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INTERNATIONAL JOURNAL OF ADVANCED PRODUCTION AND INDUSTRIAL ENGINEERING

IJAPIE-2018-07-329, Vol 3 (3), 68-71

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Emergence of Nano Particles and its Impact in Engineering Applications: A Review

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Abstract : The ever increasing demand of more reliable products, extremely fine quality of texture, surface finish, appealing appearance and more closer tolerance limits have improved the working standards with measuring scales from inches to millimetres, millimetres to micro level, micro level to nano level. Nano particles of size 1- 100 X10^{-9} m. By using nano particles , the gap between between molecules get filled with uniform pattern of bonding. Presently, in every field nano technology is used for example fabrication and testing of semi conductors, metal, metal oxides, composite materials, machining processes, medical applications, bio mechanics, bio technology, space technology, submarines etc. Nano particles play important role in improving the characteristics with properties in material fabrication and manufacturing processes with the aim of progressive , constant improvement from better to the best.

Keywords: Nano technology, nano particles, nano size, fabrication, properties, applications.

1. INTRODUCTION

The word Nano derives from Greek word 'Nanos' which means dwarf i.e. extremely small. It is a measure of about one in billionth. At such a small size the ratio of surface area to the volume in the lattice structure becomes large which greatly change the mechanical, thermal, physical properties of the material. For example, gold particles in normal particle size appear golden yellow colour but when change to nanoparticle size of 25nm reflect red color. These particles are also known as ultrafine particles by ancestors. [11]

Historical background:
Ultrafine particles have been used in medicines and craft work since ancient times. Evidences have been found out that Gold nanoparticles were used as drug by Chinese during 2500 BC. Swarna Bhasma and Makardhwaja as Red colloidal gold of size 25nm have been in use dates back 1st millennium BC in India in Medicines of Ayurvedic. During 4th century AD during Roman period vessels have been found which use Nano particles of Gold-Silver alloy for its decoration as 'Lycurgus cup' sample placed at British Museum, London. [12]
In 16th Century ultrafine particles of gold were used in drinks. In 1852, Michael Faraday described methods for synthesis of stable aqueous dispersions and optical properties of gold nano particles. Richard P.Feynman (1918-1988) in 1959 delivered a lecture at California Institute of Technology during annual meeting of American Physical Society. He is also known as Father of the field of nano particle research, with the development of technique like atomic force Microscopy, scanning Tunneling Electron Microscopy, Dynamic Light scattering have enabled us in the study and manipulation of materials at nanoscales. Researches from every field are showing attention and interest in nano particles from every field of science like engineering, medical and medicines. [13]

2. VARIETIES OF NANO PARTICLES

2.1 Inorganic nano particles:
The physical property of inorganic nano particle play an important role in modern material science and bio related applications. Including size dependent optical, magnetic, electronic and catalytic properties. Nano particles of iron oxides, gold silver silica, quantum dots etc. are useful in bio related applications.[11]

2.2 Polymeric nano particles:
Polymers are used in various applications of engineering and medical sciences 10-100 nm is the range of polymeric nano particles. It largely depends on the type of monomers which are going to join and form the polymer.[11]

2.3 Solid lipid nanoparticles:
Since 1990's for controlling drug delivery solid lipid nanoparticles have been used. There are certain alternate carrier systems to emulsing, lipsomes, and polymeric nano particles as a colloidal carrier system.[11]

2.4 Lipsomes:
Lipsomes as nanoparticular have one or more phorpholipid bilayes which are sphere – shaped vescilas. They are useful

in the field of reagen cosmetic industries, pharma ceutical industries, food and forming industries use liposomes.[11]

2.5 Nano crystal:

It consists of material which is having at least one dimension small than 100 nanometers comprising of atoms in a single or poly-crystalline arrangement. Nano crystals are aggregate of around hundreds or thousands of molecules coombining to from a crystalline structure.[11]

3. SYNTHESIZE OF NANO PARTICLES

The synthesize of nano particle is broadly classified in two type of approach.

1. Top down approach.
2. Bottom up approach.

In the top down approach the bulk material is converted into very fine size particles called Nano Narticles.

In bottom up approach the atom is processed to nuclei and finally to Nano Particles.

Sumit Chaudhary and R C Singh make nano particles of ZnO which are the unique material that exhibits multiple properties semiconducting, piezoelectric, pyroelectric high photostability, biocompatibility and biodegradability etc. At higher temperature the nature of the ZnO particles is endothermic and the loss weight upto 10%. ZnO nanoparticles can readily prepared at room temperature from zinc nitrate hexahydrate and cyclohexylamine either in aqueous or ethanolic medium. The size of ZnO Nanoparticles depends on temperature and base concentration. As the temperature increases the size of ZnO Nanoparticles goes on increasing. ZnO nanoparticles can be synthesized from zinc chloride using sodium hydroxide as the precipitant. ZnO nanoparticles/nanorods can be synthesized by reaction of zinc metal with alcohol as the C-O bond of alcohols is readily cleaved by Zn metal. The ethylenediamine can be used as the director and the shape controlling agent.[1,3].Sumit Chaudhary and R C Singh make Gold nano particles 20 ml of very dilute (0.001 M) solution of HAuCl4 (pale yellow colour, Sigma Aldrich) was taken in a beaker. Then 180 ml of distilled water at room temperature was added into the same beaker in order to decrease the molarity to 0.00001 M.Then beaker was put onto a heating plate and heated to 355 K. At around 359 K 2ml of Sodium Citrate solution was added into the beaker. The color of the solution changes from light purple to dark purple and the light red at last the solution became Ruby Red this change in color of the solution is due the scattering of light through the solution as the particle size decreases to Nanoscale the solution turns deep Ruby Red in color[2]. Nishant Mohan and R C Singh presented a review on the tribological properties of lubricating oil. The coefficient of friction and become less and wear rate decrease with the use of nanoparticles[4, 10]

3.1 Methods of synthesize of Nano-particles

1. Sol-gel technique : In this process particles from an integrated network which produce a compound pre involved in chemical reaction. It is mainly used in the fabrication of metal oxides. The procuror sol deposited on the substrate from a film which for the synthesized for powder making as Nano Particles.[11]
2. Sovlo thermal synthesis: Polar solvents are used at different conditions of temperature above boiling points and in condition of under pressure at versatile low temperature.[11]
3. Chemical reducing : Sodium borhydride, hydrazine hydrate and sodium citrate are some of commonly used reducing agents in which ionic salts get involved in reduction process by an appropriate medium in the presence of surfactant.[12]
4. Laser ablation: Highly focused beam of laser is used for removing material from a solid surface. The absorption of laser energy evaporates the material and deposited material for the processed for Nano particles.[12]
5. Intert gas condensation: In this process, an ultra - high vacuum chamber is filled with argon or helium gas. The pressure is mainted around 100 Pascal. So, metals evaporate and condense in the form of small crystals accumulate on liquid nitrogen filled chamber[13]
6. Bio synthesis of nanoporticles : It involve preparation of botanical extracts, bio reduction depend on reaction mixture and incubation time.[13]

4. CHARACTERIZATION OF NANO PARTICLES

4.1 Uv - visible absorption spectroscopy:

Uv stands for ultra violet radiations in this process a light is passed through sample solution and amount of absorbed light is measured. The difference with the variation of wavelength absorbance is measured at each wavelength. The amount of absorbance is used for measuring the concentration of solution. It is based on Beer - Lamberts Law. According to which absorbance is proportional to the concentrations of the attenuating species as well as the thickness of material sample.[13]

4.2 X- Ray diffraction (XRD) analysis:

X- rays are used for determination of crystallographic structure and morphology it gives information about translational symmetry size, shape of unit cell from peak positions and electron density inside the unit cell.[13]

4.3 Fourier Transform Infrared spectroscopy(FTIR):

This technique measures the relationship between infrared intensity vs wavelength of light. This is used to determine the nature of associated features of biological extracts with Nano Particles.[14]

4.4 Transmission electron microscopy (TEM):

In this technique a beam of electrons is transmitted through an ultra thin specimen. The image is formed through interaction of electrons transmitted over the specimen when image is magnified and focused out an imaging device. It forms a major analysis in scientific fields in both physical and biological sciences. It has application in cancer research, virology, material science, pollution, nanotechnology and semiconductor research.[13]

4.5 Scanning electron microscope (SEM):
The scanning electron microscope works on the principal of an optical microscope but it measures the electrons scattered from sample rather than photon. Therefore, electrons are accelerated by an electric potential having wavelength shorter than one photon. This results in high magnification power with 200,000 times other optical microscopic techniques.[13]

5. APPLICATION OF NANO PARTICLES

5.1 Applications of Nano Particles in drug delivery:
Nano particles are used in different types of drugs and medicines.They enhance the drug absorbity in body and reduce toxic effects.[11]

5.2 Application of Nano Particles in food technology:
Nano particles are used in manufacturing of nano materials which have been added during cultivation production processing of packaging. They enhance the productivity and provide longer life for the food item to be used without any side effects to human body[11].

5.3 Application of Nano Particles cancer treatment:
Nano Particles are used in cancer treatment and other bio medical uses. Nano Particles of gold Au, silver Ag and some magnetic oxides in particular $F_3\ O_4$ have been used and further research is going on in the treatment of cancer and other medical applications[12]

5.4 Machining processes comprise of mainly grinding, turning, milling and drilling:
In all these processes the aim is to reduce cutting forces, improve surface roughness and tool wear. Surface roughness plays an important role in engineering applications. A good surface finish is desired to improve the properties, fatigue strength, corrosion resistance and aesthetic appeal. Ranganath M S etal. conducted the analysis of influence of turning parameters such as speed, feed rate and depth of cut on surface roughness. The result of machining experiments were used to characterize main factors affecting surface roughness by DOE technique like Taguchi, Full Factorial, Response Surface Methodology , ANOVA etc.[5-7]. Ranganath M S etal. Performed experiments from conventional lathe machine to CNC Lathe Machine, workpiece material mild steel, Aluminium Alloy 6061 and cutting tool as HSS and carbide inserts with the change of tool geometry and analysis the co – related data with surface roughness in dry run with the selection of Optimum cutting parameters and surface roughness.[8-9]. Ranganath M S et al performed such operations for drilling blind holes and go through holes and selected for optimum cutting parameters. To lower down the heat generated in workpiece and cutting tool, cutting fluid plays an important role. Genarally, cutting fluid is mixed with water in the composition of 10% cutting fluid and 90% water. This emulsion has cooling properties but very less or no lubrication. Addition of nano particles increase cooling effect, lubricating effect with improve surface roughness reduce tool wear and cutting forces nano – SiO_2 in cutting fluid and nano TiO_2 as in water soluble or oil soluble reduce coefficient of friction and wear rate[15-17,23,39].

5.5 Nano Particles used in polymer composites enhance the tribological properties:
There is decrease of 27% and 47.7 % in the average friction coefficient and abrasion rate. Young Modulus increased by 190%[5]. Nanoparticles improve the wear loss volume of materials [6,7] Nano SiO_2 improve the thermal properties, mechanical performance and tribological properties[8-11]

6. CONCLUSION
In current study emergence of Nano Particles is explained from historical past. Applications of nano field are very wide which depend upon the historical past experience and enhanced by the new and innovative work of Researchers, Scientists, Engineers, Doctors and Research Scholors. The world of Nano Particles is very large and full of new challenges with great opportunities for developing new material and improving properties of the existing materials.

7. FUTURE SCOPE OF WORK
There is lot of scope for improving and inventing the change of behavior in thermal, mechanical, tribological, rhelogical with the use of Nano Particles. It has been found that an improvement of from 1% to 80% according to type of Nano particles, percentage of concentration in parent material or fluid. This field is full of new research work.

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