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The Use of Nanoparticles in the Field of Medical Physiology

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ABSTRACT

Nanoparticles (NPs) are defined as molecules have a diameter of less than (100 nanometers), and are increasingly used in different applications including drug carrier systems, and the passage of organ barriers such as the blood brain barrier. This because of its unique properties, nano crystals, (quantum dots), and other nanoparticles receive much attention for potential use in treatments, bioengineering and the discovery of medicinal drugs. In this review the using of nanoparticles, are discussed in various important fields. The special properties of these nanoparticles may advance a new development in drug invention. This physiological, and medical study is realistically applicable because it has been subjected to scientific and practical experiments.

Keyword: Nanoparticles, Creating Methods, Medicinal Drugs.

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INTRODUCTION

Nanoparticles are cornerstones of nano-science, and nanotechnology. Nanostructure science, and technology is a broad and interdisciplinary area of research, and evolution activity, that has been growing explosively worldwide in the past few years. It has the potential for revolutionizing the ways in which materials, and products are; establish and the range, and nature of functionalities that can be accessed. It is already having a remarkable commercial impact, which will assuredly, increase in the future. In nanotechnology, a particle is clarify as a small object that behaves as a whole unit in terms of its transport, and characteristics. It is moreover classified according, to its size: in terms of diameter, fine particles cover a range between; (100 and 2500) nanometers, while ultrafine particles, on the other hand, are sized between; (1 and 100) nanometers. It is like to ultrafine particles, nanoparticles are sized between (1 and 100) nanometers. Nanoparticles may exhibit size related properties that differ considerably, from those observed in fine particles or bulk materials (1, 2). In spite of the fact that the size, of most molecules would fit into the above outline, individual molecules are usually not referred to as nanoparticles. Nano-clusters have at least one dimension between (1 and 10) nanometers, and a narrow size divisions. Nano-powders (3) are agglomerates of ultrafine particles, nanoparticles, or nano-clusters. Nanometer sized single crystals, or single domain ultrafine particles, are often referred to as; nano-crystals. Nanoparticle research is currently an area, of intense scientific interest due to a wide differences of potential applications in biomedical, optical and electronic fields. The national nanotechnology Initiative has led to generous public funding for nanoparticle research in the United States. Nanoparticles play very important role in a number of these applications. NPs which in general terms are; defined as engineered structures with diameters of (less than 100 nm), are devices and systems produced by chemical, or physical processes, having specific properties (5). The reason why nanoparticles are attractive for such purposes is based on their important and unique features such as their size, and surface to mass ratio, which is much larger than that of other different particles and materials allowing for catalytic promotion of reactions, as well as; their ability to adsorb and carry other compounds. The reaction of the surface originates from quantum phenomena, and can make nanoparticles unpredictable since, immediately after generation nanoparticles may have their surface modified depending on the presence of reactants and adsorbing compounds, which may instantaneously change with changing structures and thermodynamic conditions. Therefore, on one hand, NP have a large (functional) surface which is able to bind, adsorb and carry other compounds such as drugs, probes and proteins. On the other hand, nanoparticle has a surface that might be chemically more reactive compared to their fine analogues (6).

Due to their small dimensions nanoparticles have extremely large surface area to volume ratio, which makes a large to be the surface or interfacial atoms, resulting in more surface dependent material types properties. Especially when the sizes of nanoparticles are comparable to length, the entire particle will be affected by the surface properties of nanoparticles. This in turn may develop or modify the properties of the bulk materials. For example, metallic nanoparticles (NPs) can be used as very active catalysts. Chemical sensors from nanoparticles (NPs) and nanowires enhanced the sensitivity and scout selectivity. The nano particle feature sizes of nano materials also have locative confinement effect on the materials, which bring the quantum effects.

METHODS FOR CREATING NANOPARTICLES

There are numerous and different ways of creating nanostructures: of course, macromolecules or nanoparticles or buckyballs or nanotubes and so on can be created artificially for certain specific materials. They can also be formed by methods based on equilibrium or near-equilibrium thermodynamics such as; methods of self-organization and self-assembly, (sometimes also called bio-mimetic processes). Using these methods, synthesized materials can be arranged into useful shapes, so that finally the particles can be applied to a certain application.

Mechanical grinding

Mechanical attrition is a typical example; of (top down) method of synthesis of nanoparticles, where the material is prepared not by cluster assembly but by the structural decomposition of coarser grained structures as the product of severe plastic deformation. This has become a popular method to make nano-crystalline materials because of its simplicity, the relatively inexpensive equipment needed, and the applicability to basically the synthesis of all classes of materials. The major advantage predominating quoted is the possibility for easily scaling up to tonnage quantities of material for various applications. Likewise, the serious problems that are usually cited are:

1. Contamination from milling media or atmosphere.
2. To consolidate the powder product without coarsening nano crystalline microstructure.

In fact, the contamination problem is often given as a reason to dismiss the method, at least for some materials. Here we will review the mechanisms presently believed responsible for formation of nano-crystalline structures by mechanical attrition of single phase powders, mechanical alloying of dissimilar powders, and mechanical crystallization of amorphous materials. The two important problems of contamination and powder merger will be briefly considered, figure (1)

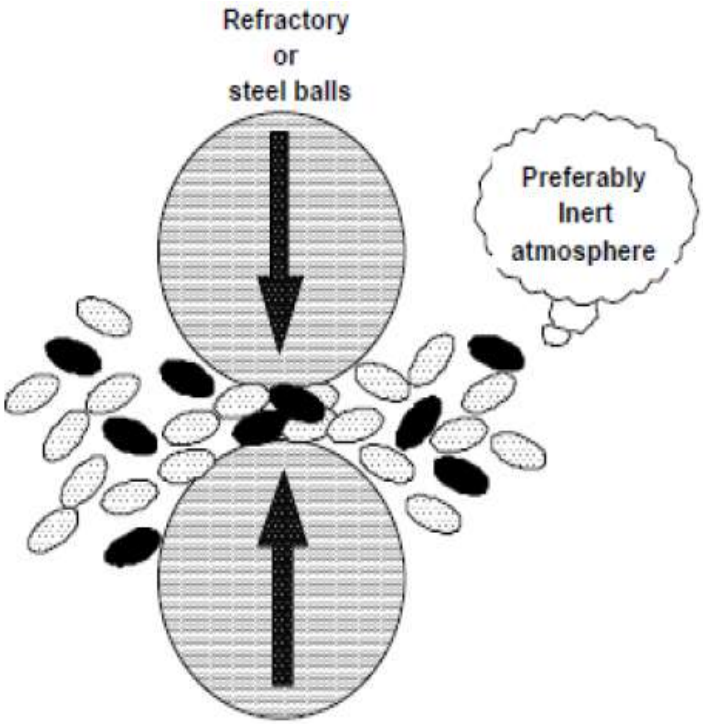

Fig 1: The illustration shows the method of mechanical grinding inside the mill device

Mechanical milling is typically achieved using high energy shaker, planetary ball, or acrobat mills. The energy transferred to the powder from headstrong, or steel balls depends on the rotatory (vibrational) speed, size and number of the balls, average of the ball to powder mass, the time of milling, and the milling atmosphere. Nanoparticles are formed by the shear action during grinding. Milling in cryogenic liquids can greatly increase the brittleness of the powders influencing the break up processes. As with any process that produces tiny particles, an adequate step to prevent oxidation is very necessary. As a result, this process is very restrictive for the production of non-oxide materials since then it requires that the milling take place in an inert atmosphere and that the powder nanoparticles be handled in an suitable vacuum system, or glove box. This method of synthesis is appropriate for producing amorphous, or nano crystalline alloy particles elemental or compound powders. If the mechanical milling broadcast sufficient energy, to the constituent powders a homogeneous alloy can be produced. Based on the energy, of the milling process and thermodynamic characteristics of the constituents the alloy can be rendered amorphous by this processing.

The chemical method of condensing vapor (CV)

As shown schematically in Figure, the evaporative source used in GPC is replaced by a hot wall reactor in the Chemical Vapor Condensation or the CV process. Depending on the processing parameters nucleation of nanoparticles is observed during chemical vapor deposition (CV) of thin films and poses a major problem in obtaining good film qualities. The original idea of the novel CV process which is schematically shown below where, it was intended to adjust the parameter field during the synthesis in order to suppress film formation and promote homogeneous nucleation of particles in the gas flowing. It is readily found that the residence time of the precursor in the reactor determines if films or particles are produced. In a certain level of residence time both particle and film formation can be obtained. Adjusting the residence time of the precursor molecules by changing the gas flow rate, the

pressure difference between the precursor delivery system and the main chamber occurs. Then the temperature of the hot wall reactor results in the fertile production of nano sized particles of metals and ceramics instead of thin films as in (CV) processing. In the simplest form a metal organic precursor is introduced into the hot zone of the reactor using mass flow controller. Besides the increased quantities in this continuous process as compared to (GPC) has been demonstrated that a wider range of ceramics including nitrides and carbides can be synthesized figure (2).

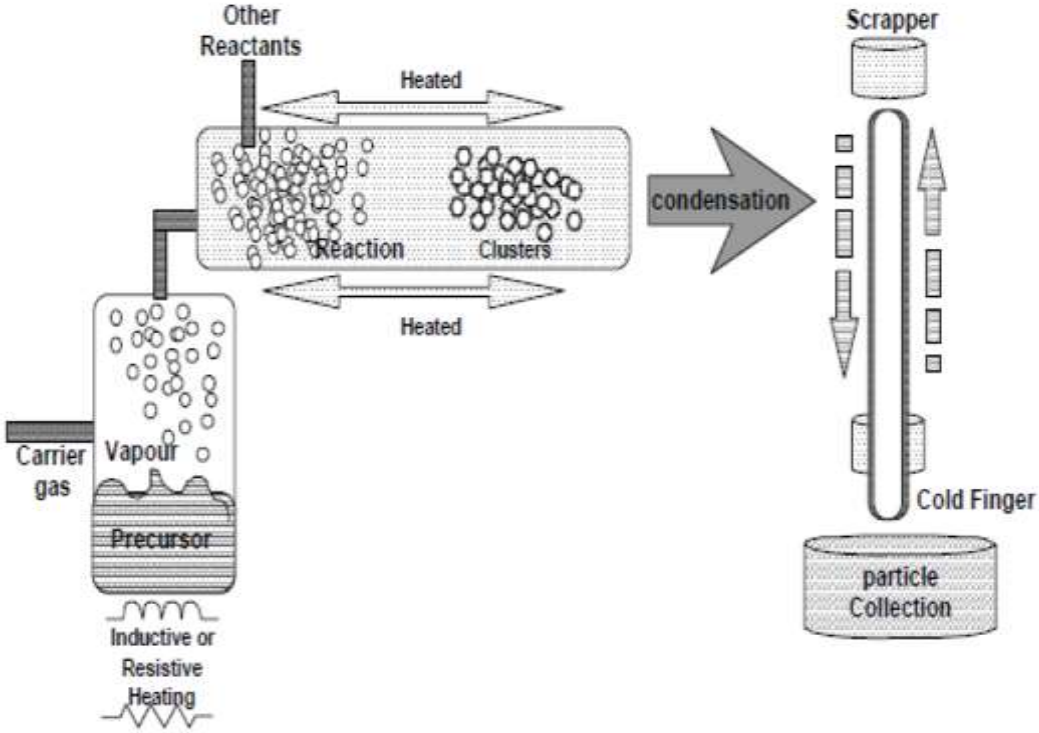

Fig 2: Schematic representation of a typical CVC atomic pile

Because (CV) processing is continuous the production capabilities are much larger than in GPC processing. Quantities in excess of (20g/hr) have been readily produced with a small scale laboratory reactor. A further expansion can be visualized by simply enlarging the diameter of the hot wall reactor and the mass flow through the reaction.

TARGETED DRUG DELIVERY

A key area in drug delivery is the accurately targeting of the drug to cells or tissue of choice. Drug targeting systems should be able to control the fate of a drug entering the body. Today's delivery technologies are far away from the design of the so called "magic bullet", proposed by Paul Ehrlich at the beginning of the 20th century, in which the drug is precisely targeted to the exact side of action. Nanotechnology offers here another challenge to come to this goal a bit closer, to deliver the drug in the right place at the right time (4). Nanotechnology is expected to bring a fundamental change in manufacturing in the next few years and will have an enormous impact on Life Sciences including drug delivery, diagnostics, nutriceuticals and the production of biomaterials.

Targeting is the ability to direct the drug-loaded system to the site of interest. Two major mechanisms can be distinguished for addressing the desired sites for drug release: (i) passive and (ii) active targeting. An example of passive targeting is the preferential accumulation of chemotherapeutic agents in solid tumors as a result of the enhanced vascular permeability of tumor tissues compared with healthy tissue. A strategy that could allow active targeting involves the surface functionalization of drug carriers with ligands that are selectively recognized by receptors on the surface of the cells of interest. Since ligand–receptor interactions can be highly selective, this could allow a more precise targeting of the site of interest (10). Passive targeting with nanoparticles, however, encounters multiple obstacles on the way to their target; these include mucosal barriers, nonspecific uptake of the particle and non-specific delivery of the drug (as a result of uncontrolled release).

Surface chemistry of a nanoparticle

Surface chemistry of a nanoparticle is an important factor during clearance or uptake in circulation. For long circulation halflife nanoparticles must escape from macrophages. Hence, residence time or circulation time is the major factor considered for effective designing of nano carriers (11). To have long circulation half-life for the nanoparticles is essential as to escape from macrophages effectively therefore, the important factor in the designing of the nanocarriers is residence time or circulation time. In cancer therapy, passive targeting requires long circulation because of the EPR effect observed in the tumor vasculature after multiple passes, in order to achieve this, drug

degradation should be minimal for the designed nanoparticles therefore the surface modification is an effective requirement to make the nanoparticle carry loaded drug to the targeted site (12). It has been reported as an effect of these changes the cells undergo apoptosis display typical condensed morphology namely cell shrinkage, chromatin condensation and nuclear fragmentation (13). Drug delivery is to be profoundly benefited by use of Magnetic Nanoparticles (MNPs) due to the ability of these particles have to target a specific site such as a tumor, thereby enhancing drug uptake at the target site and reducing the systemic distribution of the drug compounds in vivo and resulting in effective treatment at lower doses (14).

The blood half-life of nanoparticles

The blood half-life of nanoparticles is said to be dependent on the surface hydrophobicity of nanoparticles. Nanoparticle's surface hydrophobicity determines the amount of proteins (opsonins) adsorbed on to the surface. Particles which are more hydrophobic suffer more opsonization it was reported that human serum albumin (HSA) adsorption onto the nanoparticles decreased their specific surface area and porosity (15). Past studies have reported the Poly Ethyle Glycolysation (PEG) and binding of Polyphosphate and Glucose with the nanoparticles as hydrophilic blocks (16, 17). Increases the circulation time by escaping through immune cells (opsonisation) as for the past studies reported that PEG (Polyethylene glycol) prevents aggregation of the nanoparticles helps in stabilizing the nanoparticles providing a neutral surface charge to nanoparticles, nanoparticles and escape from clearance by preventing from opsonins and also has advantages over other nanocarriers such as excellent biocompatibility, biodegradability and mechanical strength for these nanoparticles (18). For effective modification of the surface, length and density of the PEG plays vital role. PEGylated mesoporous silica nanoparticles presents low systemic toxicity in healthy mice and enhanced tumour inhibition rate (19).PEG shields the inner core of nanoparticle from blood proteins by forming a brush layer on the surface of nanoparticles. The access of encapsulated drug is restricted to the enzymes by modification of the nanoparticle surface therefore improving pharmacokinetic profile and reducing non- specific toxicity. Surface modification chemistry aims at specificity by targeting ligand design is used in therapeutics imaging reporter molecules and controlled release Polymer-Coated Hydroxyapatite Nanoparticles (20).

Effect of size and density

The functional properties of the particle like its uptake, residence in circulation, adherence, degradation as well as clearance is influenced by its size, and density. Size is responsible for the movement of the nanoparticles inside the tissues. It has been known that the movement of the particles inside tissues is dependent on the size as their movement can be satirically hindered in extra-cellular matrix due to which acidic, and cysteine rich secreted protein targeted nanoparticles, and BTC, (Biodegradable Thiolated Chitosan), nanoparticles gains popularity because of their high muco adhesiveness, and extended drug release properties, (21, 22). Based on the relationship between particle size and its curvature (for spheres), size of the nanoparticles along with surface chemistry may also affect opsonization. It is well known that small size of targeting nanoparticles play vital role in that accumulated inside the tumors by EPR effect that in turn depends on the extravasation through the gaps in tumor vasculature. Studies have reported that ultra-small gold nanoparticles exhibits uniform distribution within the tumor tissues due to their ability to diffuse through tissues, smaller nanoparticles end to shown better circulation and accumulation but the uptake is poor. Particle diameter and size can be controlled by variation of different physical and chemical parameters. The size and density of a particle guides its way inside a bloodstream, diffusion in cells or membranes, air-passage or gastro-intestinal tract densely dispersed capsaicin-loaded trimethyl-chitosan nanoparticles (CL-NPs) has an effective anti-cancer agent which efficiently induced apoptosis in human, HepG2 hepato carcinoma cells, (23). Significant attempts were made in order to obtain the nanoparticles in the size range of 10-50 nm, (18-24) by biologically synthesizing to show more effectively (24). Size is an important factor to decide the destination and fate of the nanoparticles inside the body as differences in cytotoxicity could be correlated with different uptake rates (25).

CONCLUSION

The process of formation and production of nanoparticles is very important at the present time in order to continue modern scientific development in various fields, because it is of the utmost importance in solving many life, medical, and industrial problems, and using them in many applications related to our scientific and practical life. Nanoparticles have been used extensively for applications in drug discovery, drug delivery, diagnostics and for many others in medical field. Nanoparticles can also contribute to stronger, lighter, cleaner and "smarter" surfaces and systems.

CONFLICT OF INTEREST

None

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