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# An Efficient Preparation Method of ZnO Nanoparticles toward Enhanced Photocatalytic and Antibacterial Activity

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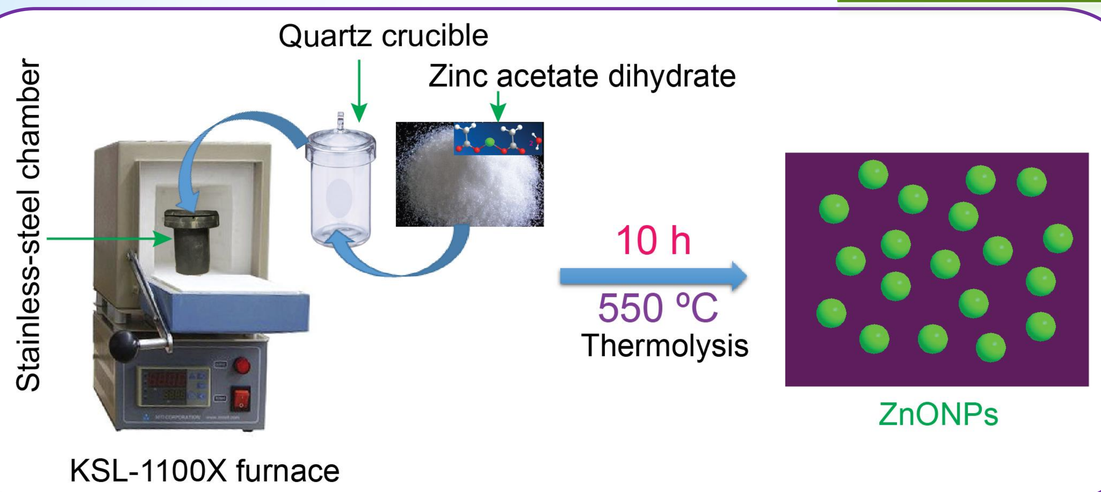
## ABSTRACT

ZnO is an attractive semiconductor material due to its potential application in various fields such as solar cells, antibiotics, gas sensors, organic pollutant degradation, etc. For this purpose, researchers are trying to synthesize ZnO by using a different method such as sol-gel, electrodeposition, mechanochemical, sonochemical, and chemical vapor deposition. However, it is still required to improve the economical method for synthesizing ZnO. In the present study, we synthesized ZnO nanoparticles (ZnO-NPs) by a thermal method. The process is environmentally safer than other methods because it does not involve more chemicals or a catalyst, acid, or base source. We used methylene blue for photocatalytic and *Escherichia coli* for antibacterial activity tests. The results found that an outstanding degradation percentage (~99%) for the photocatalytic experiment. Besides, the antibacterial activity was tested at different concentrations, and the minimum inhibitory concentration (MIC) of the ZnO-NPs was 30~50 μg/mL. Our synthesized ZnO-NPs were found to be more effective than previously described ZnO-NPs prepared via other methods.

## SAMPLE PREPERATION




**Proposed reaction mechanism of the production of ZnO-NPs**

$$Zn(CH_3COO)_2 \cdot 2H_2O \xrightarrow{\Delta} Zn(CH_3COO)_2 + 2H_2O$$

$$4Zn(CH_3COO)_2 + H_2O \xrightarrow{\Delta} Zn_4O\,(CH_3COO)_6 + 2CH_3COOH\uparrow$$

$$Zn_4O\,(CH_3COO)_6 + 3H_2O \xrightarrow{\Delta} 4ZnO + 6CH_3COOH$$

$$Zn_4O\,(CH_3COO)_6 \xrightarrow{\Delta} 4ZnO + 3CH_3COCH_3\uparrow + 3CO_2\uparrow$$

**Figure 1:** The synthesis process of ZnO-NPs from Zinc acetate dihydrate by thermal method.

## RESULTS

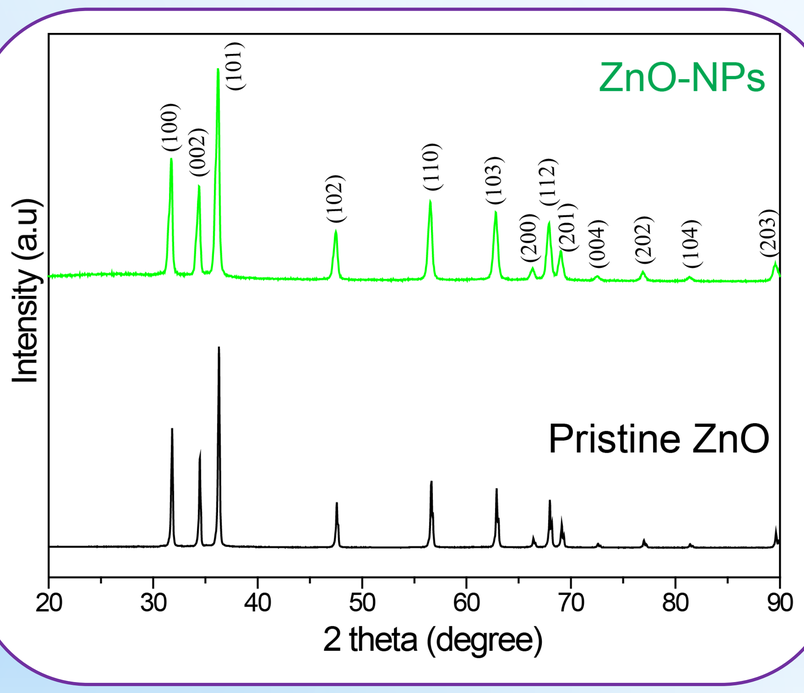



**Figure 2:** XRD patterns of the synthesized ZnO-NPs, and pristine ZnO.

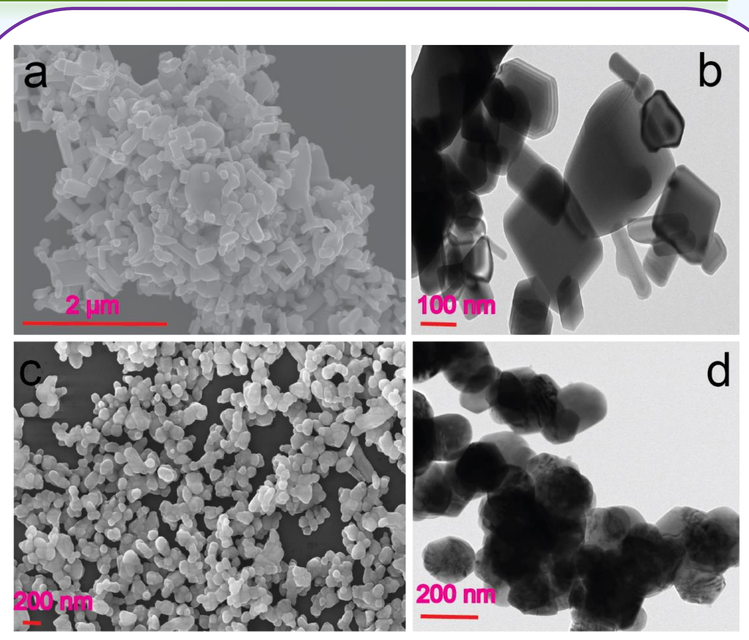



**Figure 3:** (a), (c) FE-SEM of Pristine ZnO and synthesized ZnO-NPs; (b), (d) TEM of Pristine ZnO and synthesized ZnO-NPs.

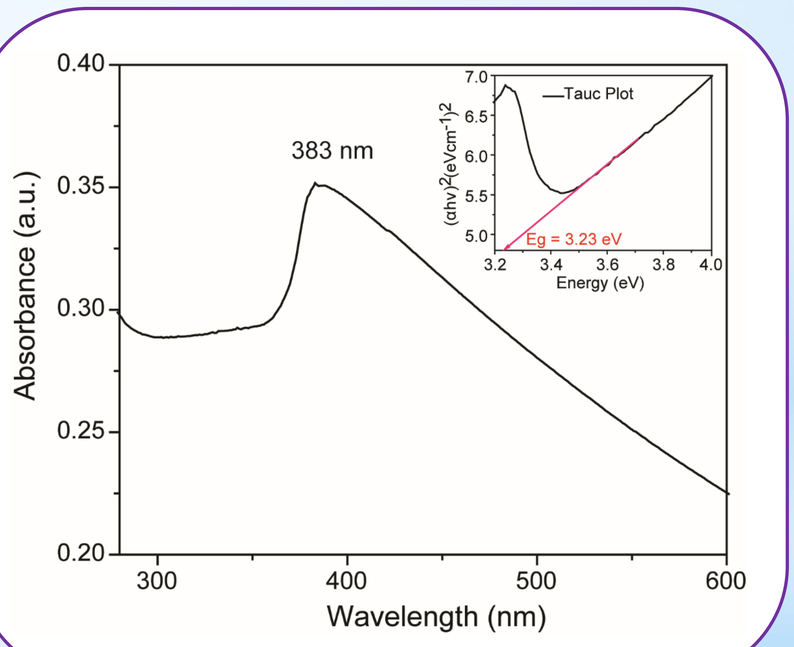



**Figure 4:** UV–vis absorption spectrum of synthesized ZnO-NPs, the inset shows the corresponding Tauc plot.

## APPLICATIONS

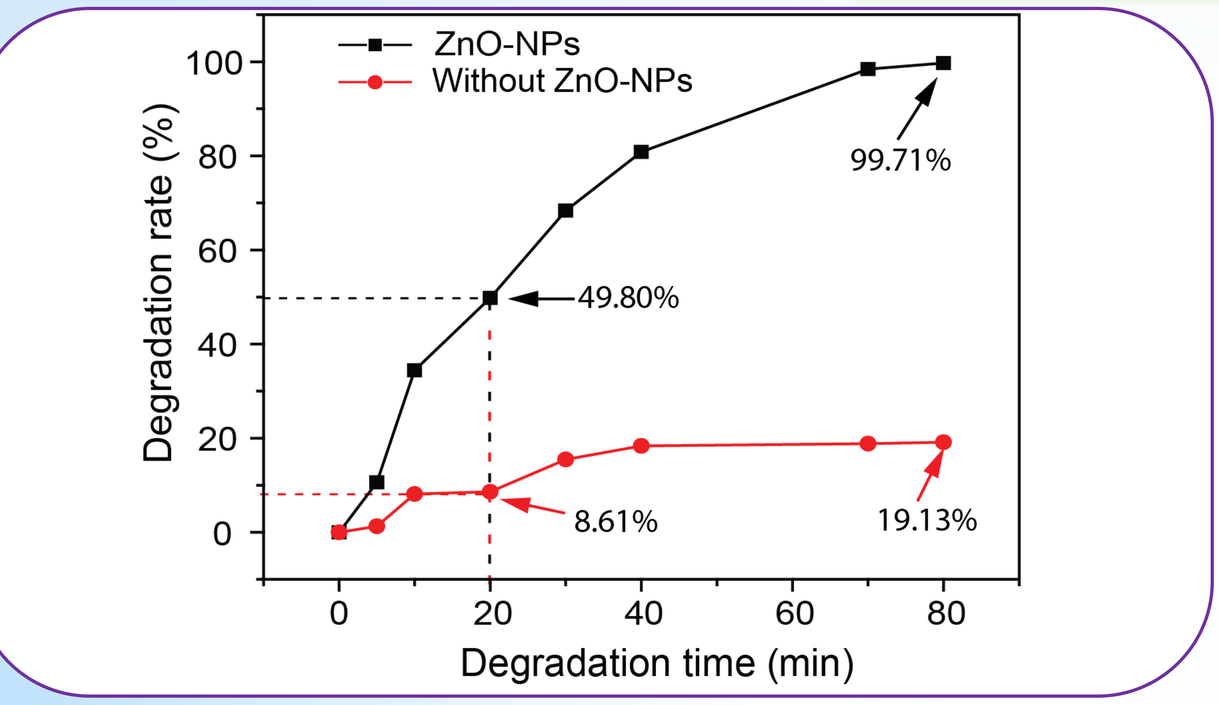



**Figure 5:** Photocatalytic degradation of synthesized ZnO-NPs, and without ZnO-NPs.

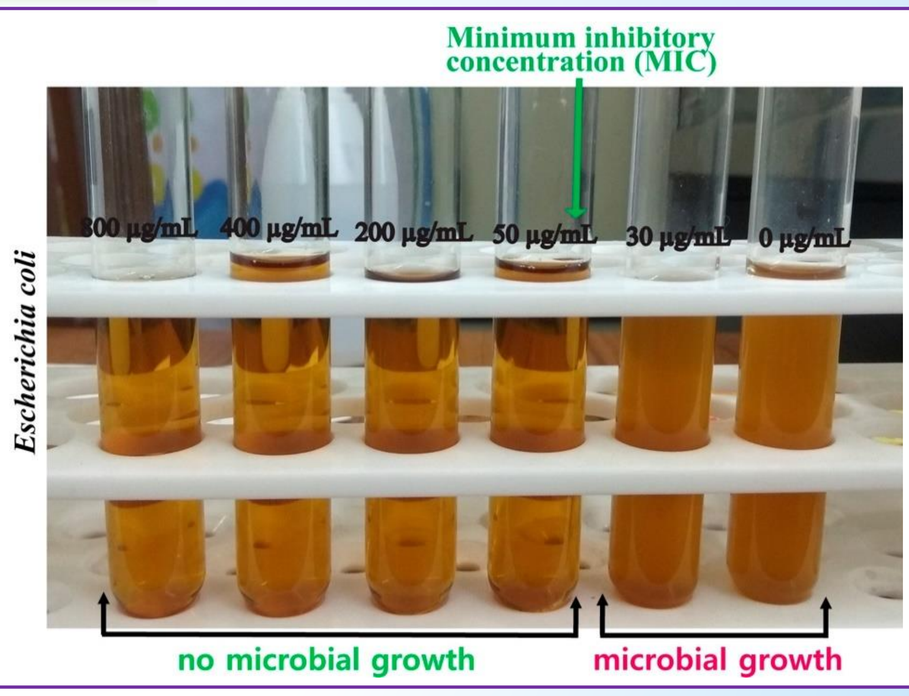



**Figure 6:** Antibacterial activity of synthesized ZnO-NPs.

## CONCLUTIONS

A ZnO-NP photocatalyst and antimicrobial agent was synthesized via an environmentally safe and cost-effective thermal method. The XRD patterns indicated that the ZnONPs crystallized in the hexagonal wurtzite structure with high crystallinity. FE-SEM and TEM analyses revealed that the synthesized particles are smooth and spherical, with a nearly aggregated size distribution. The calculated energy bandgap was 2.23 eV from Tauc plot which is smaller than pristine ZnO (3.37 eV). Photocatalytic activity tests revealed that our product exhibits an excellent degradation percentage (~99%) within a short time (80 min). Also, the antibacterial activity investigation revealed that the MIC of the ZnO-NPs against *Escherichia coli* was 30~50 μg/mL.

For more details please refer to doi:10.3390/catal9070608