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Enhancement in the Hg^0 oxidation efficiency and sulfur resistance of $CuCl_2$-modified MnO_x-CeO_x nanorod catalysts

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Physical structures of the catalysts

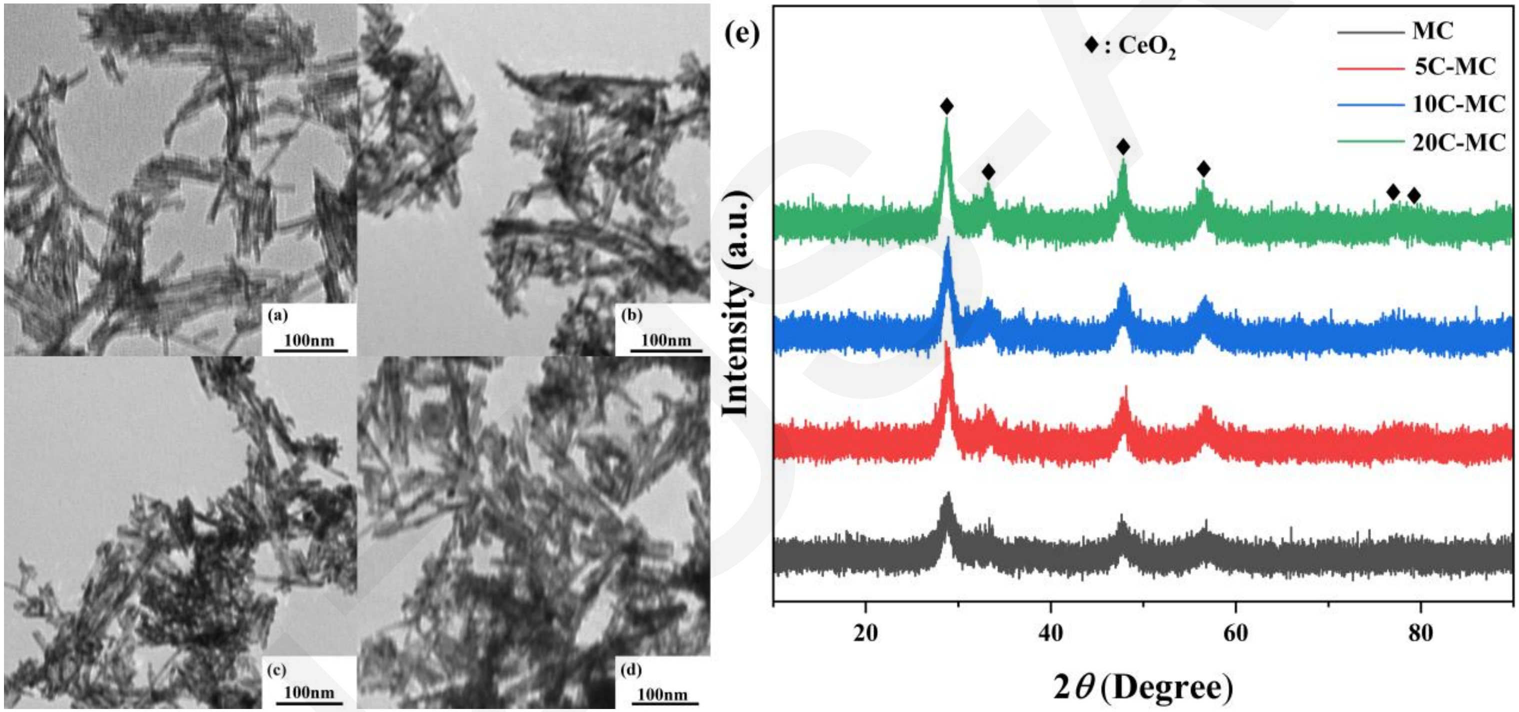

Fig. 1 TEM images: (a) MC, (b) 5C–MC, (c) 10C–MC, and (d) 20C–MC; (e) XRD patterns of the catalyst series.

Physical structures of the catalysts

Table 1 Specific surface area, average pore diameter, and total pore volume of the catalyst series.

Samples	Specific surface area (m^2/g)	Average pore diameter (nm)	Pore volume (cm^3/g)
MC	78	17.2	0.50
5C–MC	53	22.6	0.44
10C–MC	44	21.0	0.35
20C–MC	43	20.8	0.31

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Atom environment of the catalysts

Table 2 XPS data of the catalyst series.

Samples	Mn^{4+} (%)	Ce^{3+} (%)	Cu^{+} (%)
MC	24.4	14.5	/
5C–MC	22.1	16.0	16.9
10C–MC	20.9	17.4	14.1
20C–MC	18.2	17.9	7.2

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Performance of the catalysts

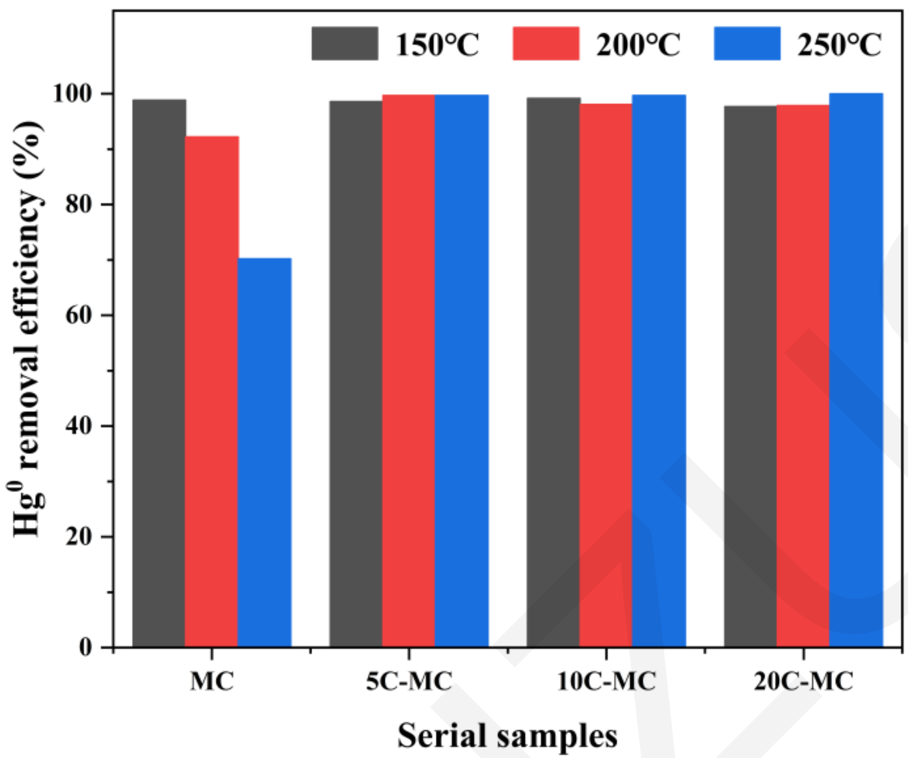


Fig. 3 Hg^0 removal efficiency of the catalyst series.

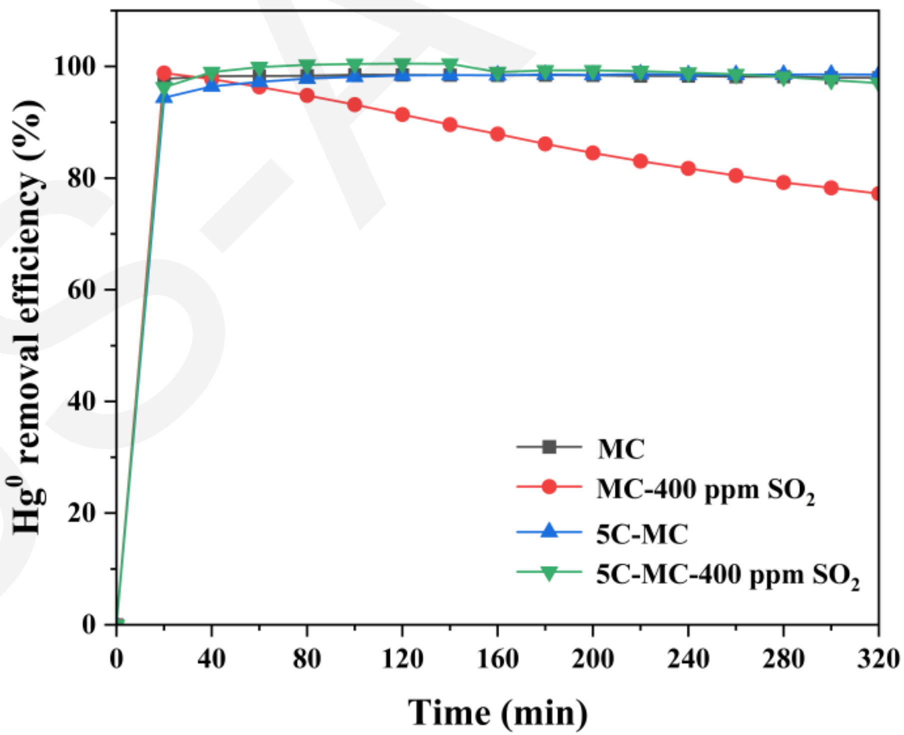
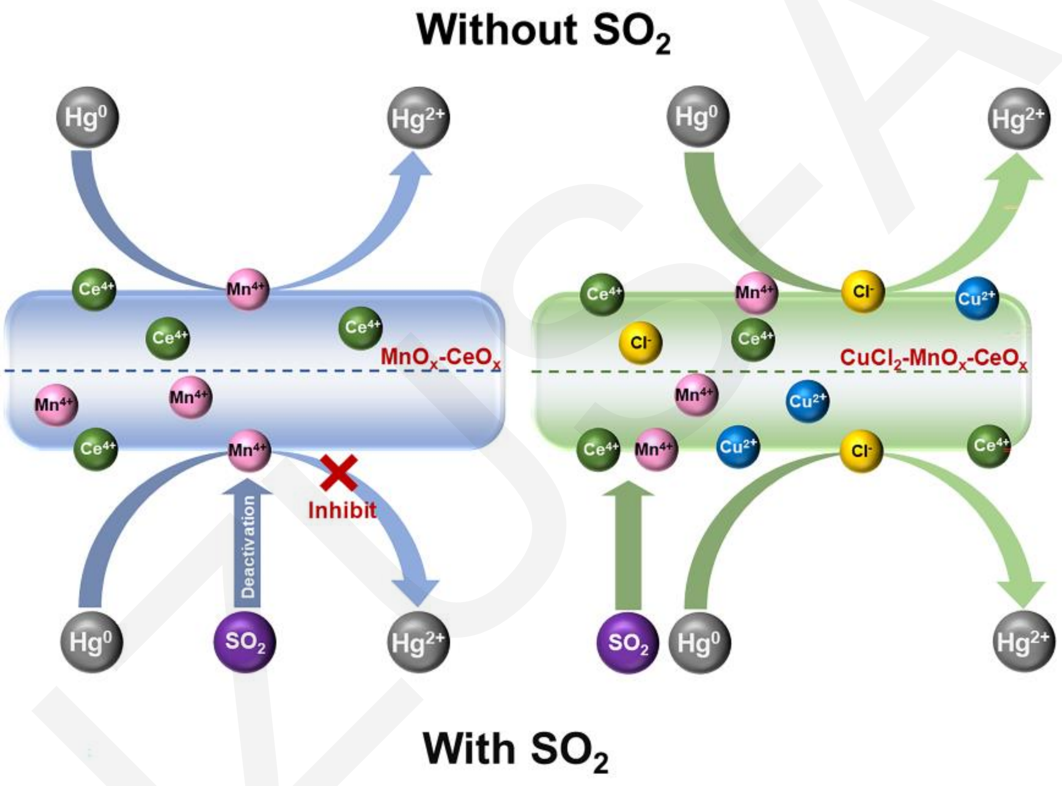


Fig. 4 SO_2-tolerance of MC and 5C–MC catalysts.

Mechanisms



Scheme 1 Mechanisms of the enhanced Hg^0 oxidation capability and SO_2-tolerance of $CuCl_2$-doped MnO_x–CeO_x catalysts.

Conclusions

- The addition of $CuCl_2$ enhances the catalyst's Hg^0 oxidation capability, with Hg^0 oxidation efficiency at >97% throughout the investigated temperature range for $CuCl_2$-doped samples. In the presence of 400 ppm SO_2, the Hg^0 oxidation efficiency of MnO_x–CeO_x steadily decreased from ~100% to ~78% after 320 min, whereas the $CuCl_2$-doped catalysts maintained ~100% Hg^0 oxidation efficiency during the SO_2 deactivation cycle.
- For the MnO_x–CeO_x catalyst, Mn^{4+} served as the active species for Hg^0 oxidization. However, with the addition of $CuCl_2$, the introduced Cl^- with high reactivity was mainly responsible for accelerating the oxidation of Hg^0, resulting in enhanced Hg^0 oxidation capability of the $CuCl_2$-doped catalysts.

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