 times on 1 wt% Pt/P sample. | Dang et al., 2014 |
| **RP** | Crystalline fibers | Commercial RP | CVD | Degradation of RhB | 100mg | λ>420 nm | 46.4% RhB was degraded after 6 h irradiation. | Shen et al., 2014 |
| **GO QDs/RP** | Nanoparticles | Graphene oxide RP | Hydrothermal and  wet milling | Degradation of RhB | 5mg | 300 W xenon lamp  λ>400nm | 90% RhB was degraded within 60min. | Chan et al., 2017 |
| **RP/TiO2** | Nanoparticles | RP  TiO2 | Ball milling | Degradation of RhB | 5mg | 400W visible light lamp λ>500nm | RhB was degraded after 6h. | Ansari et al., 2016 |
| **RP/g-C3N4** | Nanoparticles/  Nanosheets | RP  Melamine | Hydrothermal and  calcination | H2 evolution  Sterilization | 40mg  50mg | 300 W xenon lamp  with different light filters | The H2 evolution rate is 5.2 and 52.8 times higher than that of pure  g-C3N4 and RP, bacterial inactivation is 6.23 and 1.58 times higher than that of pure g-C3N4 and red P, respectively. | Wang et al., 2018 |
| **RP** | Microparticles | Commercial RP | ball milling | Degradation of RhB | 4 mg | 400 W lamp  λ>500 nm | RP treated for 36h by ball mill shows the highest photocatalytic activity. | Ansari et al., 2016 |
| **RP/rGO** | Nanoparticles | RP  Graphene Oxide | Ultrasonic dispersion  and photodeposition | Degradation of RhB  H2 evolution | 50 mg | 150 W xenon lamp  λ>420nm | 100% of RhB was removed within 3min.  The H2 evolution rate is 7 times higher than that of RP. | Li et al., 2016 |
| **P doped**  **g-C3N4** | Nanoparticles/  Nanosheets | RP  g-C3N4 | Chemical vapor  deposition (CVD) | H2 evolution | 20 mg | 300 W xenon lamp  λ>400nm | The H2 evolution rate is 4.2 times higher than that of g-C3N4. | Jing et al., 2017 |
| **Rough surface RP** | Microparticles | RP  Co(NO3)26H2O | Hydrothermal | Degradation of RhB | 100mg | 300 W xenon lamp  λ>420nm | 95% of RhB was degraded within 10 min. | Li et al., 2015 |
| **Au/RP**  **Cu/RP** | Nanoparticles | RP  HAuCl4·4H2O  CuSO4·5H2O | Hydrothermal | H2 evolution | 100mg | 300 W xenon lamp  λ>420nm | The H2 evolution rate of Au/RP and Cu/RP are 2.32 and 2.77 times than that of RP(225.8μmolg-1h-1). | Qi et al., 2018 |
| **RP/CdS** | Nanoparticles | RP Na2S Cd(CH3COO)2 | precipitation | H2 evolution | 50 mg | 300 W xenon lamp  λ>400nm | The H2 evolution rate is 2.53 times higher than that of CdS  (365μmolg-1h-1). | Shi et al., 2016 |
| **RP/g-C3N4** | Nanoparticles/  Nanosheets | RP  g-C3N4 | Ball milling | Degradation of MO  RhB, | 3mg | 400W visible light lamp λ>500nm | MO and RhB were degraded after 150min and 240min, respectively. | Ansari et al., 2016 |
| **g-C3N4/RP**  **/MoS2** | Nanoparticles/  Nanosheets | Urea MoS2  NaH2PO2 | Calcination and in-situ  photodeposition | H2 evolution | 10mg | 300 W xenon lamp  λ>420nm | The H2 evolution rate is 859.7 and 4.4 times more than that of pure  g-C3N4 and gC3N4/RP. | Zhao et al., 2017 |
| **RP/** **g-C3N4** | Nanoparticles | RP  melamine | Calcination | Degradation of RhB Metsulfuron | 15mg | 500 W xenon lamp  λ>420nm | RhB and Metsulfuron were degraed after 120min and 90min, respectively. | Muhmood et al., 2018 |