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Fabrication of Nano Material: A Review

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Abstract—*Nanoparticle, Nanomaterial and Nanotechnologies attract the incredible attention in researches and researchers. There are many scopes of research in the field of Physics, Chemistry, Material Science and Engineer of Mechanical and Electrical are also involved in this research. Nanoparticles are also used in medical field. It has done tremendous work in this field (medical). It has a capability of drug delivery in term of high stability, high specificity, high drugs carrying capacity, ability for controlled release of drug delivery [14].*

Nanoparticles are also used in various branches of industry production like solar and oxide fuel batteries for energy storage, for wide incorporation in diverse materials of everyday use such as cosmetics or clothes, optical devices, catalytic, bactericidal, and electronic, sensor technology, biological labeling and treatment of some cancers [10]. It has the unique property of antibacterial activity, high resistance to oxidation and high thermal conductivity. In this review paper, studies were carried out about the fabrication of nanoparticle, categorization, types, application of metallic nanoparticles and application of nanoparticle in medical field.

Keywords*: Nanoparticles, Nanotechnology, Preparation, Application.*

1. INTRODUCTION

Nanotechnology is a branch of science in which study about the nanoparticles and nanomaterial are being carried out, that means nanotechnology deals with the tiny or small size technology which cannot be seen with naked eyes. It is the manipulation of matter at a tiny scale. Atoms and molecules work differently and provide a variety of amazing uses at this size. In general, the size of a nanoparticle spans the range between 1 and 100 nm. Metallic nanoparticles have different physical and chemical properties of bulk metals like lower melting points, higher specific surface areas, specific optical properties, mechanical strengths, and specific magnetizations, properties that might prove attractive in various industrial applications.

These societies named as International Organization for Standardization (ISO), American Society of Testing and Materials (ASTM), National Institute of Occupational Safety and Health (NIOSH), Scientific Committee on Consumer Products (SCCP), British Standards Institution (BSI), and Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA).

Nanotechnology represents the design, production and application of materials at atomic, molecular and macromolecular scales, in order to produce new nano sized materials [6].

Table 1.1: Summarizes the definition of nanoparticles and nanomaterial by various organizations [11].

Organizations	Nanoparticles	Nanomaterial
ISO	A particle spanning 1–100 nm (diameter)	-
ASMT	An ultrafine particle whose length in 2 or 3 places is 1–100 nm	-
NIOSH	A particle with diameter between 1 and 100 nm, or a fiber spanning the range 1–100 nm.	-
SCCP	At least one side is in the nanoscale range	Material for which at least one side or internal structure is in the Nanoscale
BSI	All the fields or diameters are in the nanoscale range.	Material for which at least one side or internal structure is in the Nanoscale
BAuA	All the fields or diameters are in the nanoscale range.	Material consisting of a nanostructure or a nanosubstance

2. CATEGORIZATION OF NANOTECHNOLOGY

There are various approaches for categorization of nanomaterial. Nanoparticles are classified based on dimensions **[**5**].**

1. One dimension Nanoparticles

2. Two dimension Nanoparticles

3. Three dimension Nanoparticles

2.1 ONE DIMENSION NANOPARTICLES

One dimension Nanoparticles are thin film which are used for decades in electronics, chemistry and engineering. The size of a thin film is about to 1-100 nm and it is used as a monolayer in the field of solar or catalysis. It is used in different technology and its applications are storage systems, chemical and biological sensors, fiber-optic systems, magneto-optic and optical device.

2.2 TWO DIMENSION NANOPARTICLES

The examples of two dimension nanoparticles are “Carbon nanotube”.

CARBON NANOTUBES:-

Its structure seems to be a hexagonal network of carbon atoms, the diameter of the carbon nanotubes is about to 1nm and the length of the carbon nanotube is about to 100nm.

CNTs are generally two types:-

(1) Single Walled Carbon Nanotubes
(2) Multi Walled Carbon Nanotubes

They have amazing physical, mechanical and electrical properties which make them unique materials [6]. Nanotubes have both properties of metallic and semi -conductor property. The current density of nanotubes is very high, it’s reach one billion amperes per square meter, which make it semiconductor. They are chemically stable. The mechanical strength of carbon nanotubes is very high; their strength is sixty times greater than steel. They also have a great molecular absorption capacity.

2.3. THREE DIMENSION NANOPARTICLES:

The examples of three dimension nanoparticles are:-

FULLERENES (CARBON 60):-

A fullerene is a molecule of carbon in the form of a hollow sphere, ellipsoid, tube, and many other shapes. It seems to look like a hollow soccer ball. Fullerenes are unique physical qualities. Fullerenes bear high pressure and again a regain their original shape when the pressures are released. It has a property of superconductors. They have amazing electrical property and it is also used in electronic field for data storage, production of solar cells. Fullerenes have been extensively used for several biomedical applications including the design of high-performance MRI contrast agents, X-Ray imaging contrast agents, photodynamic therapy and drug and gene delivery.

3. PREPARATION OF NANOPARTICLES:

There are various method of preparation of nanoparticles.

1. Laser Deposition System
2. Chemical process

3.1. LASER DEPOSITION SYSTEM

Laser deposition was the first technique used to synthesize nanocrystalline metals and alloys. In laser deposition system pulse laser are used. So this process is also called Pulse Laser deposition System. The Metallic or inorganic material is vaporized using thermal evaporation sources such as a Joule heated refractory crucibles, electron beam evaporation devices, in an atmosphere of 1-50 m bar. A laser is used as external energy source results in an extremely clean process without filament. Thus deposition can occur in both inert and reactive gases. The use of carousel, housing a number of target materials, enables multilayer films to be deposited without the need to break vacuum when changing between materials.

3.1.2 PROCESS OF LASER DEPOSITION SYSTEM

In this process, the laser beam in form of pulse and energy level 700mJ, Pre-deposition vacuum of 5.0 X 10-6 Torr, Target-to-Substrate of 5- 8 cm and Pulse Repetition Rate 10 Hz. The laser beam falls on the target through a laser transmission window and the target is held by carrousel which is made of the same material of target because if laser beam misses from the target and sticks on carrousel it can be evaporated and there is no effect on evaporated material (till the vaporization continue for the same material). Evaporation is to be done from W, Ta or Mo. This process is done in a vacuum chamber. After vaporization the vaporized particles are stored and scratched when they become condense. This is the way nanoparticles formed by laser deposition system.

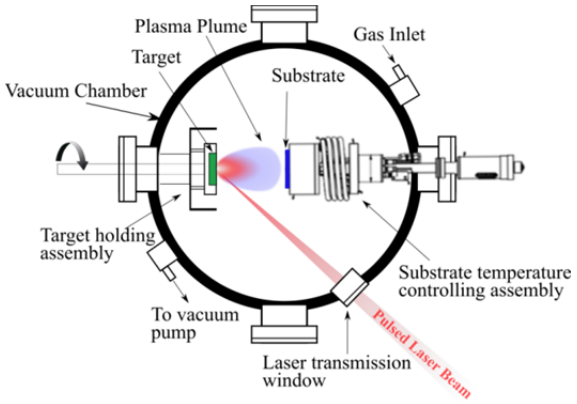

Fig. 3.1: Laser Deposition system [19]

3.2. CHEMICAL DEPOSITION

Chemical vapor deposition and Chemical Vapor Condensation are known process in which a solid is deposited on a heated surface through a chemical reaction from the vapor or gas phase. This is the most widely used in chemical synthesis technique consists essentially of growing nanoparticles. Activation energy is required to proceed by the chemical vapor deposition, this energy can be provided by several methods like thermal reaction (temperature is about 1173K)

[8]. This process is often used in the semiconductor industry to produce the thin films.

In typical CVD, the wafer (thin slices of semiconductor material used in the fabrication of integrated circuit) is exposed to one or more volatile (the tendency of a substance to vaporized) precursors, which react and decompose (breakdown is the separation of chemical compounds into elements or simple compound) on the substrate surface to produce the desired deposit. Frequently, volatile by-products are also produced, which are removed by gas flow through the reaction chamber.

4. TYPES OF NANOPARTICLES

There are various types of nanoparticle:

1. Silver
2. Gold
3. Alloy
4. Magnetic

4.1 SILVER: Silver nanoparticles have verified to most effective because of its good antimicrobial efficacy against bacteria and virus [5-9]. They are certainly the most widely used nano materials among all, thereby being used as antimicrobial agents, in textile industries, for water treatment, sunscreen lotions etc. [10-14].

4.2 GOLD: Gold nanoparticles (AuNPs) are used in immunochemical studies for identification of protein interactions. They are used as lab tracers in DNA fingerprinting to detect presence of DNA in a sample. Gold nano rods are being used to detect cancer stem cells, beneficial for cancer diagnosis and for identification of different classes of bacteria [1-2].

4.3 ALLOY: Alloy nanoparticles show structural properties that are different from their bulk samples [3]. Since Ag has the highest electrical conductivity among metal fillers and, unlike many other metals, their oxides have relatively better conductivity [7], Ag flakes are most widely used.

4.4 MAGNETIC: Magnetic nanoparticles like Fe3O4 (magnetite) and Fe2O3 (magnetite) are known to be biocompatible. They have been actively investigated for targeted cancer treatment (magnetic hyperthermia), stem cell sorting and manipulation, guided drug delivery, gene therapy, DNA analysis, and magnetic resonance imaging (MRI) [4].

5. APPLICATIONS OF NANOPARTICLES

5.1 APPLICATIONS OF METALLIC NANOPARTICLES

The various characteristics of different nanoparticles:

5.1.1 OPTICAL FUNCTION: The surface absorption plasma on of Au and Ag can express various colors by changing the size of the particle, the form or shape of the particle, and the rate of condensation. Nanoparticles smaller than the wavelength of light can be used to make high penetration conductivity materials (there is little absorption, dispersion, and reflection).

5.1.2 CATALYST FUNCTION: Reaction efficiencies can be improved since the specific surface area of such nanoparticles is large compared with existing particles; to the extent that the surface terrace is regular at the atomic level, a hyperactive catalyst with high selectivity can be made: for example, Au nanoparticles.

5.1.3 THERMAL FUNCTION: When the particle diameter is small (less than 10 nm), the melting point is also lower than a bulk metal. Electronic wiring can be made with nanoparticles that have a low boiling point, for example, a polymer.

5.1.4 ELECTRICAL FUNCTION: Since superconductivity transition temperature rises, so that particle diameter is small (less than 1 nm), it can be used to make high temperature super conductivity material.

5.1.5 MECHANICAL FUNCTION: Since the mechanical characteristics improve, mechanical strength can be sharply raised by mixing the nanoparticles with metals or ceramics.

5.1.6 MAGNETIC FUNCTION: The attractive force of a magnetic metal increases on reduction of the particle diameter, such that soft-magnetic materials can be made in the form of an alloy of nanoparticles. Moreover, a permanent magnet can be made.

5.2 APPLICATIONS OF NANOPARTICLES IN MEDICAL FIELD:

There are a various applications of nanoparticles in a medical field.

5.2.1 DRUGS DELIVERY SYSTEM: Nanoparticles have a tremendous drug delivery system. They can be able to control and release the drugs to damage tissue.

5.2.2 TREATMENT OF DAMAGE TISSUE: The nanoparticles help to treat those tissues who damage from the fatal disease. It is able to treat and taking out the damage tissue, which harmful for body.

5.2.3 NANODIAGNOSTIC: Nano diagnostic is a device which is used for disease identification at the cellular and the molecular level.

6. RESULT

The process of Pulsed Laser Deposition (PLD) is very user friendly for preparation of nanomaterial compare to other method. Pulsed Laser Deposition (PLD) Systems typically uses a focused pulsed Excimer or Nd: YAG laser to vaporize a small section of a solid target material in a vacuum chamber in order to produce a thin film. The Pulsed Laser Deposition

(PLD) process enables the deposition of many complex materials over a wide range of background gas compositions and pressures. Furthermore, other types of lasers including ps and fs lasers (picoseconds and femtosecond laser) can be utilized, and alternative techniques such as Matrix Assisted Pulsed Laser Evaporation (MAPLE) and Resonant IR Pulsed Laser Evaporation systems are available with appropriate lasers.

7. CONCLUSION

Nanoparticles make a revolution in various field's of technology, i.e., medical field, weapon field, computer and its appliance field, mechanical, electrical, chemical industry, energy production industry and so on industry. It is a tendency to increase the mechanical, chemical and electrical property. Therefore, it can be highly demanded, but the production of nanoparticles is costly, the equipments are operated by highly skilled person and the maintenance cost of equipments is high.

There are many future scopes in field of biotechnology, biomedical, genetics engineering, neuroscience, petroleum engineering, mechatronics and so on field.

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