ECCS 2025 Conference

The 3rd International Electronic Conference on Catalysis Sciences

23–25 April 2025 | Online

MDPI

Surfactant-assisted synthesis of bismuth tungstate for dye decolorization under visible light irradiation

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INTRODUCTION & AIM

Dye ・Toxic organic pollution ・Difficult to decompose → Environmental issue

Photocatalysis・・・Efficient and clean degradation technology

Bismuth tungstate (Bi_2WO_6)

Advantage
- Stable physicochemical properties
- Suitable band gap for photocalycit reaction

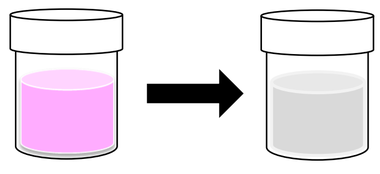
Disadvantage
- Narrow light absorption region
- High recombination rate of electron-hole pairs

Surfactant・・・Control over the morphology and structure of catalysts

This work

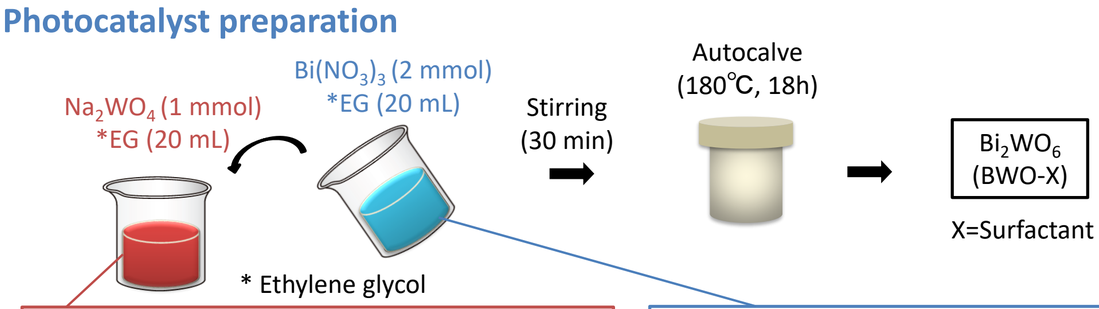
The effect of surfactants as structure-directing agents on the photocatalytic activity of Bi_2WO_6.

Evaluation method:
Rhodamine B (RhB) decolorization



METHOD

Photocatalyst preparation



Cationic surfactant
- CTAB (hexadecyltrimethylammonium bromide)
- BAC (benzalkonium chloride)

Nonionic surfactant
- OPE (polyoxylene (10) octyl phenyl ether)

Anionic surfactant
- SDS (sodium dodecyl sulfate)
- SDBS (sodium dodecyl benzene sulfonate)
- SO (sodium oleate)

（Amount of surfactants：0.5 mmol）

Fig. 1 : Preparation method of BWO-X.

Experimental condition

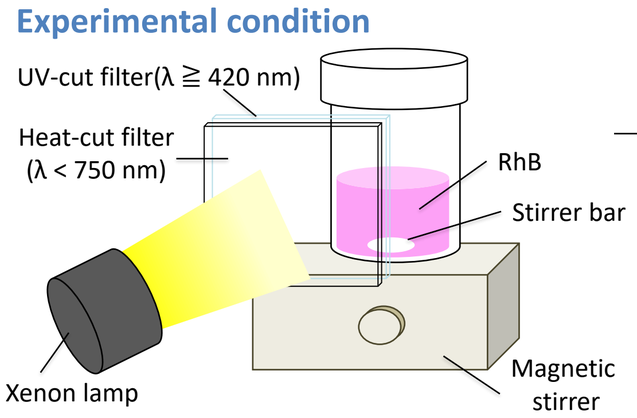


Fig. 2 : Photoreactor in photocatalytic decolorization.

Table 1: Experimental conditions.

Sample	RhB (20 ppm)
Photocatalyst	30 mg
Light source	Xenon lamp (λ≧420 nm)
Temperature	Room Temperature
Irradiation time	0-120 min
Detector	UV/vis spectroscopic detector
Detection	554 nm

RESULTS

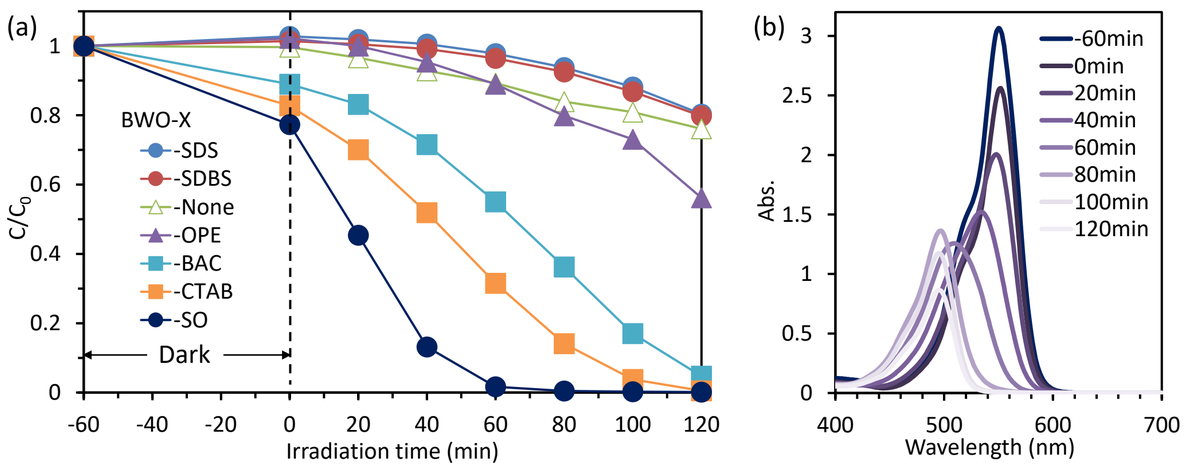


Fig.3 : (a) Decolorization of RhB by BWO-X and (b) absorption spectra of RhB decolorization with BWO-SO.

These decolorization reactions resulted in the peak shift of the maximum absorption wavelength toward shorter wavelengths, which is attributed to N-deethylation.

DISCUSSION

XRD & DRS

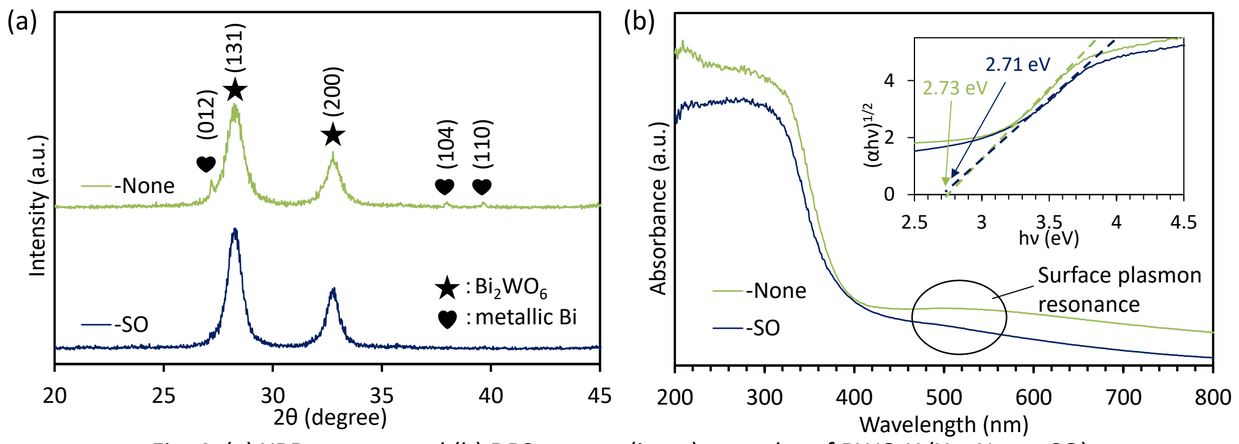


Fig. 4: (a) XRD patarns and (b) DRS spectra (inset) tauc plot of BWO-X (X = None, SO) .

XPS

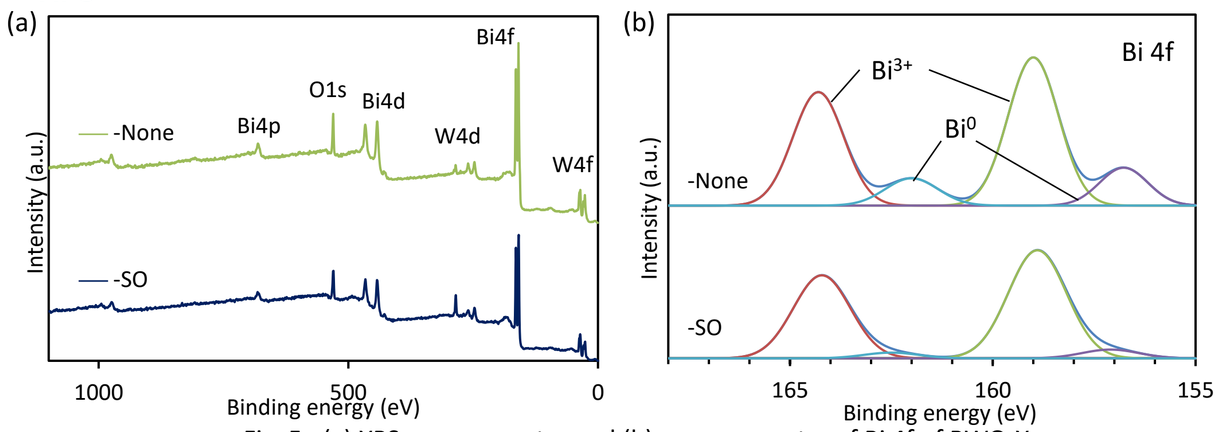


Fig. 5 : (a) XPS survey spectra and (b) narrow spectra of Bi 4f of BWO-X.

No metallic Bi-derived peaks were observed in BWO-SO. → The amount of metallic Bi was adjusted.

Mechanism

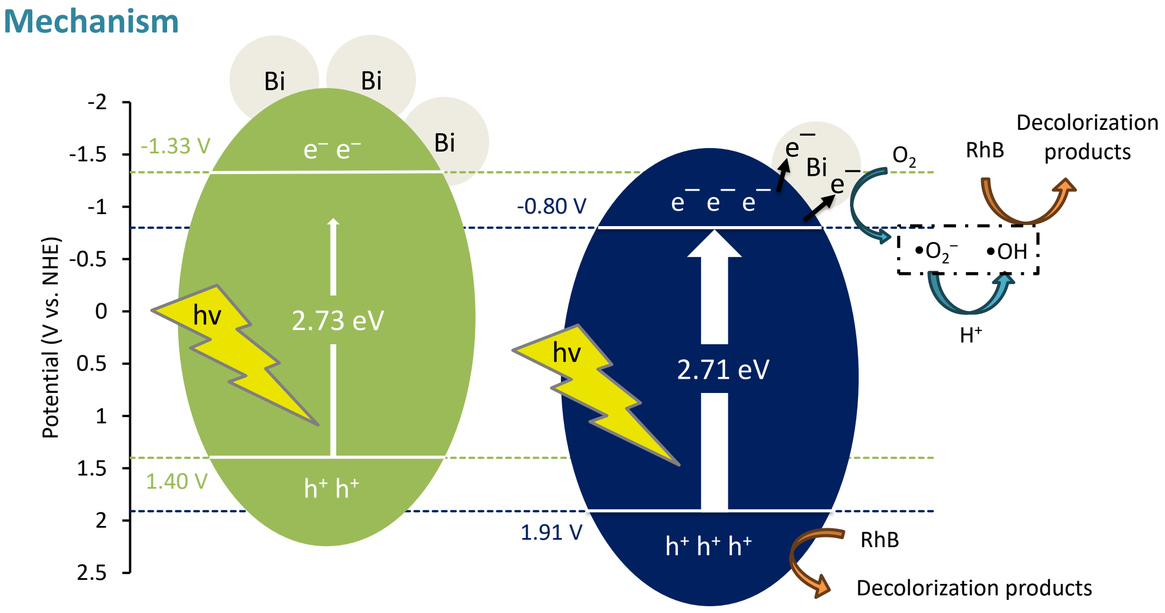


Fig. 6 : Mechanism of decolorization of RhB by BWO-None and BWO-SO.

The primary active species is $\cdot O_2^-$, while h^+ and ·OH also contribute to the photocatalytic activity.

CONCLUSION

- Bi_2WO_6 was synthesized by a simple one-pot solvothermal method.
- The surfactant induced changes in the morphology and structure of the catalyst, confirming its role as a structure-directing agent.
- The use of the surfactant (SO) as a structure-directing agent is suggested to enhance catalytic activity by modulating the amount of metallic Bi and improving crystallinity.

FUTURE WORK / REFERENCES

- Doping BWO-SO with nonmetals presents a promising approach to further enhance its photocatalytic activity.

[1]Chen, T.; Liu, L.; Hu, C.; Huang, H. Recent Advances on Bi_2WO_6-Based Photocatalysts for Environmental and Energy Applications. *Chin. J. Catal.* 2021, *42*(9), 1413–1438