Appendix A. Supplementary data

A Perovskite $CaZrO_3$ for Efficient Ozonation Treatment of Organic Pollutants in Wastewater

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Summary: *This file contains 6 pages, including 6 figures and 1 table.*

Text S1 Characterization methods

The crystal structure was characterized by X-ray diffraction measurement (XRD, Empyrean-100, Dutch PANalytical Company) at room temperature with the scanning angular range of 10^{o}-90^{o}. The morphologies of the catalysts were observed using a field-emission scanning electron microscope (SEM, Quante400F (FEI)) with the operating voltage of 20 kV. The morphologies and structures of catalysts were further analyzed by transmission electron microscopy. A high-resolution transmission electron microscope (HRTEM) was used to analyze the structure of the catalyst using a JEM-2100F high-resolution transmission electron microscope manufactured by JEOL, with an acceleration voltage of 120 kV. The X-rays photoelectron spectroscopy (XPS) measurement was carried out on AVGESCALAB 250 spectrometer using a non-monochromatized Al K X-ray source at eV= 1.602×10^{-19} J and 1bar =100 kPa (1486.6 eV).The electron paramagnetic resonance (EPR) experiments using a Bruker EPR A300 spectrometer were carried out for the determination of reactive intermediates generated in catalytic ozonation. A catalyst solution of 1000mg/L and a HAC/NaAC buffer solution of 2mM PH=4 was prepared. 200 microliter sample solution was taken, 500 microliter buffer solution was added, and ozone was injected at a flow rate of 37mL/min at 130 mg/L. Shake well and add 100 microliters of DMPO or TEMP (trapping agent) solution of 1M. After mixing well, a specific volume of the sample solution was transferred immediately into a capillary tube, and EPR spectra were recorded at room temperature under the following Operating conditions: EPR Spectra using DMPO: modulation frequency = 100 GHz, sweep width = 100.0 G, microwave power = 18.11 mW, microwave frequency = 9.87 GHz and Centerfield = 3360.0 G. Operating conditions using TEMP: sweep width = 100 G, Centerfield = 3510 G, modulation frequency = 100 GHz, microwave power: 18.11 mW, modulation frequency = 100 GHz, microwave frequency = 9.87GHz.

Text S2 Stability evaluation condition

The catalyst used for stability evaluation was $CaZrO_3$-$PEG_{10\ wt\%}$, and the powder was pressed into tablets. After the tablet was pressed, 100mL was weighed with a

measuring cylinder and loaded into the reactor for evaluation. Reaction conditions: Substrate: m-cresol (100 $mg \cdot L^{-1}$); the pH is not adjusted; influent flow of 100 $mL \cdot h^{-1}$; continuous flow of ozone through 37 $mL \cdot min^{-1}$, concentration of 130 $mg \cdot L^{-1}$.

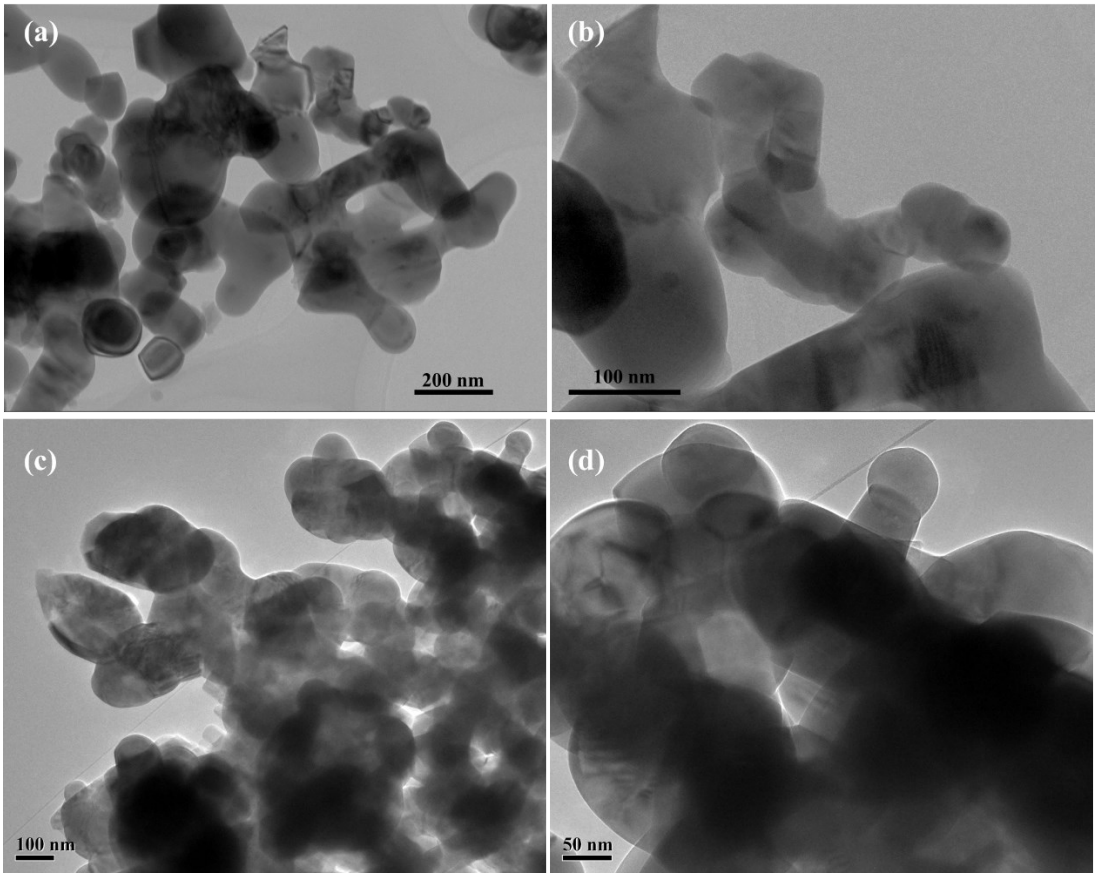

Fig.S1. TEM images of $CaZrO_3$-$PEG_{0\ wt\%}$ (a-b) and $CaZrO_3$-$PEG_{10\ wt\%}$ (c-d)

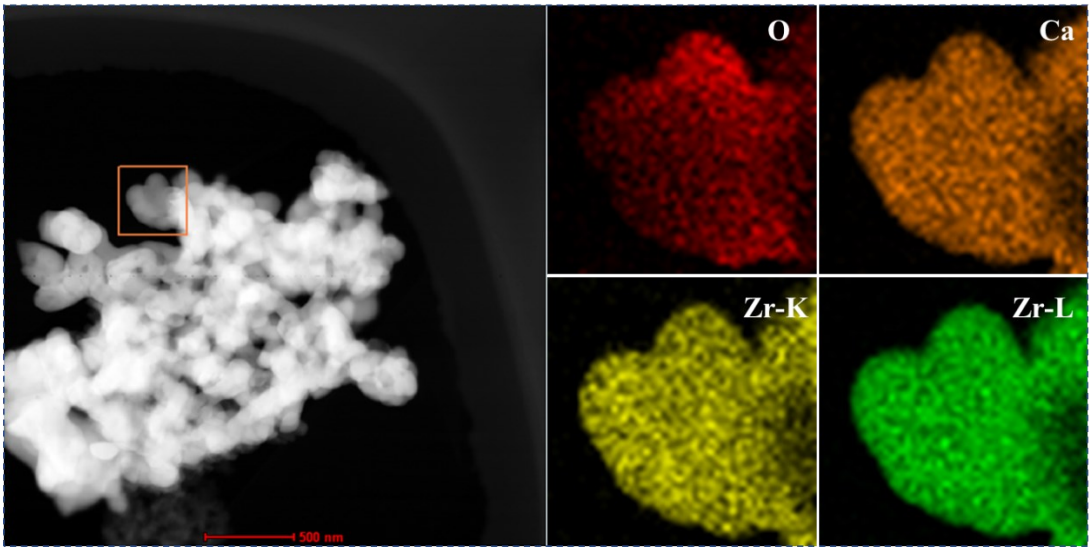

Fig. S2 TEM-EDX mappings of $CaZrO_3$-$PEG_{10\ wt\%}$

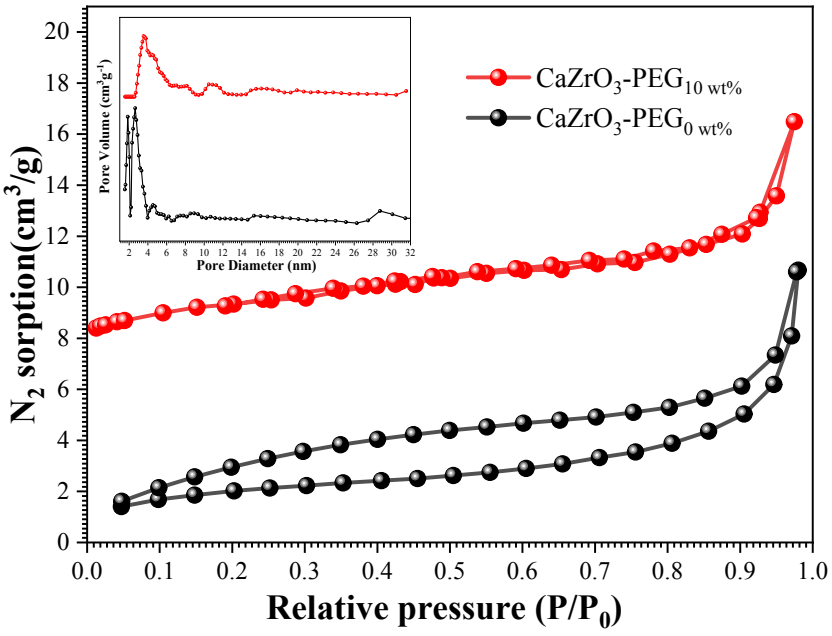

Fig.S3. The N_2 adsorption–desorption isotherms of $CaZrO_3$-$PEG_{0\ wt\%}$ and $CaZrO_3$-$PEG_{10\ wt\%}$

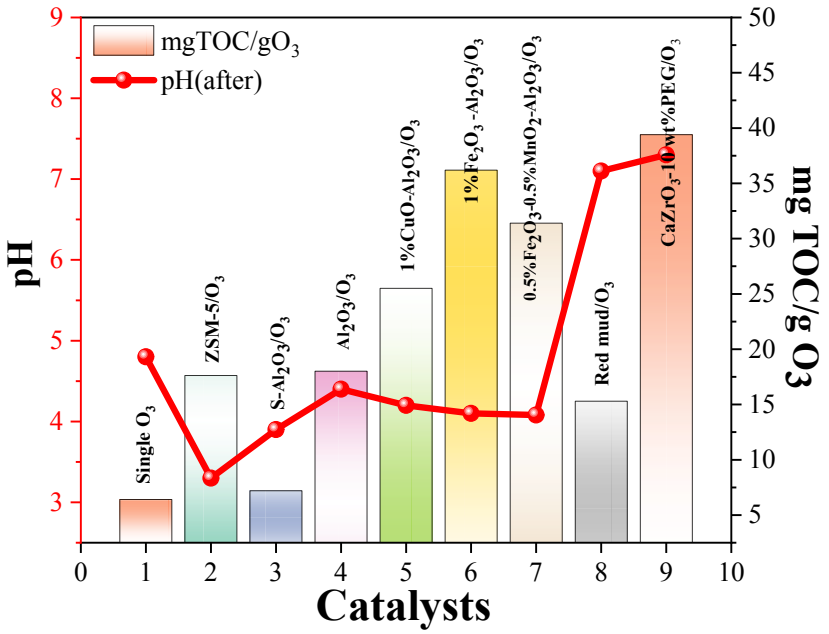

Fig. S4. Evaluation result of different types of catalysts on catalytic ozonation of m-cresol wastewater.

Substrate: 100 mg • L^{-1} m-cresol. Catalyst concentration:5g • L^{-1}, wastewater volume: 200 mL, ozone flow rate: 37 mL • min^{-1}, ozone concentration: 130 mg • L^{-1}, reaction time: 20 min

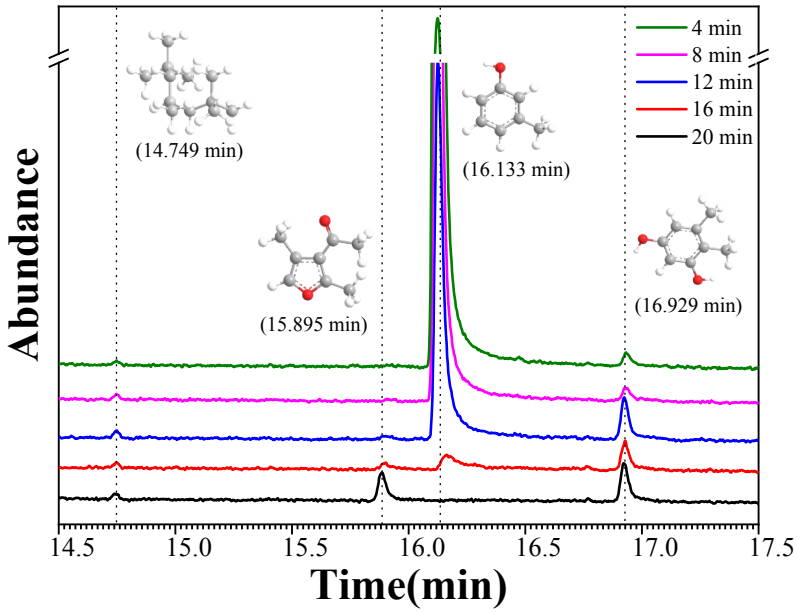

Fig. S5. GC-MS spectrum of $CaZrO_3$ catalyzed degradation of m-cresol by ozonation

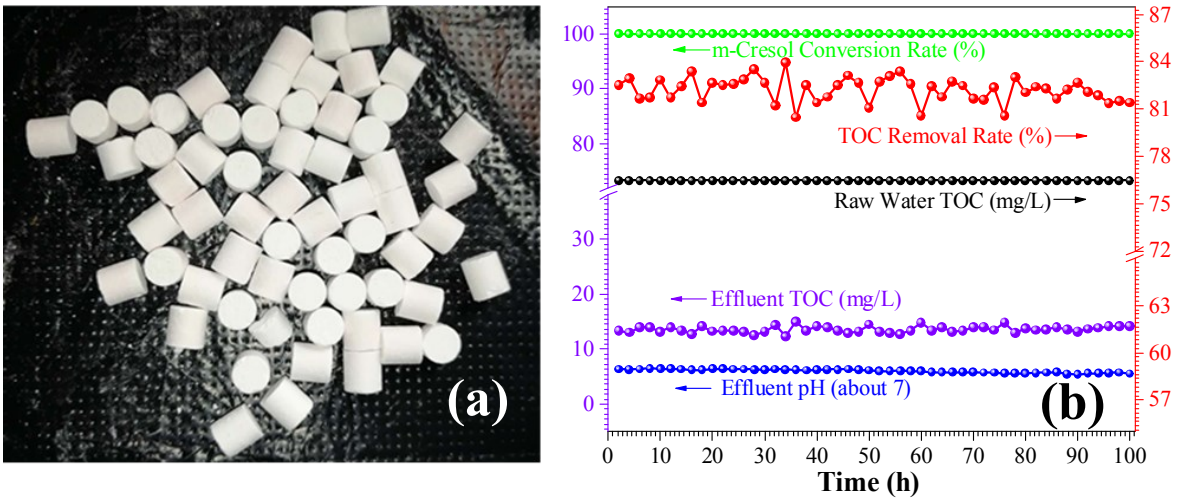

Fig. S6. (a) $CaZrO_3$ catalyst for continuous catalytic ozone oxidation; (b) Continuous results of catalytic oxidation of $CaZrO_3$

Table.S1 Ca 2p, Zr 3d and O 1s concentration of XPS spectra of $CaZrO_3$

Catalytic	Ca 2p		Zr 3d		O 1s	
	Ca $2p_{3/2}$	**Ca $2p_{1/2}$**	**Zr $3d_{5/2}$**	**Zr $3d_{3/2}$**	**O_L**	**O_A/OV**
$CaZrO_3$-$PEG_{0\ wt\%}$	77.55%	22.45%	58.39%	41.61%	43.95%	56.05%
$CaZrO_3$-$PEG_{2.5\ wt\%}$	77.59%	22.41%	58.18%	41.82%	44.15%	55.85%
$CaZrO_3$-$PEG_{5\ wt\%}$	77.34%	22.66%	57.16%	42.84%	41%	59%
$CaZrO_3$-$PEG_{7.5\ wt\%}$	77.57%	22.43%	57.18%	42.82%	39.73%	60.27%
$CaZrO_3$-$PEG_{10\ wt\%}$	73.32%	26.68%	44.47%	55.53%	27.22%	72.88%