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I-CReST 2025: 117-079 – Zinc Oxide Nanoparticles for Antibacterial Applications: A Systematic Review

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ABSTRACT

Zinc oxide (ZnO) nanoparticles (NP) have become promising photocatalytic antibacterial agents due to their ability to generate reactive oxygen species (ROS) when exposed to light irradiation, which effectively inhibiting bacterial growth. This systematic review covered on the recent research (2020–2025) of ZnO-based photocatalysts, focusing on 2 themes which are involving synthesis methods of ZnO NP, and the efficient of ZnO NP against pathogenic bacteria. Key findings reveal that sol-gel, hydrothermal, and green synthesis methods produce ZnO nanoparticles with desired properties and application, meanwhile doping with others metal (e.g., Ag, Cadmium) enhances visible-light activity. ZnO nanoparticles exhibit higher efficacy against Gram-positive bacteria (e.g., Staphylococcus aureus) compared to Gram-negative strains (e.g., Escherichia coli) because of differences in cell wall structure between these bacterial strains. Applications of ZnO NP extent to medical coatings, water disinfection, and wound dressings. However, challenges such as cytotoxicity, stability, and scalability remained. For more clinical and environmentally friendly applications, future studies should also focus on cytotoxicity and biocompatibility. This review highlights ZnO's potential as a sustainable antibacterial agent while emphasizing current limitations and future potentials.

Keywords: Zinc oxide nanoparticles; ZnO synthesis; photocatalysts; bacterial; antibacterial activity