Effects of pH on the Crystallinity and Chemical Properties of Gallium Oxyhydroxide

Ahluwalia, Pavan (School: Harmony School of Innovation - Fort Worth)

Gallium oxide is a wide-bandgap semiconductor gaining significance for its outstanding optoelectronic and gas-sensing properties. Although gallium oxide is known for its antibacterial efficacy, limited research is available on the antimicrobial properties of gallium oxyhydroxide (GaOOH). This study investigates GaOOH's antibacterial action by examining the effect of the growth solution's pH on its chemical and physical properties and their correlation with bacterial growth inhibition. The hydrothermal method was used to synthesize GaOOH microparticles (MPs). Deionized water, ammonium hydroxide, and gallium nitrate hydrate salt were mixed to create samples with pH levels ranging from 5 to 10 at 60°C. Subsequent analysis, including scanning electron microscopy, Fourier-transform infrared (FTIR) spectroscopy, and photoluminescence spectroscopy, revealed that higher pH levels increased the average GaOOH MPs length and created more crystal lattice defect sites. The correlation between surface chemistry and pH was evident in the position of higher energy FTIR Ga-OH bending bands. Antibacterial studies demonstrated a greater inhibition of Escherichia coli, a Gram-negative bacterium, at higher pHs. This suggests a potential role of defect sites in GaOOH's antimicrobial activity. There was significant inhibition of Staphylococcus aureus growth. However, no conclusive correlation with pH was established, possibly due to the characteristics of the Gram-positive cell wall. Future studies should further explicate the relationship between GaOOH MPs morphologies and growth inhibition of Escherichia coli and Staphylococcus aureus.