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Enhanced CoOOH-based catalysts for dye decolorization

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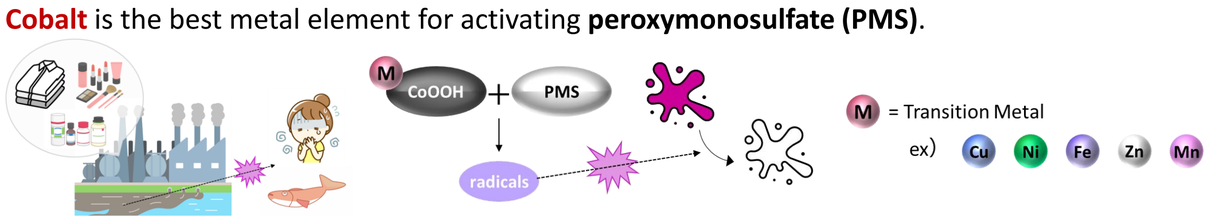
INTRODUCTION & AIM

Organic refractory pollutants are difficult to degrade in nature and thus cause water pollution.

Rhodamine B (RhB) is potentially irritating to the respiratory tract and carcinogenic.

Cobalt is the best metal element for activating **peroxymonosulfate (PMS)**.



We aimed to prepare **transition metal-doped CoOOH** catalysts to improve the activity of PMS.

METHOD

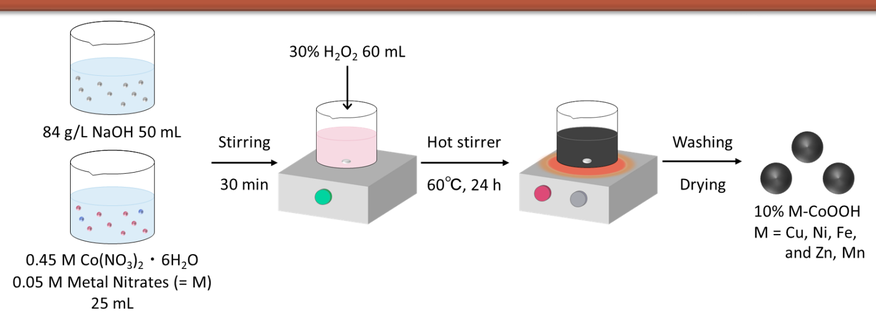


Fig. 1. Preparation of M-CoOOH.

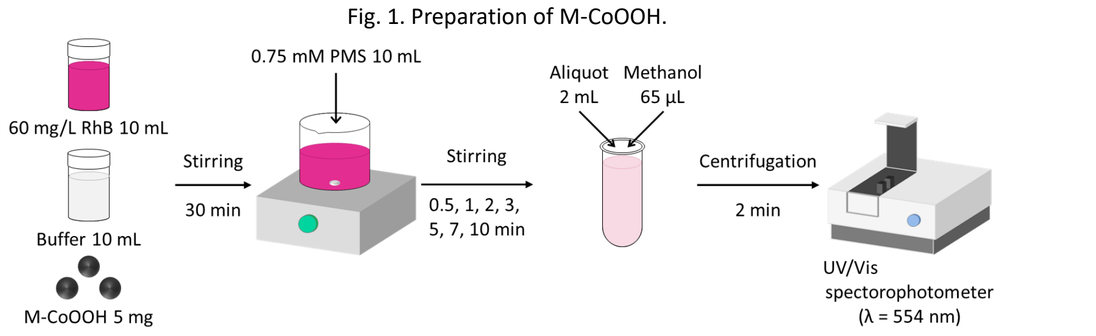


Fig. 2. Decolorization procedure.

RESULTS

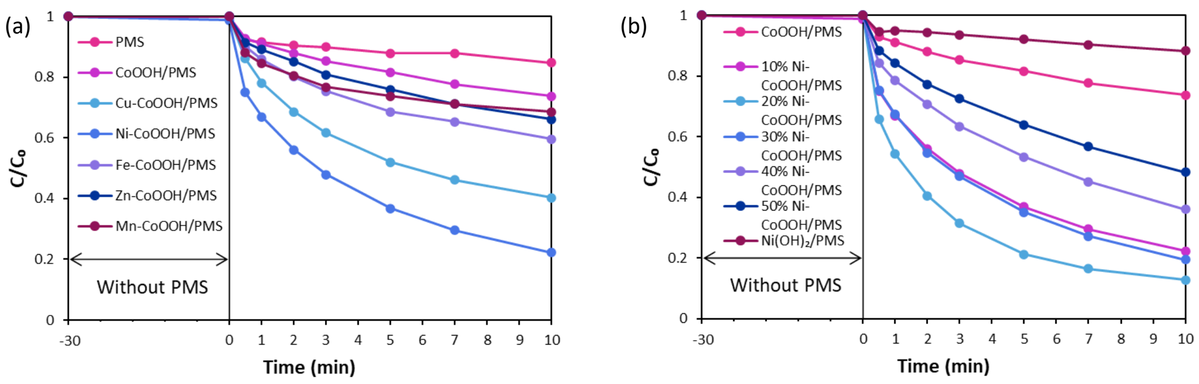


Fig. 3. Effect of (a) 10% M-CoOOH catalyst, (b) x% Ni-CoOOH catalyst on RhB decolorization in the presence of PMS. Reaction conditions: Catalyst dosage = 5 mg, $[RhB]_0$ = 60 mg/L, [PMS] = 0.75 mM and initial pH 7.

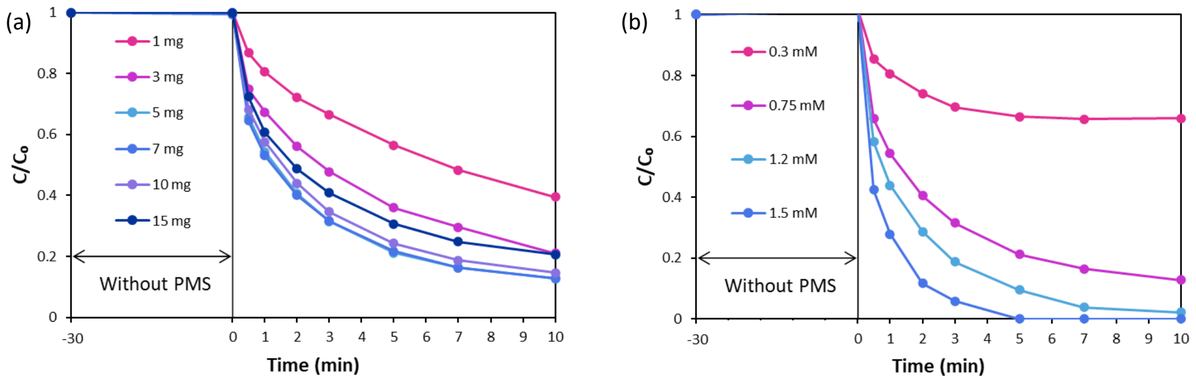


Fig. 4. Effect of (a) catalyst dosage, (b) PMS concentration on RhB decolorization in the presence of PMS using 20% Ni-CoOOH. Reaction conditions: Catalyst dosage = 5 mg, $[RhB]_0$ = 60 mg/L, [PMS] = 0.75 mM and initial pH 7.

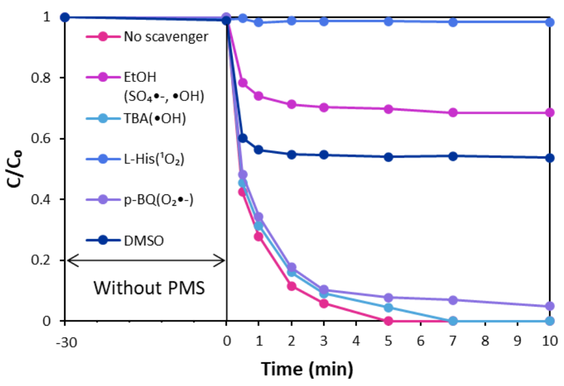


Fig. 5. Effect of scavenger on RhB decolorization in the presence of PMS. Reaction condition: Catalyst dosage = 5 mg, [PMS] = 0.15 mM, $[RhB]_0$ = 60 mg/L and initial pH 7.

The decolorization rate of the 10% M-CoOOH/PMS was faster than that of the CoOOH/PMS. Especially in the **10% Ni-CoOOH/PMS**, RhB was decolorized by **77.8%** (Fig. 3(a)). In addition, 87.2% of RhB was decolorized in the **20% Ni-CoOOH/PMS** with increased Ni doping(Fig. 3(b)). According to the scavenger experiments (Fig. 5), **$^1O_2$**, **$SO_4^{\bullet-}$**, **•OH**, **$O_2^{\bullet-}$**, and **high-value metals** are thought to be involved in RhB decolorization.

DISCUSSION

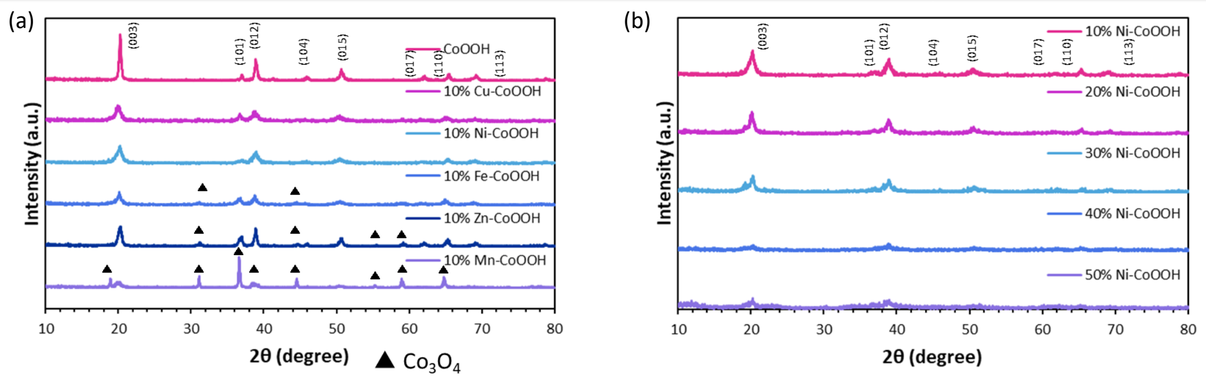


Fig. 6. XRD patterns of (a) 10% M-CoOOH and (b) x% Ni-CoOOH.

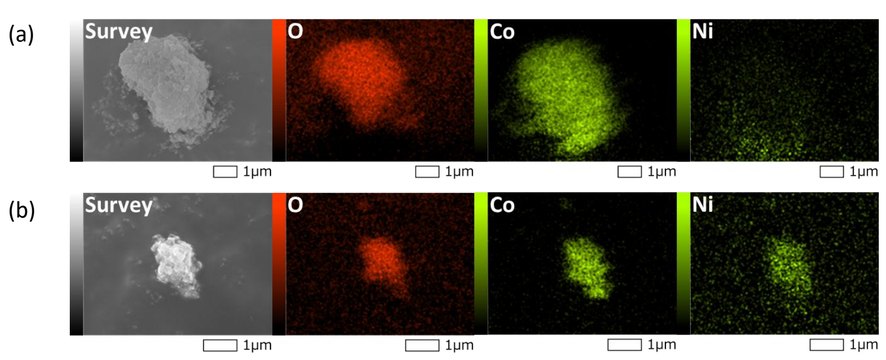


Fig. 7. EDS mapping images of (a) CoOOH and (b) 20% Ni-CoOOH.

XRD measurements confirmed that CoOOH was prepared, as the characteristic peaks of CoOOH were observed (Fig. 6). Some characteristic peaks of Co_3O_4 were observed in CoOOH doped with Fe, Zn and Mn.

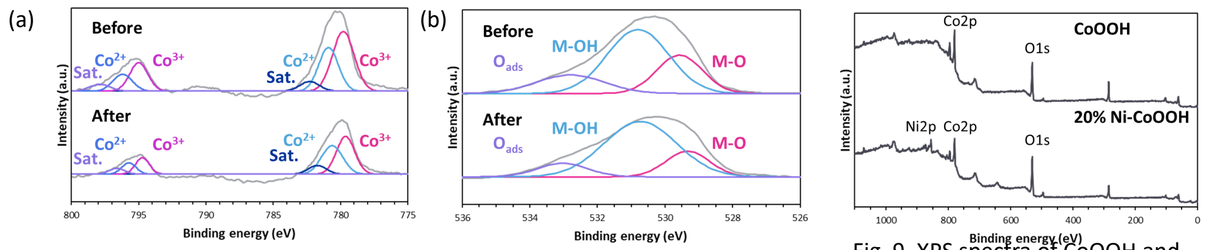


Fig. 8. High resolution XPS spectra of CoOOH before and after reaction, (a) Co 2p and (b) O 1s.

Fig. 9. XPS spectra of CoOOH and 20% Ni-CoOOH before reaction.

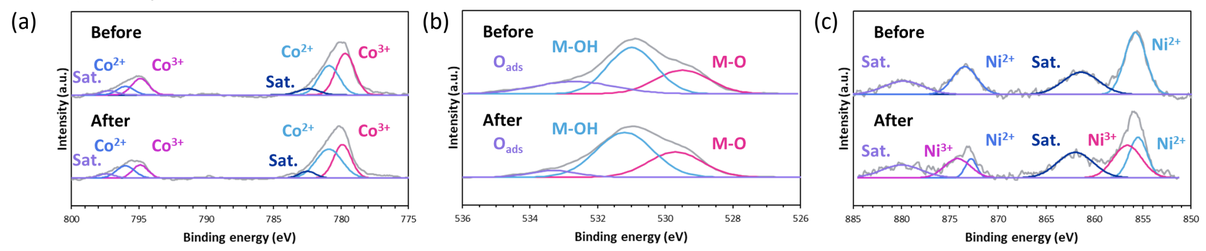


Fig. 10. High resolution XPS spectra of 20% Ni-CoOOH before and after reaction, (a) Co 2p, (b) O 1s and (c) Ni 2p.

Table 1. Ratios of chemical species on CoOOH and 20% Ni-CoOOH

	CoOOH		20% Ni-CoOOH			
	Co^{3+}	Co^{2+}	Co^{3+}	Co^{2+}	Ni^{3+}	Ni^{2+}
Before (%)	60.5	39.5	58.7	41.3	0	100
	-5.9%	+5.9%	-14.0%	+14.0%	+60.1%	-60.1%
After (%)	54.6	45.4	44.7	55.3	60.1	39.9

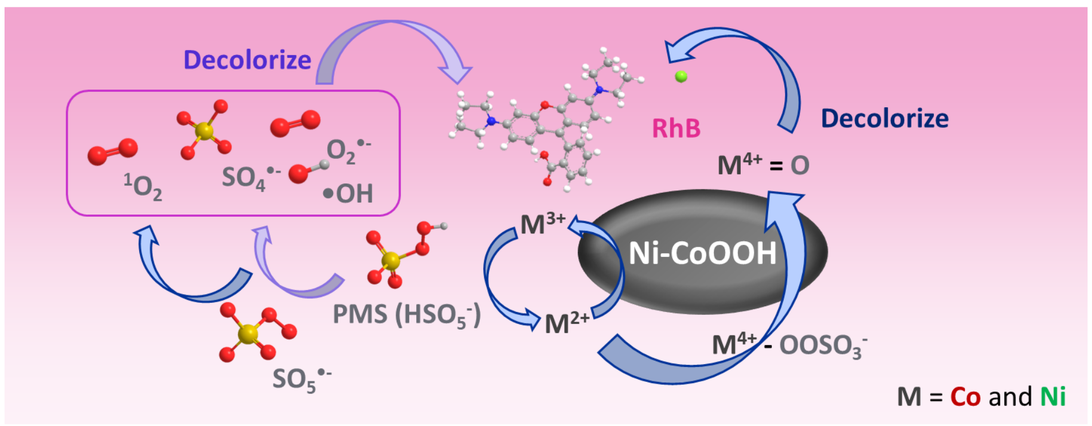


Fig. 10. Mechanism of CoOOH catalyst activating PMS to decolorize RhB.

CONCLUSION

Under optimal conditions, 20% Ni-CoOOH/PMS successfully decolorized 100% of RhB in 5 min.

(Optimal conditions: Catalyst dosage = 5 mg, $[RhB]_0$ = 60 mg/L, [PMS] = 1.5 mM and initial pH 7.)

$^1O_2$, **$SO_4^{\bullet-}$**, **•OH**, **$O_2^{\bullet-}$**, and **high-value metals** are thought to be involved in RhB decolorization.

FUTURE WORK / REFERENCES

Examine the detailed RhB decolorization mechanism.

Develop catalysts that can degrade a lot of organic refractory pollutants and study reaction conditions.

REFERENCE

[1] Y. Han, C. Zhao, W. Zhang, Z. Liu, Z. Li, F. Han, M. Zhang, F. Xu and W. Zhou, Appl Catal, B, 340 (2024) 123224