Abstract

Zinc selenide (ZnSe) nanoparticles were synthesized through a coprecipitation method, incorporating a consistent 3 wt.% of cetyltrimethylammonium bromide (CTAB) alongside varied eudragit (Eud) concentrations (2 and 4 wt.%) to develop ternary nanostructures (NSs). The addition of CTAB and Eud was found to regulate nanoparticle size and limit electron-hole recombination, which effectively enhances catalytic performance for rhodamine B (RhB) degradation and antimicrobial activity against multidrug-resistant (MDR) *Staphylococcus aureus* (*S. aureus*). The doped ZnSe NSs exhibit an increased density of active sites, improved porosity, and an enlarged surface area, facilitating both RhB dye breakdown and antimicrobial efficacy. The composite containing 4 wt.% Eud/CTAB achieved significant results, with a degradation efficiency of 94.3% and an inhibition zone measuring 8.85 ± 0.05 mm against MDR *S. aureus*.