

# The Present Scenario of Nanoparticles in the World

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## Abstract

*Nanoparticles are particles between 1 and 100 nanometers (nm) in size with a surrounding interfacial layer. The interfacial layer is an integral part of nanoscale matter, fundamentally affecting all of its properties. The interfacial layer typically consists of ions, inorganic and organic molecules. Organic molecules coating inorganic nanoparticles are known as stabilizers, capping and surface ligands, or passivating agents. In nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Particles are further classified according to diameter.*

**Keywords:** *Nanoparticles, Applications, Scenario, Ultrafine particles, Nanometer-sized single crystals, Single-domain ultrafine particles.*

## Introduction

Nanoparticles are very important for every sector in science. It used everywhere in the field of science. Scientific research on nanoparticles is intense as they have many potential applications in medicine, physics, optics, and electronics. The U.S. National Nanotechnology Initiative offers government funding focused on nanoparticle research. It is also used in Bangladesh for some purpose. A lot of researchers are conducting research on Nanoparticles in Bangladesh now-a-days.

The term "nanoparticle" is not usually applied to individual molecules; it usually refers to inorganic materials.

The reason for the synonymous definition of nanoparticles and ultrafine particles is that, during the 1970s and 80s, when the first thorough fundamental studies with "nanoparticles" were underway in the USA (by Granqvist and Buhrman) and Japan, (within an ERATO Project) they were called "ultrafine particles" (UFP). However, during the 1990s before the National Nanotechnology Initiative was launched in the USA, the new name, "nanoparticle," had become more common. Nanoparticles can exhibit size-related properties significantly different from those of either fine particles or bulk materials. Nanoclusters have at least one dimension between 1 and 10 nanometers and a narrow size distribution. Nanopowders are agglomerates of ultrafine particles, nanoparticles, or nanoclusters. Nanometer-sized single crystals, or single-domain ultrafine particles, are often referred to as nanocrystals.

## II. Methods and Materials

### II A. Classifications of Nanoparticles:

- (1). Ultrafine particles are the same as nanoparticles and between 1 and 100 nm in size.
- (2). Fine particles are sized between 100 and 2,500 nm.
- (3). Coarse particles cover a range between 2,500 and 10,000 nm.

### II. B. Applications of Nanoparticles :

#### (1) Carbon Nanotubes:

Carbon materials have a wide range of uses, ranging from composites for use in vehicles and sports equipment to integrated circuits for electronic components. The interactions between nanomaterials such as carbon nanotubes and natural organic matter strongly influence both their aggregation and deposition, which strongly affects their transport, transformation, and exposure in aquatic environments. In past research, carbon nanotubes exhibited some toxicological impacts that will be evaluated in various environmental settings in current EPA chemical safety research. EPA research will provide data, models, test methods, and best practices to discover the acute health effects of carbon nanotubes and identify methods to predict them.

**(2) Cerium oxide:**

Nanoscale cerium oxide is used in electronics, biomedical supplies, energy, and fuel additives. Many applications of engineered cerium oxide nanoparticles naturally disperse themselves into the environment, which increases the risk of exposure. There is ongoing exposure to new diesel emissions using fuel additives containing CeO<sub>2</sub> nanoparticles, and the environmental and public health impacts of this new technology are unknown. EPA's chemical safety research is assessing the environmental, ecological, and health implications of nanotechnology-enabled diesel fuel additives.

**(3) Titanium dioxide:**

Nano titanium dioxide is currently used in many products. Depending on the type of particle, it may be found in sunscreens, cosmetics, and paints and coatings. It is also being investigated for use in removing contaminants from drinking water.

**(4) Nano Silver:**

Nano silver is being incorporated into textiles, clothing, food packaging, and other materials to eliminate bacteria. EPA and the U.S. Consumer Product Safety Commission are studying certain products to see whether they transfer nano-size silver particles in real-world scenarios. EPA is researching this topic to better understand how much nano-silver children come in contact with in their environments.

**(5) Iron:**

While nano-scale iron is being investigated for many uses, including "smart fluids" for uses such as optics polishing and as a better-absorbed iron nutrient supplement, one of its more prominent current uses is to remove contamination from groundwater. This use, supported by EPA research, is being piloted at a number of sites across the country.

**(6) Laser applications:**

The use of nanoparticles in laser dye-doped poly(methyl methacrylate) (PMMA) laser gain media was demonstrated in 2003 and it has been shown to improve conversion efficiencies and to decrease laser beam divergence. Researchers attribute the reduction in beam divergence to improved dn/dT characteristics of the organic-inorganic dyedoped nanocomposite. The optimum composition reported by these researchers is 30% w/w of SiO<sub>2</sub> (~ 12 nm) in dye-doped PMMA.

**(7) Medicinal applications:**

Liposome, Dendrimer, Iron oxide nanoparticles, Nanomedicine, Polymer-drug conjugate, Polymeric nanoparticle.

**II.C Present Research on Nanoparticles in the World:**

Nanoparticle research is a fascinating branch of science. The strongly size-related properties of nanoparticles offer uncountable opportunities for surprising discoveries. The often unexpected and unprecedented behavior of nanoparticles bears great potential for innovative technological applications, but also poses great challenges to the scientists. They have to develop highly controllable synthesis approaches, more sensitive characterization tools and finally new models and theories to explain the experimental observations. In this review, we discuss a personal selection of papers dedicated to nanoparticle research, which we believe provide an illustrative overview of current research directions in this rapidly developing field. We have structured the text in five sections: introduction, nanoparticle synthesis, formation mechanisms, nanoparticle assembly, and applications. The chosen examples within these sections are not directly related to each other, but reflect the remarkable broadness of nanoparticle research covering historical aspects, basic and applied science as well as commercial applications.

Silver nanoparticles is in restorative industry, for example, topical salves to counteract disease against blaze and open injuries. The motivation behind the accompanying analyses was to explore the impacts of gold and silver nanoparticles on the HRP action, utilizing TMB as the substrate. Nanoparticles (NPs) interceded medication conveyance frameworks have the potential capacity to beat the natural boundaries because of EPR impact, productive medication repository, and the basic adaptability to be altered to discharge the remedial operators in the coveted site. In light of this reason shape, size and morphology of the nanoparticles can be controlled in a superior manner. In this work I took after a concoction technique Co-precipitation for the union of Cd<sub>x</sub>Mg<sub>1-x</sub>Fe<sub>2</sub>O<sub>4</sub> nanoparticles, which is clarified underneath. Nanomaterials (NM) are increasing expanding enthusiasm for different fields of use. They are utilized as a part of the medicinal division, in buyer items, for building materials, in PC innovation or for waste remediation. By yearly creation volumes and by number of items, silica nanoparticles. Nanoengineering empowers us to grow the surface region of silver particles notably. Silver

nanoparticles have indicated antimicrobial action against a wide exhibit of microorganisms, likely because of their various systems of antimicrobial activity.

The created nanoparticles were subjected to UV-Vis spectroscopy investigation, Atomic Force Microscopy (AFM) examination and Fourier Transform Infrared Radiation (FTIR) spectroscopy examination. In any case, their utilization for helpful reason remains a test in the field of nano and microencapsulation because of physical and concoction shakiness, proteolysis and short halflife. The examination of danger impacts of designed nanoparticles over biological community has as of late pulled in much consideration and it is frequently presumed that nanoparticles can apply cytotoxicity to creatures and plant frameworks. The boundless antibacterial, antiviral, and antifungal properties of silver nanoparticles (AgNPs) alongside their inherent reactant and optical marks make these the most prevalent and normally utilized designed nanoparticles as a part of biomedical applications, beautifying agents, attire, donning products, hardware, and of specific importance to this examination, water cleansing units, notwithstanding numerous other nano-customer items.

Selenium nanoparticles (SeNPs), which are seen as a novel Se compound, are pulling in growing thought of standard scientists on account of their extraordinary cell fortifications properties and low threat in examination with other Se-species, for instance, selenomethionine (SeMet). The advantage of MDT is the ability to direct the prescription bearing alluring particles to the tumor by the utilization of an external appealing field. Moreover, it gives the ability to keep up the particles at the looked for region, along these lines looking into concentrated on landing of the bound pharmaceutical. Starting late, there have been vital advances in the biomedical employments of nanotechnology. Sensing temperature, remotely and unequivocally, using an energetic and efficient procedure is separating to rising therapeutic and biomedical progressions. Therapeutic hyperthermia, driven either alluringly using nanosized alluring materials subjected to AC appealing fields or electromagnetically using metallic nanomaterials stimulated with appropriated light source or radiofrequency field is an imperative example of such demand.

Nanoparticles based medication conveyance methodology has tremendous clinical essentialness as showed by new nanoparticle based medication supports like pegylated liposomes of doxorubicin. Modified appropriation and slower discharge of this liposomal infusion brought about the range under bend (AUC) of doxorubicin hydrochloride liposome infusion ~2-3 times more than the AUC for comparative measurements of traditional doxorubicin hydrochloride. RNA, has as of late developed as an essential nanotechnology stage because of its unprecedented differences in structure and capacity. Little meddling RNA (siRNA), demonstrated huge potential in new sub-atomic ways to deal with down-manage particular quality expression in mammalian cells. Also nanoparticles can be misleadingly created (from designed procedures) that is particularly delivered from nanotechnologies at mechanical level to perform innovative points in different logical and modern fields. Hence the expression "nanotechnologies" alludes to the advancement and creation of materials and frameworks in the request of nanometers.

Nanoparticles are strong colloidal conveyance frameworks equipped for discharging ideal measures of medication, while evading untimely discharge. Additionally, because of their little size, they find themselves able to be retained through the oral mucosa to reach systemic dissemination. The likelihood of utilizing biocompatible and biodegradable polymers is another point of preference, since the vehicle itself is then uprooted actually without advancing poisonous quality. Bread cook's yeast liquor dehydrogenase (ADH) and formate dehydrogenase (FDH) from *Candida boidinii* were immobilized on alumina nanoparticles and connected to catalyze the coupled responses for generation of n-propanol. Cofactor recovery inside of the response cycle was accomplished as a consequence of impact between protein stacked particles and free cofactor.

Nanoparticles discharged from items and applications can get specifically or in a roundabout way to the dirt. Direct soil defilement happens from intentionally applying items like biocides, manure, compost, and nanoparticles for remediation, and items which sully soil accidentally like rubbed material, some covering materials, polluted soils, and water for watering system. Item fixings coming to soils by implication then again are discharged to other ecological compartments e.g. air, water, or groundwater. Accordingly nanoparticles get traded between the natural compartments. Nanoparticles go to the dirt and abandon it through different procedures. Out of data on nanoparticles applications found in web and writing studies, an outline of nanoparticles fluxes to and from soil could be drawn. Included are just fluxes inside of the framework limit.

#### **II D Present Situation of Nanoparticle Research in Bangladesh:**

Along with other countries, Bangladesh is also getting better into researching nanoparticles. There are several works conducted by Bangladeshi researchers. One of them will be discussed here.

Microemulsions as Nanoreactors for Preparation of Nanoparticles with Antibacterial Activity by Sakhawat Hossain, Ummul K Fatema, Md Yousuf A Mollah, M Muhibur Rahman, Md Abu Bin Hasan Susan: Nanoparticles of silver and copper have been synthesized by reduction of aqueous silver nitrate and copper chloride solutions with sodium borohydride in anionic water-in-oil (w/o) microemulsions, sodium dodecyl sulphate (SDS)/1-pentanol/cyclohexane/water. Scanning electron microscopic (SEM) images, energy dispersive spectra (EDX) and UVspectra have been used to characterize the resultant nanoparticles. The average size of the nanoparticles has been found to be influenced by the water to surfactant molar ratio ( $W_o$ ) in the microemulsions. Smaller particles are obtained at low  $W_o$ , while higher  $W_o$  yields larger particles. The antibiotic sensitivity of silver and copper nanoparticles against *Escherichia coli* (*E. coli*) was tested by zone inhibition method using nanoparticles in ethanol suspension. Both silver and copper nanoparticles showed the potential for use as antibacterial agents against *E. coli* with sensitivity as good as conventional antibiotics. Silver nanoparticles show higher antibacterial activity against *E. coli*, compared to copper nanoparticles. As the amount of the nanoparticles in the suspension decreases, antibacterial activity decreases; however the concentration dependence on antibacterial activity has been less pronounced.

### **II E. Present Situation of Nanoparticle Research in India:**

India is one the leading countries who is getting better very fast into researching nanoparticles. There are several companies producing nanoparticles. Many of them will be discussed here.

#### **Adnano Technologies:**

Adnano Technologies is a supplier of various forms of graphene and multiwalled carbon nanotubes. They also provide analytical services like FESEM, TEM, AFM, FTIR, XRD, XPS, Contact Angle, BET, Zeta sizer and Master sizer.

#### **Auto Fibre Craft:**

AFC Powders is a company involved in manufacturing specialized nanomaterials. Currently it is manufacturing Nano-size Silver Powder for use in electronic applications for e.g. making conductive inks and pastes, RFID. This product is RoHS compliant.

#### **AVANSA Technology & Services:**

The company specializes in analytical characterization, consultancy, and synthesis of nanomaterials serving to nanotechnology-based industries, universities and institutes. They also manufacture carbon nanotubes, graphene, and various nanoparticles.

#### **Bottom Up Technology Corporation:**

The company manufactures graphene and carbon nanotubes

#### **Egoma Technologies:**

The company specializes in producing customizable solutions to Ball Mill requirements and nanopowders. They also provide consultancy in material related industrial and research R&D related problems.

Kerala Minerals & Metals (KMML): The company manufactures various grades of titanium dioxide nanoparticles.

#### **Nanomics Technologies:**

The company manufactures a wide range of nanomaterials such as carbon nanotubes, graphene, nanoalloys, nanowires, and nanoparticle powders and suspensions.

#### **Nano Research Elements:**

A provider of nanomaterials.

#### **Nanoshel:**

Nanoshel makes more than 50 types of nanomaterials, among which the main products are nanotubes, SWCNT's, MWCNT's, nanoparticles.

#### **Nanospan:**

The company is active in in manufacture, supply and application of graphene related materials. They offer a range of graphene types, functionalized graphene, graphene intermediates, carbon nanotubes and nanomaterials. They provide analytical testing & engineering services for emerging nanotechnology-based products in the areas of energy storage, electronics, polymer/resin/lubricants, electronic inks and 3D printing. They also provide

nanomaterial characterization & testing services like HR-TEM, FESEM, FTIR, XRD, BET, Raman Spectroscopy, AFM.

#### **NanoXpert Technologies:**

KCIL-NanoXpert Technologies is an intrapreneurial arm of KCIL (Kairav Chemofarbe Industries Ltd) India for high-tech nanoparticle business, it has a technological collaboration with National Chemical Laboratories, Pune, India, under the prestigious Prime Minister's Fellowship Program. NanoXpert's products have been developed by experts in the field with individual experience of over a decade.

#### **Neo-Ecosystems:**

The company is specialized on researching and production of metal nanopowders.

**Platonic Nanotech:** The company uses its proprietary bottom-up process for the production of high quality graphene. Quantum Corporation: Quantum Corporation (QCorp) is the parent company of group of companies, head quartered in Bangalore, India. QCorp was established in 2007 with a vision to create world class Nanomaterials and Nanocomposites with strong Intellectual Property that are changing the properties of products across the globe. QCorp has developed high quality Smart Polymers, Nanomaterials and Nanocomposites as core materials for manufacturers in Telecommunications, Electronics, Drug Delivery, Conductive films, Lighting and Energy industries - without the need to change their existing processes.

#### **Reinste Nano Ventures:**

A manufacturer of nanomaterials. Sisco Research Laboratories (SRL): The company is a manufacturer and supplier of about 3500 Laboratory Chemical and Allied Products. They specialize in Molecular Biology Reagents, Biochemicals, Enzymes, Nanopowders and Carbon Nanotubes, Organic & Inorganic Intermediates, High Purity Solvents, Culture Media & BioLit™ DNA & Protein Tools for PCR and regular Molecular Biology. Smart Nanoz: The company manufactures nanoparticles.

#### **Ultrananotech:**

Manufactures nanoparticles and graphene. United Nanotech Innovations: A manufacturer of graphenes and nanocomposites.

### **II F. RePresent Situation of Nanoparticle Research in Japan:**

Along with other countries, Japan is also getting better into researching nanoparticles. There are several works conducted by Japanese researchers. One of them will be discussed here.

Nanoparticles Effectively Target Rapamycin Delivery to Sites of Experimental Aortic Aneurysm in Rats by Takuro Shirasu, Hiroyuki Koyama, Yutaka Miura, Katsuyuki Hoshina, Kazunori Kataoka, Toshiaki Watanabe: Several drugs targeting the pathogenesis of aortic aneurysm have shown efficacy in model systems but not in clinical trials, potentially owing to the lack of targeted drug delivery. Here, we designed a novel drug delivery system using nanoparticles to target the disrupted aortic aneurysm micro-structure. We generated poly(ethylene glycol)-shelled nanoparticles incorporating rapamycin that exhibited uniform diameter and long-term stability. When injected intravenously into a rat model in which abdominal aortic aneurysm (AAA) had been induced by infusing elastase, labeled rapamycin nanoparticles specifically accumulated in the AAA. Microscopic analysis revealed that rapamycin nanoparticles were mainly distributed in the media and adventitia where the wall structures were damaged. Co-localization of rapamycin nanoparticles with macrophages was also noted. Rapamycin nanoparticles injected during the process of AAA formation evinced significant suppression of AAA formation and mural inflammation at 7 days after elastase infusion, as compared with rapamycin treatment alone. Correspondingly, the activities of matrix metalloproteinases and the expression of inflammatory cytokines were significantly suppressed by rapamycin nanoparticle treatment. Our findings suggest that the nanoparticle-based delivery system achieves specific delivery of rapamycin to the rat AAA and might contribute to establishing a drug therapy approach targeting aortic aneurysm.

### **II G. Present Situation of Nanoparticle Research in USA:**

USA leads the research in nanoparticles. They have the latest technologies to produce and conduct experiments on nanoparticles. Some of those aspects are discussed here. Zeta Potential for Metal Oxide Nanoparticles, A Predictive Model Developed by a NanoQuantitative Structure–Property Relationship Approach by Rasulev, Alicja Mikolajczyk, Agnieszka Gajewicz, Bakhtiyor Rasulev, Nicole Schaeublin, Elisabeth Maurer-Gardner, Saber Hussain, Jerzy Leszczynski and Tomasz Puzyn: According to Rasulev, physico–chemical characterization of nanoparticles in the context of their transport and fate in the environment is an important challenge for risk assessment of nanomaterials. One of the main characteristics that defines the behavior of nanoparticles in solution is zeta potential. "In this paper, we have demonstrated the relationship between zeta potential and a

series of intrinsic physico–chemical features of 15 metal oxide nanoparticles revealed by computational study,” Rasulev said. “It was shown that zeta potential depends on spherical size of nanomaterial and electron orbital energy.” Silver nanoparticles' synthesis, properties, toxicology, applications and perspectives by Quang Huy Tran, Van Quy Nguyen and Anh-Tuan Le: In recent years the outbreak of re-emerging and emerging infectious diseases has been a significant burden on global economies and public health. The growth of population and urbanization along with poor water supply and environmental hygiene are the main reasons for the increase in outbreak of infectious pathogens. Transmission of infectious pathogens to the community has caused outbreaks of diseases such as influenza (A/H5N1), diarrhea (Escherichia coli), cholera (Vibrio cholera), etc throughout the world. The comprehensive treatments of environments containing infectious pathogens using advanced disinfectant nanomaterials have been proposed for prevention of the outbreaks. Among these nanomaterials, silver nanoparticles (Ag-NPs) with unique properties of high antimicrobial activity have attracted much interest from scientists and technologists to develop nanosilverbased disinfectant products. This article aims to review the synthesis routes and antimicrobial effects of Ag-NPs against various pathogens including bacteria, fungi and virus. Toxicology considerations of Ag-NPs to humans and ecology are discussed in detail. Some current applications of Ag-NPs in water-, air- and surface- disinfection are described. Finally, future prospects of Ag-NPs for treatment and prevention of currently emerging infections are discussed.

### III. Conclusion

Nanoparticles and Nanotechnology hold the future of technology. Though they have some health and safety issues, still it is quite reasonable to conduct further research into this matter to eliminate every negative or controversial issue

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