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Review Article

Properties and Applications of Nanoparticles - Review

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Abstract

It's science on the smallest of levels. It's the truth in the statement that good things come in small packages. The most traditional approaches to synthesis of nanoscale materials are energy inefficient, require stringent synthesis conditions (e.g., high temperature, pressure, pH), and often produce toxic by products. The use of different microorganisms in the synthesis nanoparticles is a relatively recent addition and have several advantages over physical and chemical synthesis of nanoparticles.

Keywords: Properties of nanoparticles, Optical Properties, Applications

Introduction

Properties of nanoparticles

General Properties

High Surface Area Materials:

The trend to smaller and smaller structures, that is, miniaturization, is well known in the manufacturing and microelectronics industries.¹¹ In the Nanotechnology area this same trend towards miniaturization also is occurring, but for different reasons. New properties intrinsic to novel structures will enable breakthroughs in a multitude of technologically important areas (Siegel, 1991; Gleiter, 1989). Nanostructures have *higher surface areas* than do conventional materials. The impact of nanostructures on the properties of high surface area materials is an area of increasing importance to understanding, creating, and improving materials for diverse applications. High surface areas can be attained either by fabricating small particles or clusters where the *surface-to-volume ratio* of each particle is high, or by creating materials where the *void*

surface area (pores) is high compared to the amount of bulk support material.

Pressure based properties:

Nanocrystalline materials (NM) have distinctive mechanical and energetic properties, which derive from their extremely small grain size and large interfacial area per unit volume. Further, the interfaces of NM do not seem to behave as equilibrated interfaces of coarser crystals. As a consequence, the transport properties of NM, and their chemical reaction pathways would be dramatically different from those of single crystals or fine-grained aggregates.

Surface forces:

Surfaces and interfaces play an increasingly important role for particles or structures as they are made smaller. High surface area of nanoparticulate matter also results in large area of interfaces. This condition is primarily responsible for nanoparticle agglomeration. A variety of

physical mechanisms underlie the forces that act at surfaces, but the overall effect is simple; small objects have a very strong tendency to stick together. These phenomena also underlie the almost universal tendency of protein molecules to stick to any surface immersed within the body, with important consequences for the design of biomedical nanodevices.

Catalytic activity

The catalytic activity of nanoparticles because of the enormous number of active sites is available to the reactants. In catalysis the key goal is to promote reactions that have high selectivity with high yield. It is anticipated that this goal will be more closely approached through tailoring a catalyst particle via nanoparticle synthesis and assembly so that it performs only specific chemical conversions, performs these at high yield, and does so with greater energy efficiency. The efficacy of nanoparticle catalysts depends on various other factors such as morphology, average size distribution, porosity, and phase composition (Rakesh kumer Sharma et al., 2003)

Mechanical Properties

The great interest in the mechanical behavior of nanostructured materials originates from the unique mechanical properties.

Among these early observations/predictions were the following:

- * Lower elastic moduli than for conventional grain size materials—by as much as 30 - 50%
- * Very high hardness and strength—hardness values for nanocrystalline pure metals (~ 10 nm grain size) are 2 to 7 times higher than those of larger grained (>1 μm) metals.

Optical Properties

Nanometer particles have unique optical properties, which are used both for scientific and practical purposes. The absorption and scattering of light by silver and gold nanoparticles and their aggregates provides a powerful mechanism for detecting important molecules in a variety of applications. The nanoparticles of interest are typically large enough that classical electromagnetic theory can accurately describe their interaction with light but small enough so that there are strong variations in optical properties with particle size, shape, and local environment. The optical characteristics of these particles are determined by conventional spectroscopic methods (Mastalir et al., 2002). Optical spectra provide

fundamental information on the electronic structure of small metal particles. In particular, investigation into optical spectra allows one to follow the variation of electronic properties on passing from bulk samples to small particles.

The unique optical properties of small particles are finding application in the design of optical filters, markers of biomacromolecules, reversible photosensitive monochromic glasses, optical switches and optical traps and for surface enhancement of Raman light scattering spectra.

Applications of nanotechnology

Nanomedicine:

From nanotechnology it is only one step to nanomedicine, which may be defined as the monitoring, repair, construction, and control of human biological systems at the molecular level, using engineered nanodevices and nanostructures. It can also be regarded as another implementation of nanotechnology in the field of medical science and diagnostics. One of the most important issues is the proper distribution of drugs and other therapeutic agents within the patient's body.

Targeting the delivery of drugs to diseased lesions is one of the important aspects of the drug delivery systems. To convey a sufficient dose of drug to the lesion, suitable carriers of drugs are needed. Nano- and micro-particle carriers have important potential applications for the administration of therapeutic molecules. Nanoparticles are more efficient drug carriers than liposomes due to their better stability and possess more useful control release properties. These are the reasons why many drugs have been associated with nanoparticles (e.g. antibiotics, antiviral and antiparasitic drugs, cytostatics, vitamins, protein and peptides, including enzymes and hormones. Nanoparticles and nanospheres have considerable utility as controlled drug delivery systems. (Hans, 1997). When suitably encapsulated, a pharmaceutical can be delivered to the appropriate site, its concentration can be maintained at proper levels for long periods of time, and it can be prevented from undergoing premature degradation. Nanoparticles (as opposed to micron-sized particles) have the advantage that they are small enough that they can be injected into the circulatory system. Nanoparticles generally vary in size from 10 to 1000 nm. The drug is dissolved, entrapped, encapsulated, or attached to a nanoparticle matrix.

Biodegradable polymeric nanoparticles have attracted considerable attention as potential drug delivery devices;

this is in view of their applications in controlling drug release, their ability to target particular organs/tissue as carriers of oligonucleotides in antisense therapy, DNA in gene therapy, and in their ability to deliver proteins, peptides and genes through oral administration.

Molecular Nanotechnology:

The qualifier "Molecular" has been added to the term "Nanotechnology" (cf. Nanotechnology) to point out the so-called "**bottom-up**" approach, i.e. starting from atoms and molecules, and the related key problems in building objects of any size with atomic or molecular structural accuracy. This is the ultimate goal of such emerging technology that will be attained through so-called "assemblers", pre programmed molecular-size robots or nanofactories. This is a real turning point in chemical thought, as the substitution of conventional "bulk chemistry" and "solution-phase chemistry" with a "machine phase chemistry" involves completely new patterns of designing and controlling chemical processes. The approach to the building of nanoscale size tools and machines for attaining Molecular Nanotechnology capabilities follows two ways: the "wet approach", based on the exploitation of biological nanomachines (biomacromolecules), and the "dry approach", based on tools and devices of nm size like those achievable through so-called "enabling technologies".

Molecular Manufacturing:

This term designates the non-biological synthesis of complex structures with atomic accuracy according to the methods of Molecular Nanotechnology. This is a general term encompassing all technologies aiming to build objects, make measurements, and carry out processes on the nm lengths scale. In this general acceptance, the term refers to a widely developed field as to the nm-scale accuracy with which many mechanical working operations can now be carried out, and as to measuring technologies, which allow nm-scale lengths and forces to be appreciated. Devices have been built capable of measuring forces acting on or exerted by single molecules. The so-called "**top-down**" approach designates the approach to the building of nanomachines by building increasingly smaller micro-machines.

Nanoelectronics:

Quantum-confinement nanostructures on semiconductors and monomolecular electronics (single molecules as electronic devices) are emerging

technologies that would realize extremely large scale integrated, extremely low-power consumption electronic circuits and powerful computers of very small size. This is a kind of Nanotechnology that will have a great impact on many markets, not just the electronic appliances and computer market, in the near future. This term should be properly reserved to single-molecule-based devices and systems. (Schnur, 1994).

Nanomaterials:

In materials, things start to behave differently at the nanoscale. The bulk materials that we have traditionally dealt with are uncontrolled and disordered at small scales. The strongest alloys are still made of crystals the size and shape of which we control only crudely. By comparison, a tiny, hollow tube of carbon atoms, called a carbon nanotube, can be perfectly formed, is remarkably strong, and has some interesting and useful electrical and thermal properties. When particles get small enough (and qualify as nanoparticles), their mechanical properties change, and the way light and other electromagnetic radiation is affected by them changes (visible light wavelengths are on the order of a few hundred nanometers). Using nanoparticles in composite materials can enhance their strength and/or reduce weight, increase chemical and heat resistance and change the interaction with light and other radiation.

Computers:

The smallest synthetic Nanotechnology made so far are the individual components of an Intel Pentium III microprocessor and they span about 200 nanometers.

Biological label:

Bioconjugate quantum dots as fluorescent biological label:

Semiconductor nanocrystals (size range 2-8 nm in diameter) are highly light absorbing, luminescent nanoparticles. Semiconductor quantum dots absorb light over a very broad spectral range and have resulted in increased fluorescence quantum efficiencies (>50%) and greatly improved photochemical stability. Specific binding to the cell surfaces, insertion into cells and binding to cell nuclei have all been demonstrated following conjugation of nanoparticles with the appropriate targeting protein -cadmium sulfide nanoparticles (Anders, et al., 2013)

A gold nanoparticle bioconjugate -based calorimetric assay:

The labeling of targeting molecules, especially proteins, with gold nanoparticles has revolutionized the visualization of cellular or tissue components by electron

microscopy. The optical and electron beam contrast qualities of gold colloid have provided excellent detection qualities for such techniques as immunoblotting, flow cytometry and hybridization assays. Conjugation protocols exist for the labeling of a broad range of biomolecules with gold colloid such as protein A, avidin, streptavidin, glucose oxidase and IgG. (Anders, et al., 2013)

Drug delivery system:

A primary goal in modern drug therapy of intracellular infections is the site-specific drug delivery. One of the possible solutions to a problem is enhanced drug delivery to macrophages that serve as reservoirs of pathogens. This may be achieved by incorporation of drugs into colloidal carriers. Polymeric nanoparticles appear to be a promising colloidal drug delivery system due to their high stability and relatively cheap and easy production technology which is fairly reproducible and allows synthesizing of nanoparticles with narrow size distribution and high drug loading. eg. Polybutyl cyanoacrylate nanoparticles based formulations. Also drug delivery systems for antibiotics of various classes, such as doxorubicin, ampicillin, gentamycin, and rifampicin have been developed. eg. in rats with experimental acute lung abscess caused by *S.aureus*, nanoparticles provided a 10 fold increase of the gentamycin concentration at the site of abscess comparing to the free drug.

A gold nanoshell-polymer composite photothermally triggered drug delivery system. Gold nanoshells are new composite nanoparticles that combine infrared optical activity with the uniquely biocompatible properties of gold colloid. Metal nanoshells are concentric sphere nanoparticles consisting of a dielectric core and a metal shell. Successful gold nanoshell conjugation with enzymes and antibodies has been demonstrated. When optically absorbing gold nanoshells are embedded in a matrix, illuminating them at their resonance wavelength causes the nanoshells to transfer heat to their local environment. This photothermal effect can be used to optically 'remote control' drug release in a nanoshell-polymer composite drug delivery material. eg. Gold nanoshell-copolymers of N-isopropylacrylamide and acrylamide composite (Anders et al., 2013)

Antimicrobial Agents:

Silver is a useful antimicrobial agent. It acts effectively with low toxicity, especially important in the topical antibacterial treatment of burn wounds, where transient

bacteraemia is commonly cited. However due some reasons there exists toxicity. Therefore, the application of silver-binding membranes has recently been suggested to further reduce the likelihood of silver toxicity to retard the movement of silver ions and minimize silver absorption at a healing wound.

Silver complexes of poly (amidoamine) PAMAM dendrimers as well as different (silver -PAMAM) dendrimer nanocomposite solutions have been tested *in vitro* against *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* bacteria. Both, PAMAM silver salts and nanocomposites displayed considerable antimicrobial activity without loss of solubility and activity (Jennifer, 2000)

Nanoparticles Fine-tune Cancer Treatment:

In principle one can deliver interested cancer drug, using nanoparticles and deliver it to a fixed or targeted site. Thus nanoparticles can be used as a diagnostic tool .eg. Microscopic magnetic nanoparticles can race through the bloodstream and dispatch cancer-fighting medicine directly to malignant tumors or cancerous cells. These microscopic machines act like 'guided missiles' travelling directly to the affected areas, only avoiding healthy cells (Donald Tomalia.,2000)

Nanoparticles For Bioseperation:

Gold-iron core or shell superparamagnetic nanoparticles can be used for bioseperation applications.

Spread The Word About Nanofluids:

Liquid spreads and wets a surface. But wetting behavior changes if the liquid contains nanoparticles. Different ways to create effective detergents for cleaning oil from a surface have been developed .The spreading behavior of nanofluids containing surfactant micelles has implications for soil remediations, oily soil removal, lubrication and enhanced oil recovery (Terry Shropshire, 2001).

Optically Functional Nanoparticles:

Ceramic-metal composites (ceramets) are known to exhibit interesting optical and electrical properties, such as spectrally selective light absorption and tunable electrical resistivity. Ceramet materials are conventionally produced by physical and chemical methods. A new microbiologically based production method for a ceramet material, consists of an organic

carbon matrix with embedded, crystalline metallic silver particles, bio-synthesized by the bacterial strain *Pseudomonas stutzeri* AG259. Triangular, hexagonal and spheroidal silver-containing particles are accumulated at different cellular binding sites in the periplasmic space of the bacterial cell (Manoj K.Chaudhury 2000).

Nanotechnology And The Cosmetic Chemist:

Cosmetic chemists have developed nanoscale (<100 nm) inorganic ultraviolet absorbers or 'nanopowders'. Eg.zinc oxide (ZnO) and titanium oxide (TiO₂) have been used for many years to protect people from the effects of U.V. radiation. These have many desirable characteristics such as, long history of topical use, low irritancy, broad-spectrum absorption and high photo stability (Ralph Joerger,2000).

Reduction of metal nanoparticles from solutions

Chemical reduction is used most widely to synthesize colloidal particles. (Roldughin, 2000). Metal salts can be reduced by various reducing agents in the presence of stabilizers (special ligands, polymers, surfactants), which suppress particle aggregation (Shchukin, 1982). Reduction yields particles of different sizes. The size cannot be predicted because it is affected simultaneously by several factors: the nature and the concentration of the solvent and the stabilizing agent used, reaction temperature, and reaction time. In addition, the particle size is determined to a large extent by the supersaturation developed. Higher supersaturation results in smaller particles; hence, the size of the particles can be controlled by varying supersaturation (Shchukin, 1982). The degree of supersaturation reached in the experiments is governed by the rate of the chemical reduction, temperature and the amount of the reduced metal spent for the particle formation and growth. For this reason, the main way of controlling the particle size is to use growth retardants, which play a dual role. On the one hand, they retard the transfer of the reduced metal from the solution to the particles and thus increase supersaturation. On the other hand, the retardants directly limit the rate of the increase in the particle size.

Mechanism of formation of nanoparticles

Rearranging matter at the nanoscale using 'weak' molecular interactions, such as Van der Waal forces, hydrogen bonds, electrostatic dipoles, fluidics and various surface forces, requires low energy consumption

and allows for reversible or other subsequent changes. Such changes of usually 'soft' nanostructures in a limited temperature range are essential for bioprocesses to take place. Biosystems are governed by nanoscale processes that have been optimized over millions of years; examples of biostrategies have been surveyed. (Ball, 2002). The history of metal nanoparticles begins with Faraday's study of gold colloids. However, it was not until Feynman's revolutionary insights on quantum electrodynamics (Richard Feynman, 1960). and the recent advent of microscopic techniques with subnanometer resolution that nanomaterial research has become increasingly popular. A computer search through the chemical abstracts reveals that more than 5000 articles concerning nanoparticles have been published in international journals during just 2002, which demonstrates the popularity of this topic.

There are several different methods of nanoparticles synthesis. The most common approach is based on the use of a suitable capping agent, which passivates growth at an early stage.

A discussion on the role of capping agents in controlling particle size has been presented by Murray et al in describing processes in the growth of organically passivated cadmium chalcogenides. (Murray, 1979) or cobalt nanoparticles. (Sun and Murray, 1999). Water is one of the best-known and most common solvents. Water has a high permittivity, which makes it a good solvent for polar or ionic compounds. Therefore, many chemical reactions take place in aqueous media.

The synthesis of particles in a solution occurs by chemical reactions that result in the formation of stable nuclei and subsequent particle growth. The term *precipitation* is often used to describe this series of events. Precipitation is often accompanied by the formation of insoluble hydroxides due to hydrolysis. The reactants are introduced in liquid in the aqueous solvent. The phenomenon of precipitation of solids in solution has been well studied (Walton, 1979). Elemental or multicomponent particles can be precipitated. Upon addition of reagents such as reducing or oxidizing agents to the solution containing the reactants, chemical reactions occur and the solution becomes supersaturated with the product. The thermodynamics equilibrium state of the system is restored by condensation of nuclei of the reaction product. Two types of nucleation can occur. Primary nucleation is characterized as being driven by the solution itself, either strictly within the solution, as in homogeneous nucleation, or catalyzed by extraneous material in the solution, as in heterogeneous nucleation. In a supersaturated solution when the nuclei form at

nearly the same time, subsequent growth of these nuclei results in formation of particles with a very narrow size distribution, provided that secondary nucleation does not occur later (LaMer, 1950). This narrow size distribution can be maintained as long as agglomeration of particles in solution does not occur. (Shanefield, 1995).

One of the most challenging problems in synthesis is the controlled generation of monodispersed nanoparticles with size variance so small that size selection by centrifugal precipitation or mobility classification is not necessary. The monolayer coverage provides two key functions:

- Shielding the particles from agglomeration and
- Furnishing a scaffold for the attachment of functional molecular entities.

Nanoparticles possess large surface areas and often form agglomerates as a result of attractive Van der Waals forces and the tendency of the system to minimize the total surface or interfacial energy. It should be noted here that surface area is inversely proportional to the particle size. Larger the surface area smaller the particle size and vice versa. This necessitates the use of Dispersants in nanoparticles synthesis. In chemical terminology Dispersants are often surfactants. They can adsorb on the surface or form an envelope around the particle to provide either electrostatic or steric repulsion. The proteins present in ECF act as dispersants and cause monodisperse synthesis of nanoparticles.

Repulsive interparticle forces are needed to prevent the particles from agglomeration during synthesis. To produce unagglomerated particles, surfactants are used to control the dispersion during chemical synthesis.

In biosynthesis of nanoparticles the proteins present in extracellular fluid prevent the agglomeration of nanoparticles. In the case of fungus and actinomycete mediated bioreduction; nanoparticles are synthesized under ambient conditions at room temperature. The fungus plays the role of biological nanofactories. The proteins present in enzymes secreted from fungus during fermentation act as reductants and stabilizers, which reduce the metal salts and capping proteins, prevent aggregation of nanoparticles respectively. Although the reaction time may be slightly more than the chemical reduction processes in some cases but the reaction temperature is drastically less than the chemical routes of synthesis. The nanoparticles prepared are comparable to nanoparticles prepared from traditional routes from every aspect e.g. optical properties, particles size etc.

Furthermore the particles are prepared from green route of chemistry and thus environmental friendly and no toxic chemicals are used in the process. Following the biosynthesis of nanoparticles, the cells of fungus or actinomycete continue to multiply normally, as the metallic ions used are not toxic to the cells – which is important as more nanoparticles would be formed as the cells multiplied. This suggests that the organism is still in viable state and capable of performing important life processes. So, the process of bioreduction apart from being environment friendly is also life friendly.

Bacterial mediated biosynthesis of nanoparticles

Bacteria have been used with success in the synthesis of cadmium sulphide (CdS) nanoparticles (Beveridge., 1980; Smith, 1998)., Holmes and co-workers have shown that the bacterium, *Klebsiella aerogenes* when exposed to Cd²⁺ ions resulted in the intra-cellular formation of CdS nanoparticles in the size range 20 – 200 nm.³¹ In an interesting extension of the bacteria-based methodology for the growth of magnetic nanoparticles, Roh and co-workers showed that metals such as Co, Cr and Ni may be substituted into magnetite crystals biosynthesized in the thermophilic iron-reducing bacterium, *Thermoanaerobacter ethanolicus* (Roh, 2001)., This procedure resulted in the formation of octahedral-shaped magnetite nanoparticles in large quantities that co-existed with a poorly crystalline magnetite phase near the surface of the cells. *Lactobacillus* strains present in buttermilk when exposed to silver and gold ions, results in the large-scale production of nanoparticles within the bacterial cells (Klaus-Joerge, 2001).

Recently Klaus *et al.* (2001) have found that single crystalline silver-based particles of well defined compositions and shapes are synthesized by *Pseudomonas stutzeri* AG259, a bacterial strain previously isolated from a silver mine T.J. Beveridge (1989)., The study reports on the detailed structure and phase composition of the silver-containing particles with a flat morphology that form within the periplasmic space. In some cyanobacterial species, an outer cell surface proteinaceous membrane, an S layer, is a template for calcium-sulfate/carbonate synthesis. The thin layer of inorganic shell is a protective covering, consisting of highly organized two-dimensional ordered tiles (tessellations) (Gardea-Torresdey, 2001).

Yeast mediated biosynthesis of nanoparticles

It has long been recognized that yeasts such as *Candida glabrata* and *Schizosaccharomyces pombe* when exposed to Cd^{2+} ions lead to the intra-cellular formation of CdS quantum dots. (Reese, 1988) In this particular case, the biochemical process resulting in the nanoparticle formation is well understood. (Damerron, 1989). Yeast cells exposed to Cd^{2+} ions produce metal chelating peptides (glutathiones). This is accompanied by an increase in the intra-cellular sulfide concentration and finally, formation of nanocrystalline CdS. The biogenic CdS quantum dots are capped and stabilized by the peptides, glutathione and its derivative phytochelatins with the general structure, $(\gamma\text{-Glu-Cys})_n\text{Gly}$. (Damerron, 1989). Based on an extensive screening program, Kowshik and co-workers have identified the yeast, *Torulopsis* sp. as being capable of intra-cellular synthesis of nanoscale PbS crystallites when exposed to aqueous Pb^{2+} ions. (Lovely, 1987). Ultimately, biogenic nanoparticles would have to compete with chemically synthesized nanoparticles in terms of performance in devices. As a step in this direction, Kowshik *et al.* have shown that CdS quantum dots synthesized intra-cellularly in *Schizosaccharomyces pombe* yeast cells exhibit ideal diode characteristics. Biogenic CdS nanoparticles in the size range 1-1.5 nm were used in the fabrication of a heterojunction with poly (*p*-phenylenevinylene). Such a diode exhibited 75 mA/cm² current in the forward bias mode at 10 V while breakdown occurred at 15 V in the reverse direction.

The use of fungi and actinomycetes in the synthesis of nanoparticles is a relatively recent addition to the list of microbes discussed above. Two genera of fungi that when challenged with aqueous metal ions such as $AuCl_4^-$ and Ag^+ ions yielded large quantities of metal nanoparticles extra-cellularly (*Fusarium oxysporum*) (Ahmad, 2002) and intra-cellularly (*Verticillium* sp.) (Mukherjee, 2002). In the case of *Verticillium* gold ions are thus reduced intra-cellularly, further evidence of which is provided by TEM analysis of thin sections of the cells after formation of gold nanoparticles. The nanoparticles ranging in size from 5 nm to 200 nm with an average size of 20 ± 8 nm are clearly seen populating both the cell wall and cytoplasmic membrane of the fungus. The reduction of the gold ions is expected to be due to reaction with enzymes present in the cell walls of the mycelia. (Mukherjee, 2002). From the application point of view, synthesis of nanoparticles extra-cellularly would be more important. Fungus mediated extracellular synthesis of gold, silver and CdS quantum dots have been reported. (Ahmad, 2002).

These uses, in fact, are exciting prospects for understanding the principles of nanoparticle (and hard tissue) synthesis could potentially be exploited in materials sciences. The use of biological principles in materials formation is an emerging field called *Biomimetics*. Materials produced by organisms have properties that usually surpass those of analogous synthetically manufactured materials with similar phase compositions. Biological materials are assembled in aqueous environments under mild conditions by using biomacromolecules (Charle, 1982). Therefore, *Biomimetics*, the use of biological principles in materials synthesis and assembly, may be a path for realizing nanotechnology. Nonetheless the presence of an inorganic compound in conjunction with a biological macromolecule within a tissue is intriguing in terms of the phase compatibility in these complex systems.(Sarkariya, 1995).

Current understanding of the mechanisms of inorganic materials formation (biomineralization) in organisms and their regulation are far from complete. Their major role may be due to either templating (Addadi, 1985), or enzymatic effects. (Greenfield, 1984), An enzyme could regulate inorganic phase synthesis by controlling local chemistry. These studies, however, are preliminary, because a large number of macromolecules are present in an organism and may affect, independently or in concert. Further studies, therefore, are essential to elucidate the specific effects of macromolecules in simulated *in vivo* conditions that mimic natural, physiological synthesis.

Objective the biosynthesis of silver nanoparticles (Ag NPs) was carried out by using actinobacteria isolated from medicinal garden soil sample.VIT University. Methods AgNPs synthesized by mixing culture supernatant with 1mm of $AgNO_3$ inoculated at room temperature under dark condition. Result based on morphological characteristics,14 strains were select and screened for the production of AgNPs. Among 14 strains only one strain (PSBVIT-13) showed positive result for biological synthesis of Ag NPs were characterized by using biosynthesized AgNPs showed activity against *L. Monocytogenes* (17 ± 0.15), *S.typhi* (8.63 ± 0.25), *S.aureus*(6.17 ± 0.15),*B.cereus*(6.8 ± 0.2) and *P.aergenosa* (9.2 ± 0.2). F.urthermore, the cytotoxicity effects of biosynthesized AgNPs were tested on brine shrimps. AgNPs showed 70% of inhibition at the concentration of 50 μ g/ml and complete inhibition was observed from the concentration of 75 to 100 μ g/ml.

In the present work two new strain of thermophilic actinomycetes *Thermoactinomyces* spp. 44th, isolated from the red soil of Adjara region, and *Thermomonospora* spp. 67th, isolated from the cinnamon calcareous soil of Tetrtskaro region at high temperature were studied to use them in the synthesis of gold nanoparticles. The gold nanoparticles obtained in biomass of thermophilic actinomycetes were characterized using various optical and analytic methods.

In the present study an attempt was made to evaluate the antimicrobial potential of culture filtrate of *Streptomyces* sp. VITBT7 and biologically synthesized silver nanoparticles using the culture filtrate of VITBT7. actinomycetes isolates obtained from soil samples were screened for antimicrobial activity against selected fungal and bacterial pathogens by well diffusion method. The potential isolate was identified by molecular taxonomic characterization. The culture filtrate of the potential isolate was assessed for the synthesis of silver nanoparticles. The synthesized silver nanoparticles were characterized for surface plasma resonance (SPR) peak, shape and size distribution by TEM analysis. Out of 240 actinomycetes colonies recovered, 19 isolates showed mild to moderate antimicrobial zone of inhibition against *Pseudomonas aeruginosa* and *Aspergillus niger*. The isolate was identified to belong to filtrate synthesized silver nanoparticles (AgNPs) within 24h. the biologically synthesized AgNPs also exhibited antimicrobial activity against fungal and bacterial pathogens. The secondary metabolites produced by *Streptomyces* sp. VITBT7 could be responsible for observed antimicrobial activity.

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