International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 6, September-October 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Nanoparticles: Methods for Nanoparticles Synthesis: Overview

Dr. Ilamathi Jayaraman[1], Dr. Vijayakumari. S[2]

[1]Head and Assistant Professor, Department of Biotechnology,
[2]Head and Assistant Professor, Department of Zoology,
[1,2]DKM College for Women (Autonomous), Affiliated to Thiruvalluvar University, Vellore, Tamil Nadu, India

ABSTRACT

Nanoparticles exist in several different morphologies such as spheres, cylinders, platelets, tubes etc. The word nanoparticles are used to describe a particle with size in the range of 1nm to 100nm, at least in one of the three possible dimensions. In this size range, the physical, chemical and biological properties of the nanoparticles changes in fundamental ways from the properties of both individual atoms/molecules and of the corresponding bulk materials. The enormous diversity of the nanoparticles arising from their wide chemical nature, shape and morphologies, the medium in which the particles are present, the state of dispersion of the particles and most importantly, the numerous possible surface modifications the nanoparticles can be subjected to make this an important active field of science now-a-days.

KEYWORDS: *Nanoparticles, spheres, platelets, atoms, diversity, molecules*

How to cite this paper: Dr. Ilamathi Jayaraman | Dr. Vijayakumari. S "Nanoparticles: Methods for Nanoparticles Synthesis: Overview" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-6, October 2021, pp.1630-1631, URL: www.ijtsrd.com/papers/ijtsrd46478.pdf

IJTSRD46478

INTRODUCTION

Phytochemical studies indicate that the plant and plant metabolites contain important phytochemicals such as lupeol, ursolic acid, oleanolic acid, sitosterol, rutin, leucocyanidin, anthocyanins, proanthocyanidins, glycosides of kaempferol and quercetin. Pharmacological studies suggest that the plant possesses anti-oxidative, antibacterial, gastro protective, hepatoprotective, anti- diarrheal, anti-nociceptive, anti-mutagenic, anti- ecoplastic and chemo preventive effects The Green chemistry which involves using eco-friendly materials and ensures compatibility for pharmaceutical and other biomedical applications, where toxic chemicals are not used for the synthesis process. The biological approach which includes different types of microorganisms has been used to synthesize different metallic NPs, which has advantages over other chemical methods as this is greener, energy saving and cost- effective.

The biocompatibility of bio-inspired NPs offers very interesting applications in biomedicine and related fields. The coating of biological molecules on the surface of NPs makes them biocompatible in comparison with the NPs prepared by chemical methods. The use of agricultural wastes or plants and their parts has emerged as an alternative to chemical synthetic procedures because it does not require elaborate processes such as intracellular synthesis and multiple purification steps or the maintenance of microbial cell cultures *(Piccinno F*

Physical approaches

Most important physical approaches include evaporation-condensation and laser ablation. Various metal nanoparticles such as silver, gold, lead sulfide, cadmium sulfide, and fullerene have previously been synthesized using the evaporation- condensation method.The absence of solvent contamination in the prepared thin films and the uniformity of nanoparticles distribution are the advantages of physical approaches in comparison with chemical processes. *(Magnusson, M.D et al., 1999).*

It was demonstrated that zinc nanoparticles could be synthesized via a small ceramic heater with a local heating source *(Jung, J.O. et al., 2006)* The

evaporated vapor can cool at a suitable rapid rate, because the temperature gradient in the vicinity of the heater surface is very steep in comparison with that of a tube furnace. This makes possible the formation of small nanoparticles in high concentration.This physical method can be useful as a nanoparticle generator for long-term experiments for inhalation toxicity studies, and as a calibration device for nanoparticle measurement equipment. Zinc oxide nanoparticles could be synthesized by laser ablation of metallic bulk materials in solution.

The ablation efficiency and the characteristics of produced nano zinc particles depend upon many factors such as the wavelength of the laser impinging the metallic target, the duration of the laser pulses (in the femto-, pico- and nanosecond regime), the laser fluence, the ablation time duration and the effective liquid medium, with or without the presence of surfactants*(Kawasaki, M.N et al.,2006).*

One important advantage of laserablation technique compared to other methods for production of metal colloids is the absence of chemical reagents in solutions. Therefore, pure uncontaminated metal colloids for further applications can be prepared by this technique *(Tsuji, T.I et al.,2002)*

Chemical approaches

The most common approach for synthesis of zinc oxide nanoparticles is chemical reduction by organic and inorganic reducing agents. In general, different reducing agents such as sodium citrate, ascorbate, sodium borohydride (NaBH4), elemental hydrogen, polyol process, Tollens reagent, N, N-dimethylformamide (DMF), and poly (ethylene glycol)- block copolymers are used for reduction of zinc ions in aqueous or non- aqueous solutions.

It is important to use protective agents to stabilize dispersive nanoparticles during the course of metal nanoparticle preparation, and protect the nanoparticles that can be absorbed on or bind onto nanoparticle surfaces, avoiding their agglomeration. The presence of surfactants comprising functionalities (e.g., thiols, amines, acids, and alcohols) for interactions with particle surfaces can stabilize particle growth, and protect particles from sedimentation, agglomeration, or losing their surface properties. Recently, a simple one-step process, Tollens method, has been used for the synthesis of zinc nanoparticles with a controlled size. In the modified Tollens procedure, silver ions are reduced by saccharides in the presence of ammonia, yielding zinc nanoparticle films (50-200 nm), zinc hydrosols (20-50 nm) and zinc nanoparticles of different shapes *(Yin, Y.L et al., 2002).* Efficient green chemistry methods employing natural reducing, capping, and stabilizing agents to prepare zinc nanoparticles with desired morphology and size have become a major focus of researchers. Biological methods can be used to synthesize zinc nanoparticles without the use of any harsh, toxic and expensive chemical substances *(Ankamwar, B.D et al., 2005).*

The bioreduction of metal ions by combinations of bio molecules found in the extracts of certain organisms (e.g., enzymes/proteins, amino acids, polysaccharides, and vitamins) is environmentally benign, yet chemically complex. Many studies have reported successful synthesis of zinc nanoparticle using organisms (microorganisms and biological systems*) (Iravani, S et al., 2011)*

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