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Antibacterial Activity of Cadmium Stannate Nanoparticles Synthesized by Chemical Precipitation Method

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Abstract:
The removal of bacteria from water is an extremely important process for drinking and sanitation systems, especially against bacteria and fungi. Cadmium Stannate (Cd_2SnO_4) is a peculiar and promising material, that received much attention from scientific perspectives and industries for its excellent structural, optical and electrical properties. In this present work, cubic phase Cd_2SnO_4 nanoparticles have been synthesized by the chemical precipitation method. XRD, FESEM, EDAX, FTIR, PL and UV analysis have been performed to study the structural, surface morphological, elemental composition and optical properties. The antibacterial activities of the nanoparticles were carried out for Staphylococcus aureus (gram-positive) and Escherichia coli (gram-negative) by using zone inhibition method. The XRD results confirm the formation of a cubic structure with a particle size of 46 nm. FESEM image shows the cubic-like structure of the nanoparticle. The absorbed peaks from EDAX spectrum confirm the presence of Cd, Sn and O elements. The formation of absorption bands in the range of 500–1200 cm^{-1} is attributed to the metal-oxygen stretching of Cd-O and O-Sn-O. The transmittance value was measured as 76% from the UV graph. The optical band gap was measured as 2.4 eV from Tauc's plot. The photoluminescence spectrum reveals the presence of multiple emission bands in the UV-Vis region. The antibacterial activities confirm Cd_2SnO_4 nanoparticles have great potential against gram-positive and gram-negative bacteria and can be used effectively to remove pathogens and bacteria from contaminated water.
Key Words*:Cd_2SnO_4 nanoparticles, XRD, FESEM, EDAX, FTIR, Antibacterial activity.*

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I. INTRODUCTION

The application of nanomaterials in water and wastewater treatment has drawn wide attention, due to their small sizes and large specific surface areas, nanomaterials have high mobility [1], strong adsorption capacities, and reactivity [2]. In addition, heavy metals [3], organic pollutants [4], inorganic anions [5], and bacteria [6] have been reported to be successfully removed by various kinds of nanomaterials. The antimicrobial efficiency of metal oxide nanoparticles depends on the particle size, presence of light, the composition of the aqueous medium used in assay *etc*. Metal oxide nanoparticles are found to be the good inhibitors to bacterial strains [7]. One of the members of the ternary oxide family, Cadmium Stannate (Cd_2SnO_4) is an n-type semiconductor with bandgap values around 2.6 - 3.2 eV, high carrier density ($\sim 10^{21} cm^{-3}$), high mobility ($\sim 100 cm^2V^{-1}s^{-1}$) and low absorption, these impressive optical and electronic properties mold them to use in several applications, such as lithium-ion batteries, solar cell and photocatalysis, water splitting, gas sensor, *etc*.. [8-12]. Cd_2SnO_4 forms two different crystal structures, the cubic phase at low temperature (up to 750 °C) and the orthorhombic phase at high temperature *i.e*., above 1000°C [12]. Cd_2SnO_4 nanoparticles were synthesized using several methods such as solution combustion method [11], hydrothermal [10], and chemical precipitation method [13] sol-gel [14] *etc*.

Hence, in this present work, we have made an attempt to develop cubic phase Cd_2SnO_4 nanoparticles by the chemical precipitation method. Further, the antibacterial activities of the nanoparticles were carried out against gram-positive *Staphylococcus aureus*and gram-negative *Escherichia coli* by using the Zone inhibition method. To the best of my knowledge, no reports were available in the literature which explores the antibacterial activity of Cd_2SnO_4 nanoparticles against gram-positive *Staphylococcus aureus*and gram-negative *Escherichia coli* for wastewater treatment.