Supporting Information

Enhanced Removal of Veterinary Antibiotic Florfenicol by Cu-based Fenton-like Catalyst with Wide pH Adaptability and High Efficiency

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Text S1

**Reusability.** To investigate the stability and reusability of the screened CuNiFeLa-2-LDH, the catalyst was filtered after each reaction and washed with ultrapure water more than 3 times until the pH of the supernatant reached 7.0. Then, the filtered powder was dried at 40 °C. The regenerated materials were used for five cycles to degrade the solution of 10 mg·L⁻¹ FF. During each cycle, the degradation efficiency was calculated by detecting the concentration of residual FF.

Text S2

**ROS trapping.** For identifying the role of the reactive oxygen species (ROS) during the reaction process, tert-Butanol (TBA), p-benzoquinon (BQ), sodium azide (NaN₃) were used as the scavengers of hydroxyl radicals (•OH), superoxide radical (•O₂⁻) and singlet oxygen (O₂¹). The signal of hydroxyl radicals was detected by photoluminescence (PL) emission spectra using a benzoic acid method at room temperature with the excitation wavelength at 316 nm.¹ Briefly, a certain amount of catalyst was mixed with 50 mL of benzoic acid (10 mmol·L⁻¹), FF (10 mg·L⁻¹) and H₂O₂ (5 mmol·L⁻¹) solution. After the beginning of the reaction, a certain amount of supernatant was taken from the reactor at a designed time intervals, and then the filtered solution was analyzed by PL emission spectroscopy to indirectly measure the amount of hydroxyl radicals.

Text S3
**ESR measurement.** In addition, the electron spin resonance (ESR) spectra with DMPO (·OH, ·O$_2^-$) and TEMP (O$_2^1$) as trapping reagents was used to detect the ROS on a Miniscope MS-5000 ESR spectrometer (microwave frequency: 9.47 GHz; microwave power: 10 mW; modulation: 0.2 mT; and sweep time: 60 s). The signal of ·OH, ·O$_2^-$ and O$_2^1$ with and without catalyst or H$_2$O$_2$ were detected in the aqueous solution and DMSO solution, respectively. In a typical procedure, the ESR measurement of each sample was prepared by adding 5 mg catalyst to 2 mL water or DMSO. Then, 1 mL of the above suspension, 5 μL DMPO and 10 μL H$_2$O$_2$ (30%, w/w) were mixed. After 5 min, the ESR spectra was recorded on the ESR spectrometer.

![Figure S1. N$_2$ adsorption-desorption isotherms for CuNiFe-LDH, CuNiFeLa-2-LDH (the inset represents pore size distribution calculated from the desorption branch data by the BJH method).](image-url)
Figure S2. Zeta potential of CuNiFeLa-2-LDH

Figure S3. The high resolution XPS spectrum of CuNiFeLa-2-LDH (a) C 1S and (b) O 1s.
Figure S4. Effects of catalyst dosage on degradation of FF by CuNiFeLa-2-LDH. Conditions: $[\text{H}_2\text{O}_2]=5 \text{ mmol} \cdot \text{L}^{-1}$, $[\text{FF}]=10 \text{ mg} \cdot \text{L}^{-1}$, natural pH.

Table S1. Chemical composition analysis of La-doped CuNiFe-LDHs

| Materials     | $m(\text{Cu})$ | $m(\text{Ni})$ | $m(\text{Fe})$ | $m(\text{La})$ | $M(\text{Cu/)}$ | Chemical composition |
|---------------|----------------|----------------|----------------|----------------|-----------------|---------------------|
|               | %              | %              | %              | %              | (Cu/Fe/La)$^b$  |                     |
| CuNiFeLa-1-LDH | 6.83          | 18.68         | 11.14         | 1.38          | 1:2.96:1.85:0.09 | [Cu$^{2+}_{0.17}$Ni$^{2+}_{0.85}$Fe$^{3+}_{0.33}$La$^{3+}_{0.02}$ (OH)$_2$$^{0.33}$]$(\text{CO}_3^{2-})_{0.165}\cdot \text{mH}_2\text{O}$ |
| CuNiFeLa-2-LDH | 6.99          | 19.00         | 10.34         | 2.41          | 1:2.94:1.68:0.16 | [Cu$^{2+}_{0.17}$Ni$^{2+}_{0.85}$Fe$^{3+}_{0.29}$La$^{3+}_{0.03}$ (OH)$_2$$^{0.32}$]$(\text{CO}_3^{2-})_{0.16}\cdot \text{mH}_2\text{O}$ |
| CuNiFeLa-3-LDH | 6.16          | 16.64         | 8.08          | 4.08          | 1:2.93:1.49:0.30 | [Cu$^{2+}_{0.17}$Ni$^{2+}_{0.83}$Fe$^{3+}_{0.26}$La$^{3+}_{0.06}$ (OH)$_2$$^{0.32}$]$(\text{CO}_3^{2-})_{0.16}\cdot \text{mH}_2\text{O}$ |
| CuNiFeLa-4-LDH | 5.93          | 15.85         | 6.00          | 14.09         | 1:2.89:1.15:1.09 | [Cu$^{2+}_{0.16}$Ni$^{2+}_{0.84}$Fe$^{3+}_{0.19}$La$^{3+}_{0.18}$ (OH)$_2$$^{0.37}$]$(\text{CO}_3^{2-})_{0.185}\cdot \text{mH}_2\text{O}$ |

$^a$ Mass content of Cu, Ni, Fe or La in the material.

$^b$ Cu/Ni/Fe/La molar ratio.

Table S2. EDS results of element analysis
| El | AN | Series | Unn. C wt.% | Norm. C wt.% | Atom. C at.% | Error wt. % |
|----|----|--------|-------------|--------------|-------------|------------|
| O  | 8  | K-series | 35.65       | 38.23        | 55.29       | 4.5        |
| C  | 6  | K-series | 12.89       | 13.83        | 26.64       | 2.4        |
| Ni | 28 | K-series | 21.46       | 23.01        | 9.08        | 0.6        |
| Fe | 26 | K-series | 11.14       | 11.95        | 4.95        | 0.3        |
| Cu | 29 | K-series | 8.84        | 9.48         | 3.45        | 0.3        |
| La | 57 | L-series | 3.27        | 3.51         | 0.58        | 0.1        |
|    |    | Total:   | 93.26       | 100.00       | 100.00      |            |

REFERENCES

(1) Zhou, L.; Lei, J. Y.; Wang, L. Z.; Liu, Y. D.; Zhang, J. L., Highly efficient photo-Fenton degradation of methyl orange facilitated by slow light effect and hierarchical porous structure of Fe$_2$O$_3$-SiO$_2$ photonic crystals. *Appl. Catal. B: Environ.* **2018**, *237*, 1160-1167.