Review

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Differentiation of Nanoparticle Synthesis Methods: Physical, Chemical, and Biological

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Abstract

Many researchers have recently been interested in nanomaterials and nanotechnologies. This is owing to the technology's use in a variety of fields, including engineering, medicine, computer science, materials science, biology, chemistry, physics, and agriculture. As a result, numerous scientists and engineers are doing research and making substantial advancements in nanomaterial fabrication processes. However, the majority of currently accessible procedures are traditional physical and chemical approaches, which are costly, time-consuming, potentially damaging to the environment and living beings, and inefficient in terms of material and energy use. Despite the fact that green nanoparticle production has just recently been created, a variety of physical and chemical approaches with numerous drawbacks are still in use. As a result, it is possible to choose the best method(s) based on energy, cost, and environmental toxicity.

Keywords: Nanomaterials; Nanotechnology; Nanoparticle Synthesis Methods; Bottom up Approach

Introduction

Many researchers have recently been interested in nanomaterials and nanotechnologies. This is owing to the technology's use in a variety of fields, including engineering, medicine, computer science, materials science, biology, chemistry, physics, and agriculture. As a result, numerous scientists and engineers are doing research and making substantial advancements in nanomaterial fabrication processes. However, the majority of currently accessible procedures are traditional physical and chemical approaches, which are costly, time-consuming, potentially damaging to the environment and living beings, and inefficient in terms of material and energy use. Despite the fact that green nanoparticle production has just recently been created, a variety of physical and chemical approaches with numerous drawbacks are still in use. As a result, it is possible to choose the best methods based on energy, cost, and environmental toxicity & nanotechnology (scales of 1 to 100 nanometers) [1]. Utilising multiple nanoparticle manufacturing methods The evaluation Nanoparticles are now causing problems in a variety of disciplines, including industrial uses, environmental investigations, and human health effects, due to their unique physical and chemical properties [2,3]. Nanomaterials created from metals such as titanium, silver, gold, cerium, and aluminium have been widely used for commercial reasons in the industrial sphere.

Bottom-up and top-down approaches can both be used to make these critical nanoparticles. Bottom-up techniques, such as quantum dot production of nanoparticles from colloidal dispersion, entail the downsizing of materials components (down to the atomic level) followed by a self-assembly process that leads to the formation of nanoparticles.

Chemical synthesis is the deliberate carrying out of chemical processes in order to obtain a product, or a set of products. Physical and chemical manipulations, usually involving one or more reactions, are used to achieve this. This tends to imply that the procedure is repeatable, dependable, and proven to function in various laboratories in modern laboratory practise [4]. Metallic nanoparticles are most commonly synthesised via chemical processes. Different physical and chemical procedures are commonly employed to create metal nanoparticles, according to the researchers, allowing one to generate particles with the necessary features. These production methods, on the other hand, are typically costly, labor-intensive, and potentially dangerous to the environment and living beings [5-7].

Similarly, the review published by came to the conclusion that, regardless of the method used, chemical processes have limits, either in the form of chemical contamination during the syntheses procedures or in subsequent applications [8]. Nonetheless, their ever-increasing applicability in everyday life cannot be denied. For example, "The Noble Silver Nanoparticles" are pursuing cutting-edge applications in every sphere of research and technology, including medicine, and so cannot be overlooked just because of their source of production. Silver nanoparticles have been used in over 200 consumer products, including apparel, medications, and cosmetics, due to their medical and antibacterial characteristics. Chemists, physicists, material scientists, biologists, and doctors/pharmacologists are all involved in their expanding uses to maintain their most recent establishments As a result, it is now the job of every

researcher to emphasise an alternate synthetic technique that is both cost effective and environmentally beneficial.

Green synthesis has advanced over chemical and physical approaches in recent years because it is environmentally acceptable, economically effective, and easily scaled up for large-scale nanoparticle syntheses. Furthermore, no high-temperature, high-pressure, high-energy, or harmful substances are required. However, identifying effective methods of NMs synthesis has proven difficult to date, and as a result, older methods with several flaws are still in use. This could be due to a lack of well-organized documentation that explains the progress of nanotechnology and the advantages and disadvantages of the technologies employed to synthesise nanomaterials. As a result, the purpose of this review paper is to assemble a timeline of achievements in nanoscience and nanotechnology in terms of technology the review also goes through the specifics of physical, chemical, and biological nanomaterial manufacturing methods, as well as the benefits and drawbacks of each. This will aid future researchers in selecting acceptable methodologies and synthesising tailored NPs for their studies.

Conclusion

The use of nanoparticles in the medical, food, pharmaceutical, and agricultural industries has piqued attention, with an emphasis on developing more convenient methods for producing eco-friendly, nontoxic, and environmentally benign nanoparticles utilising green biotechnology technologies.

Nanoparticles have been created using both physical and chemical methods. However, these methods are expensive and use harmful substances during nanoparticle creation using ultraviolet irradiation, laser ablation, and aerosol spray. Despite the fact that these technologies are widely employed, the usage of harmful substances is a source of concern. The physical technique to nanoparticle creation limits lower synthesis, necessitates higher energy use, and costs are extremely expensive. Harmful solvents are used in chemical methods, resulting in chemical pollution and toxic byproducts. To address these issues, biological nanoparticle synthesis using bacteria, fungus, yeast, viruses, and plant extracts as reducing agents is being investigated as an alternate technique for the synthesis of metal and metal oxide nanoparticles. The biological method yields a high yield at a low cost is safe for the environment and can be be scaled up for large-scale nanoparticle production. Green synthesis produces nanoparticles with a wide size distribution, great disparity, and high stability. Furthermore, nanoparticle synthesis does not necessitate the use of high temperatures, pressures, energy, or harmful substances.

These and other advantages of green nanoparticle manufacturing have piqued researchers' interest in studying the mechanisms of metal ion uptake and bio-reduction by plants. In terms of aesthetics, green synthesis is establishing itself as a significant method and demonstrating its potential at the top. As a result, biological nanoparticle production is a green chemistry approach that is regarded an attractive field of research for future applications. As a result, it is the moment for every researcher to focus on green syntheses as an alternative synthetic approach that is not only cost effective but also environmentally beneficial.

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