Antibacterial properties of composite materials based on metal/metal-oxide nanoparticles, nanosilica and polylactid acid

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The global rise in antimicrobial resistance necessitates the development of alternative materials with effective antibacterial properties. This study compares two classes of nanocomposites: silver nanoparticle (AgNP)- and zinc oxide (ZnO)-based systems, both immobilized on silica (SiO_2) and treated with polylactic acid (PLA) to enhance biocompatibility and biodegradability. AgNP-containing composites (SiO_2-Ag and SiO_2-Ag-PLA) exhibited potent, broad-spectrum antibacterial activity, particularly against Gram-negative *E. coli* and *K. pneumoniae*, though activity decreased when modified with PLA—likely due to reduced ion release and surface coverage interference [1]. In contrast, ZnO-based composites (SiO_2-ZnO and SiO_2-ZnO-PLA) showed weaker antibacterial efficacy, with native SiO_2-ZnO only inhibited some *S. aureus* strains. However, PLA modification improved ZnO composite performance, likely due to enhanced dispersion and cellular interactions.

Zeta potential measurements suggested that Ag-based composites maintained higher colloidal stability in alkaline environments, while ZnO systems exhibited improved performance in neutral to slightly basic conditions after PLA inclusion.

Overall, silver-based composites offer stronger and more consistent antibacterial activity across bacterial types, although with higher potential cytotoxicity. ZnO-based materials, while less potent, are more biocompatible and may be preferable for long-term or lower-dose applications. Both nanocomposites show promise for biomedical coatings, but further investigation is needed.

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