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Research Article

'A Review on Nanotechnology And Its Applications In The Field Of Pharmacy

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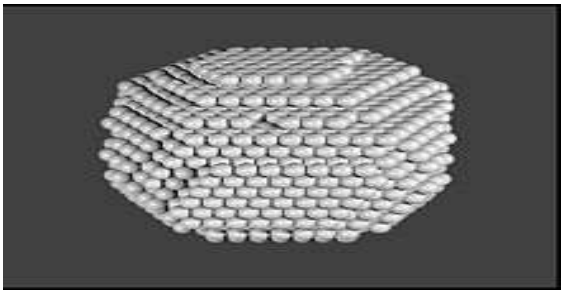
ARTICLEINFO **ABSTRACT**

Nano particles are novel formulation a number of pharmaceutical preparations were developed by using this technology. Nano particles are tiny materials having size ranges from 1 to 100 nm. They are classified into different classes., based on the shapes and properties. The various groups include fullerenes, metal nanoparticles, ceramic nanoparticles and polymeric nanopartcles. Nanoparticles posses unique physical and chemical properties due to their high surface area and nanoscale size.. The optical properties were dependent on the size, which imparts different colors due to absorption in the visible region. Their reactivity, toughness and other properties are also dependent on their unique size, shape and structure. Due to these characteristics, they are suitable candidates for various commercial and domestic applications, which include catalysis, imaging, medical applications, energy-based research, and environmental applications. The use of nanotechnology in human diseases introduced the term of 'nanomedicine' to describe such application.
KEYWORDS: Nanoparticles. Preparation methods, Classification, Evaluation test

INTRODUCTION

Nanotechnology, as defined by the United States (US) Nanotechnology Initiative, is 'the understanding and control of matter at dimensions of roughly 1–100 nanometers, where unique phenomena enable novel applications'. In the last decade, engineered nanoparticles have become an important class of new materials with several properties that make them very attractive for commercial development. In fact, they have been increasingly used for manufacturing diverse industrial items such as cosmetics or clothes and for infinite applications in electronics, aerospace and computer industry. In addition, as the need for the development of new medicines is pressing, and given the inherent nanoscale functions of the biological components of living cells, nanotechnology has been applied to diverse medical fields such as oncology and cardiovascular medicine. Indeed, nanotechnology is being used to refine discovery of biomarkers, molecular diagnostics, and drug discovery and drug delivery, which could be applicable to management of these patients. The National Institutes of Health (USA) reviewing the use of nanotechnology in human diseases introduced the term of 'nanomedicine' to describe such applications. To achieve these aims, nanotechnology strives to develop and combine new



materials by precisely engineering atoms and molecules to yield new molecular assemblies on the scale of individual cells, organelles or even smaller components, providing a *personalized medicine* (Jain, 2005a, 2005b). Personalized medicine is individualized or individual-based-therapy which allows the prescription of precise treatments best suited for a single patient (Jain, 2002).

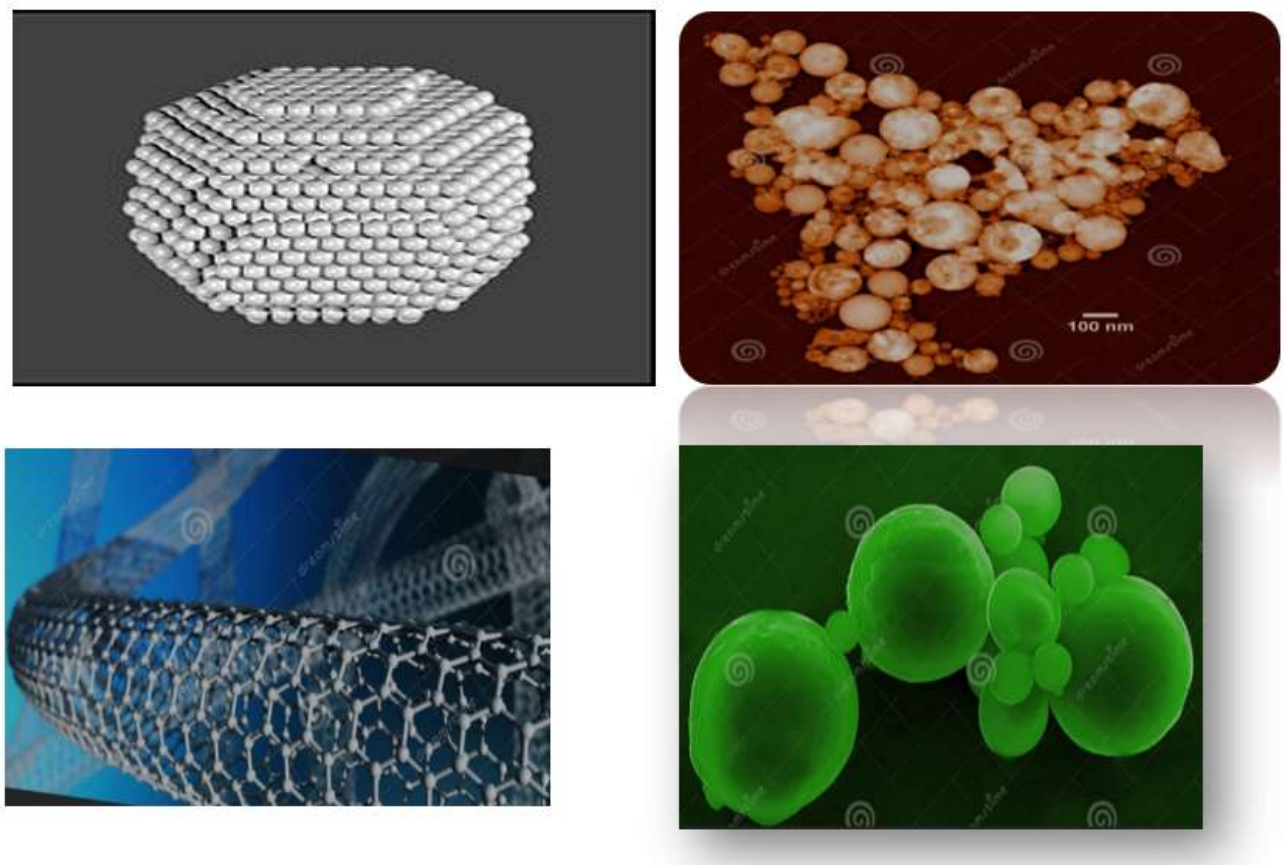
Nanoparticles are tiny materials (<1000 nm in size) that have specific physicochemical properties different to bulk materials of the same composition and such properties make them very attractive for commercial and medical development.

Nanoparticles or ultrafine particle is usually defined as a particle of matter that is between 1 and 100 nanometres (nm) in diameter.

The term is sometimes used for larger particles, up to 500 nm, or fibers and tubes that are less than 100 nm in only two directions at the lowest range, metal particles smaller than 1 nm are usually called atom clusters .

The study of nanoparticles is defined as Nanotechnology.Nanotechnology deals with the study and engineering of nanoparticles (NPs) or nanomaterials (NMs), which are materials with at least one dimension between 1 nm to 100 nm . Over the last decades, this discipline has grown and witnessed formidable developments due to the sustained growth and diversification of NP applications in various fields, such as agriculture, electronics, biomedicine, catalysis, and bioremediation, to name a few, enabled by their unique properties when compared to their bulk or molecular counterparts. The difference between bulk and NMs is related to the interaction and behaviour of surface atoms at the nanoscales that are less stable and, therefore, more reactive.

REFERENCE PICTURES OF NANOPARTICLES ARE AS FOLLOWS :



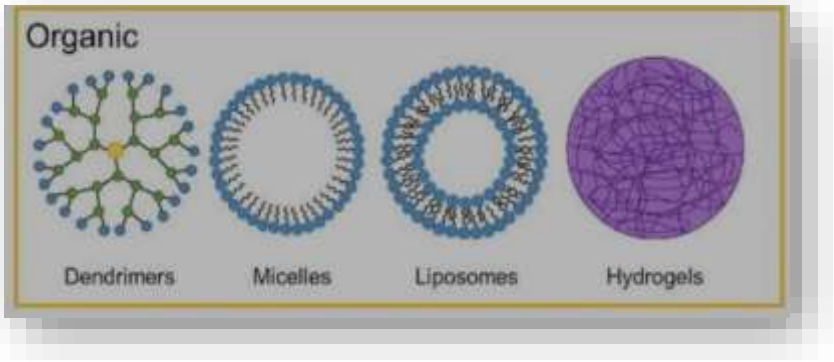
CLASSIFICATION OF NANOPARTICLES:

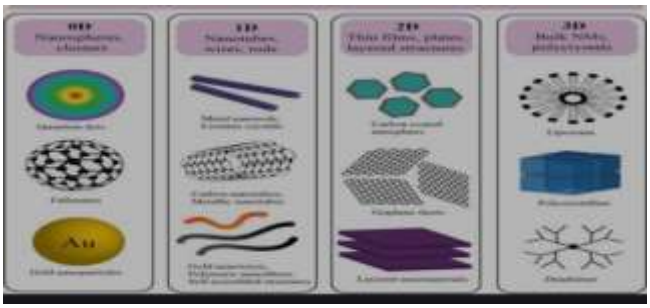
Based on nature of nanoparticles they are classified as :

- **Organic Nanoparticles :**

- These are small particles or ploymers made of aggregated molecules or polymers.these materials are of broad interst owing to ease of fabrication.

Ex:Dendrimers,liposomes,miscelles



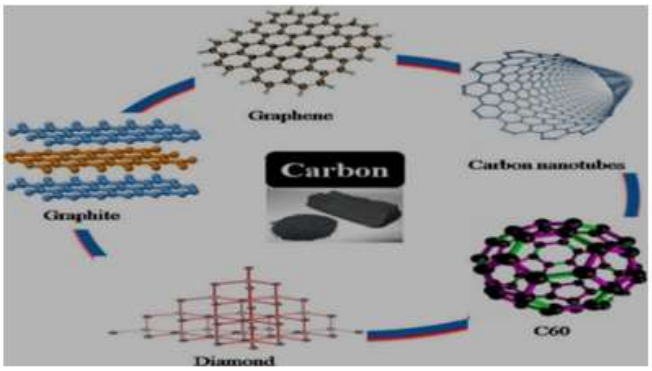


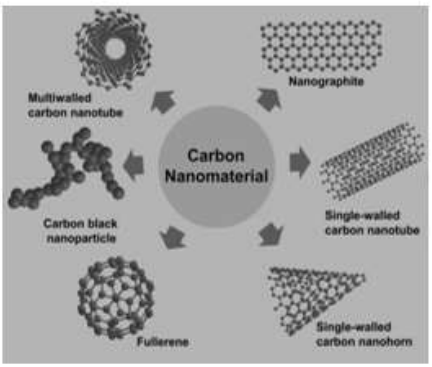
➢ **Inorganic nanoparticles:**

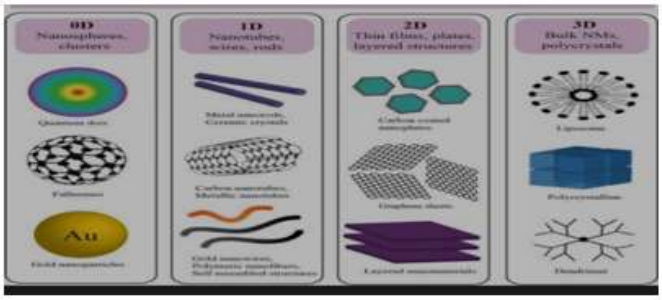
- These are extremely important in modern technologies.
- They can be easily and cheaply synthesized and mass produced.
- Ex:metal or non-metal elements like phosphate compounds ,hydroxide , silicate compounds etc.
- These applications include electronics ,photonics, chemical and physical biosensors etc.

Carbon – based nanoparticles:

- These are novel class of nano materials that are widely used in biomedical fields .
- The applications include the delivery of therapeutics , biomedical imaging ,cancer therapy and tissue engineering.
- Ex: graphene ,carbonnanotubes,carbon nanofibers.







Classification based on size of nanoparticles:

➢ **Zero dimensional nanoparticles**:

- Zero-dimensional nanostructures are the materials in which all the dimensions are within the nanoscale (no dimension is greater than 100 nm).
- Carbon-based nanomaterials are well explored in the area of nano-technology .
- Examples of carbon-based [0D] nanomaterials are fullerenes and carbon dots .

➢ **One dimensional nanoparticles**:

- One-dimensional (1D) nanomaterials have been widely used in the field of catalysis .
- Due to their unique linear morphology with large specific surface area, high electron-hole separation efficiency, strong light absorption capacity, plentiful exposed active sites, and so on.
- Ex: ceramic crystals,carbon nanotubes.

➢ **Two dimensional nanoparticles**:

- Two-dimensional nanomaterials such as metal nanosheets, graphene-based materials, transition metal oxides/dichalcogenides.
- They provide enhanced physical and chemical functionality owing to their ultrathin structures, high surface-to-volume ratios, and surface charges.
- Ex:carbon coated nanoplates,graphene sheets.

➢ **Three dimensional nanoparticles**:

- Three-dimensional nanomaterials (3D) are materials that are not confined to the nanoscale in any dimension.
- This class can contain bulk powders, dispersions of nanoparticles, bundles of nanowires, and nanotubes as well as multi-nanolayers.
- Ex:liposome , polycrystalline,dendrimer.

Preparation method of nanoparticles

1. **Dispersion of performed polymers**

➢ Solvent evaporation method.
➢ Salting out method.
➢ Spontaneous emulsification method
(or) solvent diffusion method.

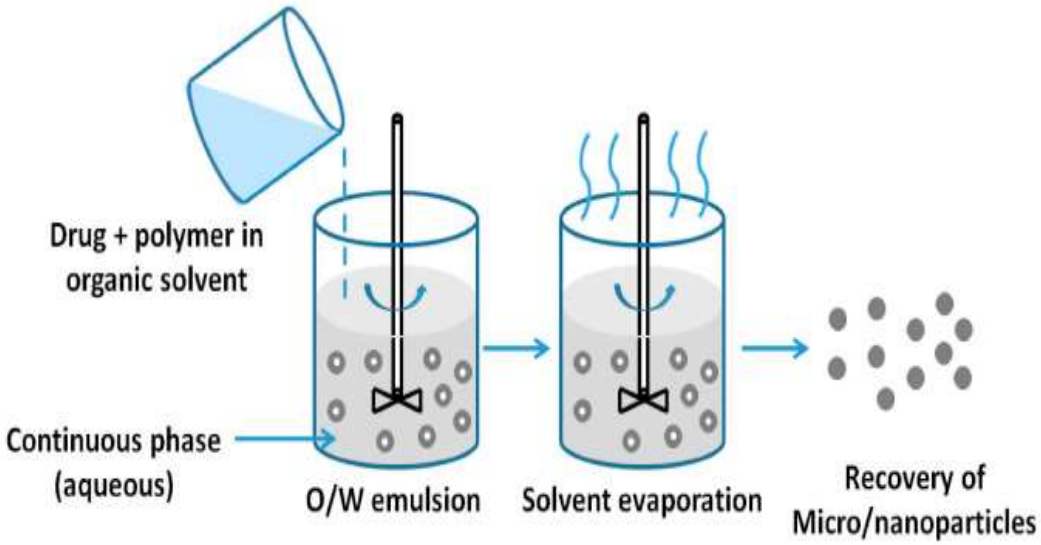
2. **Polymerization method**
3. **Coacervation (or) ionic gelatin meth**
4. **Supercritical fluid technology**

1.Dispersion of performed polymers:

Dispersion of performed polymers is a common technique used to prepare biodegradable nanoparticles by three methods such as,

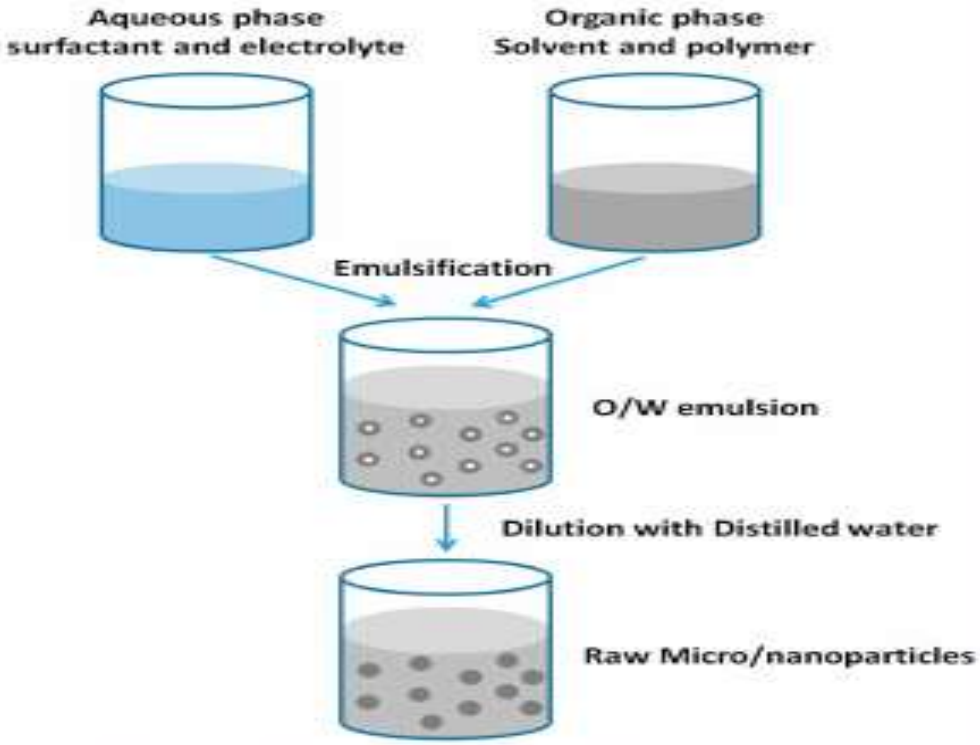
❖ **Solvent evaporation method:**

▪ In this method,the polymer is dissolved in an organic solvent such as dichloromethane, Chloroform,or ethylacetate.
▪ Which is also used as the solvent for dissolving the hydrophobic drug.
▪ The mixture of polymer and drug solution is then emulsified in an aqueous solution or emulsifying agent to form an oil in water(o/w)emulsion.
▪ After the formation of stable emulsion,the organic solvent is evaporated either by reducing by reducing the pressure or by continuous stirring.
▪ Particle size was found to be influenced by the type and concentrations of stabilizer, homogenizer speed and polymer concentrations.
▪ In order to produce small particle size, a high speed homogenization or ultrasonication may be employed.



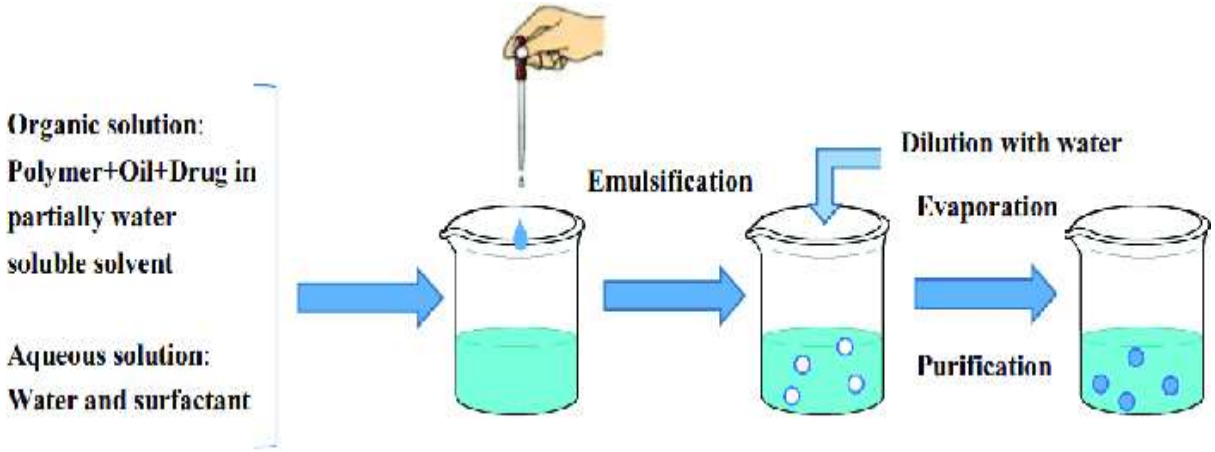
❖ Salting out method:

- it is one of the commonly used method for preparation of nanoparticles.
- This method involves the mixing of saturated aqueous solution of polyvinyl alcohol(PVA).
- And an acetone solution of the polymer under magnetic stirring resulting in the formation of o/w emulsion.
- The precipitation of the polymer occurs when sufficient amount of water is added to the external phase to allow complete diffusion of the acetone from internal phase into aqueous phase.



spontaneous emulsification (or) solvent diffusion method:

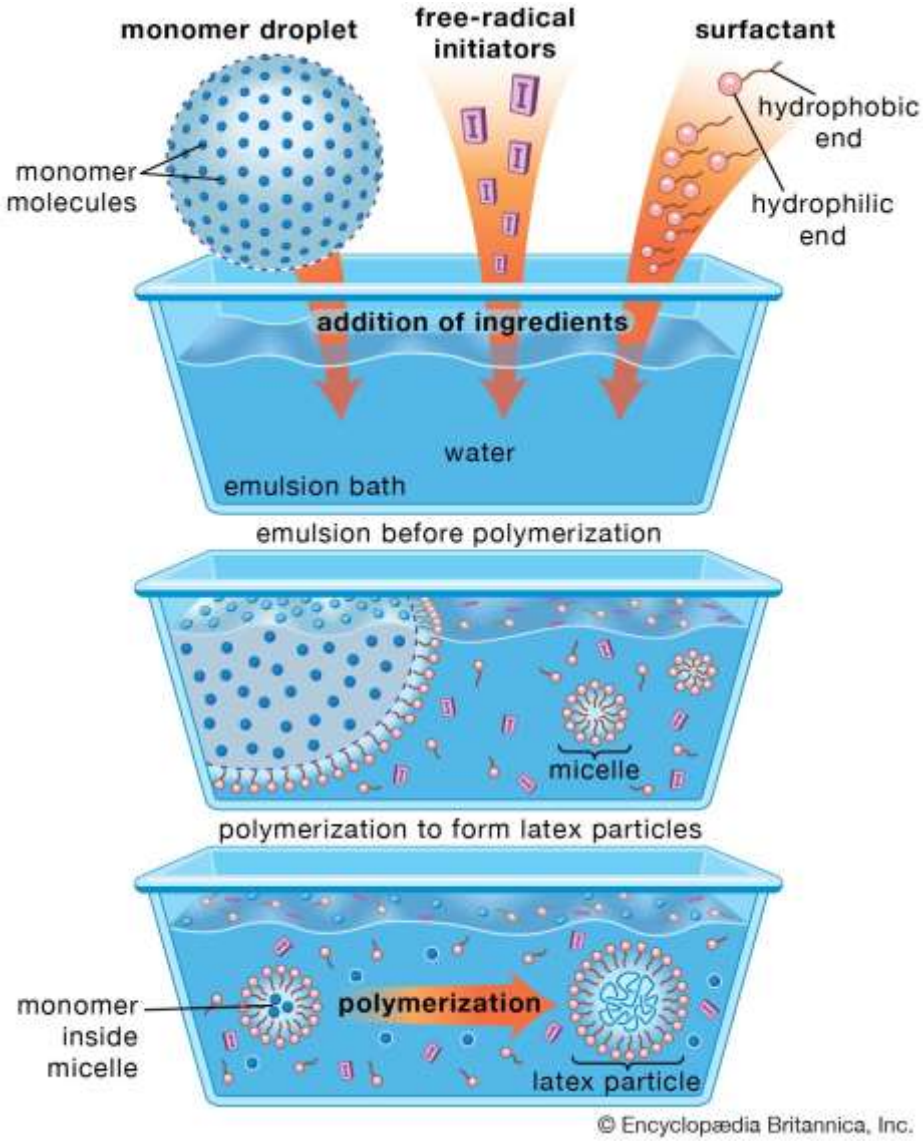
- This is a modified version of solvent evaporation.
- In this method,the water miscible solvent along with a small amount of the water immiscible organic solvent is used as an oil phase.
- Due to the spontaneous diffusion of solvents an interfacial turbulence is created between the two phases leading to the formation of small particles.
- As the concentration of water miscible solvent increases, a decrease in the size of particle can be achieved.
- Both solvent evaporation and solvent diffusion methods can be used for hydrophobic or hydrophilic drugs.
- In the case of hydrophilic drug, a multiple w/o/w emulsion needs to be formed with the drug dissolved in the internal aqueous phase.



Emulsification-solvent diffusion method

Polymerization method:

- In this method , monomers are polymerized to form nanoparticles in an aqueous solution.
- Drug is incorporated either by being dissolved in the polymerization medium or by adsorption onto the nanoparticles after polymerization completed.
- The nanoparticles suspension is then purified to remove various stabilizers and surfactants.
- And employed for polymerization by ultracentrifugation and the particles in an isotonic surfactant free medium.

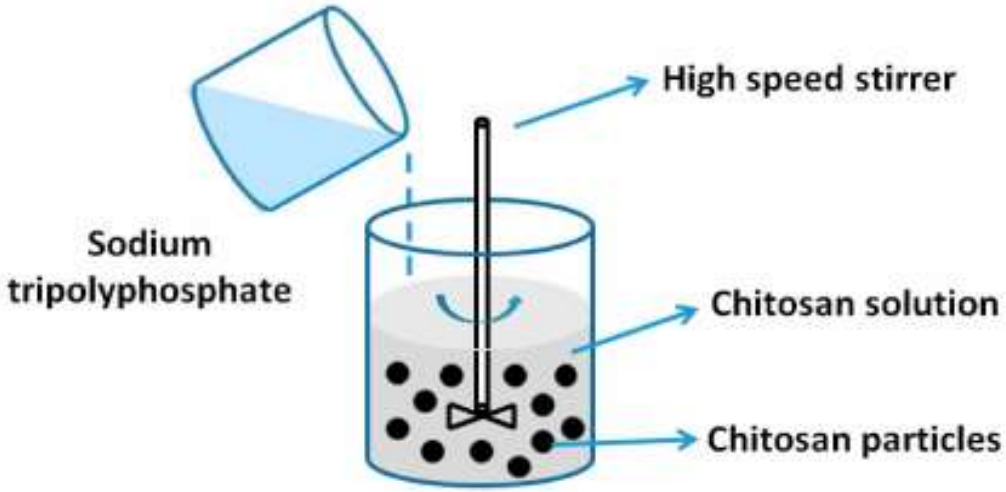


❖ **Coacervation(or)ionic gelation method:**

- Hydrophilic biodegradable polymers such as chitosan, sodium alginate and gelatin are used for preparation of nanoparticles by coacervation method.

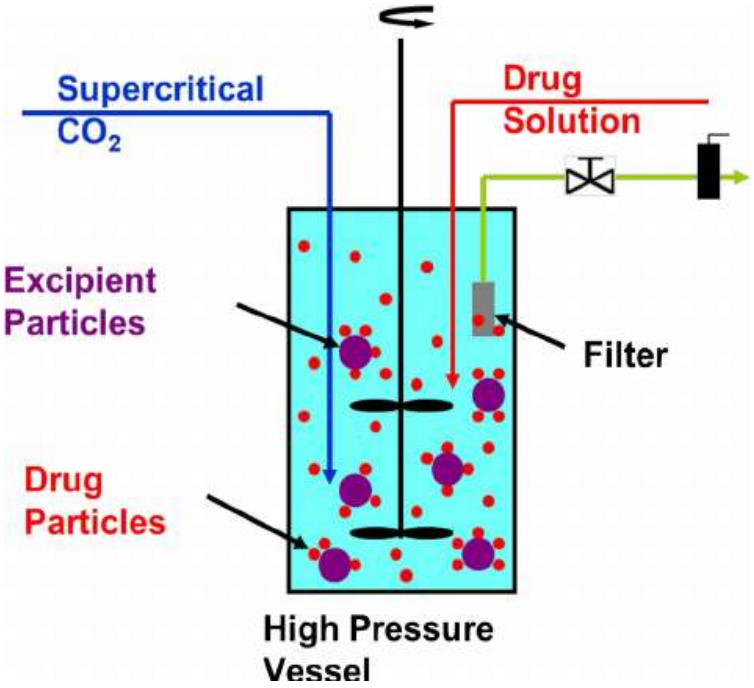
Preparation of hydrophilic chitosan nanoparticles by ionic gelation was developed by calvo and co-worker

- The preparation involves two aqueous phases, one is the polymer chitosan, adi-block co-polymer ethylene oxide or propylene oxide (PEO-PPO) and other is a polyanion sodium tripolyphosphate.
- Both are mixing positively charged amino group of chitosan interacts with negative charged tripolyphosphate to form coacervates with a size in the range of nanometer.
- Due to ionic force, resulting intransition form liquid phase to gel phase at room temperature this is known as ionic gelation method.



❖ **Supercritical fluid technology:**

- Various conventional approaches like solvent diffusion, solvent extraction-evaporation and organic phase separation require the use of organic solvent.
- And are hazardous to the environment as well as the physiological systems.
- Supercritical fluid technology thus has been investigated as an alternative to prepare biodegradable micro and nanoparticles.
- Supercritical fluid co2 is the most widely used supercritical fluid.
- The most common processing techniques are supercritical antisolvent(SAS)and rapid expansion of critical solution(RESS).
- Thus with solvent power of super critical fluid decrease and the solute eventually precipitate.



LIST OF INSTRUMENTS USED IN NANOPARTICLES

ATOMIC ABSORBTION SPECTROMETER:

It is the procedure to measure the quantitative determination of free atoms in the gaseous state[1]. Atomic absorption spectroscopy is based on absorption of light by free metallic ions. AAS is one of the most commonly used methods for concentration determination.

ELECTRON MICROSCOPY:

Electron microscopy used a beam of accelerated electrons to provide a higher resolution which cannot be achieved d by light microscope. The most commonly used electron microscopy is transmission electron microscopy (TEM) and scanning electrons microscopy (SEM).

The TEM uses a high voltage electron beam to illuminate the specimen and generate an image. The electron beam is originated from an electron gun, accelerated and then transmitted through the specimen on a conducting grid. The transmitted electron carries information about the structure of the specimen and such information can be recorded by an image detector (fluorescence screen or CCD camera). The TEM normally requires extremely thin section of specimen, typically no more than 100nm. Biological specimens, organic polymers and similar materials may need special treatment with heavy atom labels in order to obtain sufficient image contrast.

The SEN is based on the interaction of electron beam with the specimen surface. Due to the high depth of field in SEM, a three-dimensional appearance can be displayed. If not conductive the specimen needs to be coated with an ultra thin layer of conductive material like gold, platinum or graphite to obtain a clear image. The substrate, where the specimen is held is typically a filter membrane or a conducting grid.

ATOMIC FORCE MICROSCOPY (AFM)

It has capability of three-dimensional visualization and material sensing to measure the size, height, morphology, surface texture, roughness of the nanoparticle. It has a cantilever with a nanoscale thin tip. They oscillate over the sample surface. The scanning over the surface (X and Y-axis) and oscillating movements (Z axis) by piezoelectric actuators. With proper statistical analysis. AFM can provide both qualitative and quantitative information.

XRAY DIFFRACTION (XRD):

It is most common method utilized for determining the atomic and molecular structures of materials. The crystalline atoms lead to the diffraction of the incident X-ray beam into specific directions. The corresponding intensity and diffraction are measured and recorded. A number of crystalline materials can be characterized by XRD, including inorganic and organic material, biological materials. The physical states of the materials for XRD measurement are flexible, and they can be loose powders, thin films, poly crystalline and bulk materials. It includes minimum quantity of sample required, Non-destructive measurement, easy to interpret are the advantages of XRD techniques.

ZETA POTENTIAL INSTRUMENT:

Zeta potential is the measurement for electric charge on nanoparticle surface. Particles has electric charge which are dispersed in suspension or solution, because of their intrinsic ionic properties and other dipolarcharacteristic. Zeta potential represents the extent of electrostatic repulsion between all adjacent and it is fundamental stability of various colloidal dispersion. Nanoparticles which has high absolute zeta potential shows a improved stability, while nanoparticles with zeta potential close zero may lead to dispersion, aggregation or flocculation problems in the solution or suspension. Various zeta potential instrument can provide various data and varies from company to company.

Liquid Chromatography - Mass Spectrometry (LC-MS/MS):

Liquid Chromatography can evaluate organic component analysis. It provides information about the identification, quantitation, mass analysis of the compounds. LC/MS first separates the test compound in a sample mixture via the chromatography compounds intrinsic affinity for stationary and mobile phase. When separated compound passes through mass detector, it collectintensity for compound as it is vaporized and atomized in the plasma compared to reference material. The mass fraction or size of compounds can be correlated to the measured data point.

Themogravimetric Analysis(TGA):

The quantitative information the amount of coating molecules and relation to surface area are necessary and key parameters needed to be evaluated. So TGA is used as analytic method to provide information about surface coating, purity and compositional data of nanoparticles. TGA is based on measurement of gain or loss of mass/weight change and the rate of weight change in relation to change of time, temperature and atmosphere.

Fourier Transform infrared Spectroscopic (FTIR):

Functional groups chemical information of nanoparticles is measured by FTIR. Most molecules can absorb infrared light so their absorption will create molecular fingerprints of the sample and show how the sample absorb light at each wave length. So it is very useful for identification of functional groups, side chains and cross links of nanoparticles, because all of them have characteristic vibrational frequencies in IR range.

Dynamic Space Light Scattering (DLS):

Lightscattering techniques are used to determine particle size. DLS also calledquasi elasticlight scattering are photon correlation spectrographic. Usually, the Brownian, motion of particle cause the fluctuations and neighbouring particles may have destructive or constructive interference of scattered light intensity in certain direction.

Calorimeter

Different scanning calorimeter (DSC) is a thermal analysis method for determination how much energy a sample can absorb or emits as heat capacity. The phase diagram, entropy, thermal capacity, may all determined with DSC equipment

3D Printing Nanotechnology

The 3D printing nanotechnology is an emerging field in research of pharmaceutical enhancing human health. In 3D printing objectives can be almost any shape or geometry, and are produced from a 3D model as defined in a computer-aided design (CAD). 3D printing has ability to develop any structure from micrometer size up to several meters. Further, there decreases the price of product. It is a good tool for drug delivery and diagnosis.

Piezo actuator

The piezo actuator is the piezo mechanical device intended for actuation of mechanisms, it converts electrical signals into mechanical movement or force.

Nano Identification for nano-mechanical testing

Nano Identification is approve method for conducting mechanical indentation test on very small samples (Nano-mechanical Testing). It provides high resolution imaging of the specimen before and after indentation. It is used in metallic and non metallic, elastic modulus, fracture toughness and dynamic properties such as storage

Fluorescent microscope

A florescence microscopy is an optical microscope that uses fluorescence instead of scattering ,reflection, absorption ,to study the property of organic and inorgnic substances. Fluorescence microscope refers to any microscope that uses florescence to generate an image.

CONCLUSION:

In this review, we explained a detail overview about NPs, their types, synthesis, characterizations, physiochemical properties and applications. Through there were different characterization techniques such as SEM, TEM and XRD, it was revealed that NPs have size ranges from few nanometer to 500 nm. While the morphology is also controllable. Due to their tiny size, NPs have large surface area, which make them suitable candidate for various applications. Beside this, the optical properties are also dominant at that size, which further increase the importance of these materials in photocatalytic applications. Synthetic techniques can be useful to control the specific morphology, size and magnetic properties of NPs. Though NPs are useful for many applications, but still there are some health hazard concerns due to their uncontrollable use and discharge to natural environment, which should be consider for make the use of NPs more convenient and environmental friendly.

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CONFLICTS OF INTREST: There was no conflits of intrest among the authors and all are contributed work equally.

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