

Sustainable Production of Tin Oxide Nanoparticles: Exploring Synthesis Techniques, Formation Mechanisms, and Versatile Applications

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Abstract : Nanotechnology has emerged as a highly promising field of research with wide-ranging applications across various scientific disciplines. In recent years, tin oxide has garnered significant attention due to its intriguing properties, particularly when synthesized in the nanoscale range. While numerous physical and chemical methods exist for producing tin oxide nanoparticles, these approaches tend to be costly, energy-intensive, and involve the use of toxic chemicals. Given the growing concerns regarding human health and environmental impact, there has been a shift towards developing cost-effective and environmentally friendly processes for tin oxide nanoparticle synthesis. Green synthesis methods utilizing biological entities such as plant extracts, bacteria, and natural biomolecules have shown promise in successfully producing tin oxide nanoparticles. However, scaling up the production to an industrial level using green synthesis approaches remains challenging due to the complexity of biological substrates, which hinders the elucidation of reaction mechanisms and formation processes. Thus, this review aims to provide an overview of the various sources of biological entities and methodologies employed in the green synthesis of tin oxide nanoparticles, as well as their impact on nanoparticle properties. Furthermore, this research delves into the strides made in comprehending the mechanisms behind the formation of nanoparticles as documented in existing literature. It also sheds light on the array of analytical techniques employed to investigate and elucidate the characteristics of these minuscule particles.

Keywords : nanotechnology, tin oxide, green synthesis, formation mechanisms

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