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# DEVELOPMENT OF NANOMATERIALS AND THEIR RECENT APPLICATIONS

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## ABSTRACT

Some nanomaterials occur naturally, but of particular interest are engineered nanomaterials (E N), which are designed for, and already being used in many commercial products and processes. They can be found in such things as sunscreens, cosmetics, sporting goods, stain-resistant clothing, tires, electronics, as well as many other everyday items, and are used in medicine for purposes of diagnosis, imaging and drug delivery. Engineered nanomaterials are resources designed at the molecular (nanometer) level to take advantage of their small size and novel properties which are generally not seen in their conventional, bulk counterparts. Today nanophase engineering expands in a rapidly growing number of structural and functional materials, both inorganic and organic, allowing to manipulate mechanical, catalytic, electric, magnetic, optical and electronic functions. The production of nanophase or cluster-assembled materials is usually based upon the creation of separated small clusters which then are fused into a bulk-like material or on their embedding into compact liquid or solid matrix materials. e.g. nanophase silicon, which differs from normal silicon in physical and electronic properties, could be applied to macroscopic semiconductor processes to create new devices. For instance, when ordinary glass is doped with quantized semiconductor "colloids," it becomes a high performance optical medium with potential applications in optical computing.

***Keywords-*** *Nanomaterials, nanometer, nanophase, colloids.*

## I. INTRODUCTION

The term nanotechnology, which enjoys wide public use, is a concept that covers a wide range of developments in the field of nanoscale electronic components, along with its decades-old application in nanocarbon-black particles or silicates manufactured using the sol–gel process. When we refer to nanotechnology today, the term is limited to dealing with particles or assemblies whose dimensions range in size from a few nanometres up to around 100 nm. Intensive development work is now being carried out in new fields in many industrial and university research facilities, with the help of nanoscale particles or subassemblies. Along with the already familiar items, this applications-oriented research has covered such new developments as carbon nanotubes or electronic circuits. All materials are composed of grains, which consist of many atoms. Grains of conventional materials vary in size from tens of microns to one or more millimetres. Nanomaterials are no longer merely a laboratory curiosity and have now reached the stage of commercialization being lead by activity, often government supported, in the USA, UK, Japan, Singapore, Malaysia, Taiwan, Korea, Germany and in recent years China and Australia. This is the opening of a whole new science in some respects, and the usefulness to our everyday lives will become increasingly apparent. The potential of nanominerals, as just one sector of nanomaterials technology have some very real and useful outcomes, Production of materials and products with new properties.Contribution to solutions of environmental problems.Improvement of existing technologies and development of new applications.Optimisation of primary conditions for practical applications.These materials are revolutionizing the functionality of material systems. Due to the materials very small size, they have some remarkable, and in some cases, novel properties. Significant enhancement of optical, mechanical, electrical, structural and magnetic properties are commonly found with these materials. Some key attributes include, Grain size on the order of $10^{-9}$ m (1–100 nm).Extremely large specific surface area.Manifest fascinating and useful properties.Structural and non-structural applications.Stronger, more ductile materials.Chemically very active materials.

## II. DEVELOPMENT OF NANOMATERIALS

There are various widely known methods to produce nanomaterials other than by direct atom manipulation. In *plasma arcing*, the very high temperatures associated with the formation of an arc or plasma is used to effectively separate the atomic species of feedstock, which quickly recombine outside the plasma to form nanosized particles, which may have novel compositions. In the case of *chemical vapour deposition*, feed gases are reacted in a chamber and the resulting species attracted to a substrate. Once again the reaction products can be controlled and not only in terms of composition but also in terms of how they are deposited. The substrate effectively provides a template from where the deposited coating can grow in a very well controlled manner. *Electro-deposition* involves a similar process; however the controlled coating is deposited from solution by the application of an electric field. *Sol–gel synthesis* uses chemical means to produce intimately mixed compounds that are hydrolysed into gels. The gels can be deposited on any surface and shape at well controlled thicknesses and on subsequent heating, decompose to leave a thin layer of the desired coating. This technique is well suited to coating large surface areas with very well defined nanometre scale compounds. In *high intensity ball milling*, as the name suggested, high impact collisions are used to reduce macro crystalline materials down into nano-crystalline structures without chemical change. A relatively new technique termed Mechanochemical Processing (MCP) technology, being developed by Advanced Nanotechnologies based in Perth, is a novel, solid-state process for the manufacture of a wide range of nanopowders. Dry milling is used to induce chemical reactions through ball-powder collisions that result in nanoparticles formed within a salt matrix. Particle size is defined by the chemistry of the reactant mix, milling and heat treatment conditions. Particle agglomeration is minimized by the salt matrix, which is then removed by a simple washing procedure.Nanomaterials (gold, carbon, metals, and alloys) with variety of morphologies (shapes) are shown in Fig. 1.

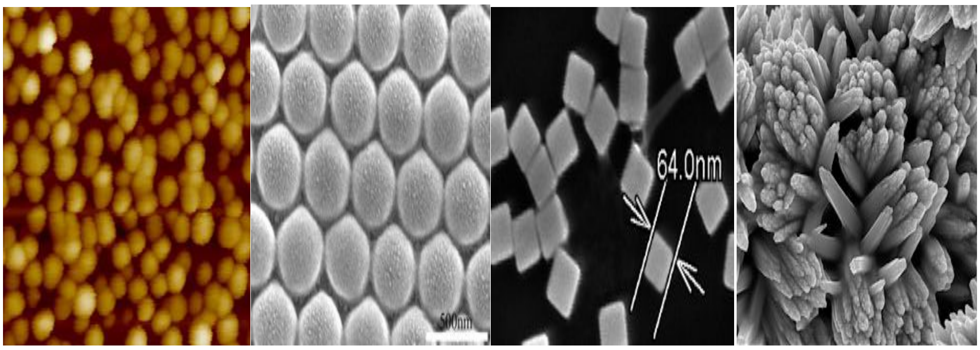


***Fig.1. (i) Gold nanoparticle, (ii) FePtnanosphere, (iii) Silver nanocubes, (iv) Titanium nanoflower***

## III. PROPERTIES OF NANOMATERIALS

One significant property that makes nanoparticles different from other materials is the fact that nanomaterials have a massive surface area. Because of their very high surface area, nanoparticles are extremely reactive compared to its larger form. This property is used to create materials with distinctive characteristics for various applications. One nanotechnology application is carbon nanotubes that have a very high strength. Its remarkable strength is due to the higher surface area of its originating materials. In the nano level, quantum effects have a higher effect on the behavior of particles. Therefore some materials have special effects that have utilized smartly to produce innovative products. Then magnetic, electrical and mechanical properties can be effectively exploited to certain applications. As an example if Gold particles can be rendered in to particles with radius of 2 nm then their melting can be lowered from $1060^0$ C to $600^0$ C.

**1. Electrical properties:**Electrical Properties of Nanoparticles discuss about fundamentals of electricalconductivity in nanotubes and nanorods, carbon nanotubes, photoconductivity ofnanorods, electrical conductivity of nanocomposites. One interesting method which can be used to demonstrate the steps in conductance is the mechanical thinning of a nanowire and measurement of the electrical current at a constant applied voltage. The important point here is that, with decreasing diameter of the wire, the number of electron wave modes contributing to the electrical conductivity is becoming increasingly smaller by well-defined quantized steps. In electrically conducting carbon nanotubes, only one electron wave mode is observed which transport the electrical current. As the lengths and orientations of the carbon nanotubes are different, they touch the surface of the mercury at different times,which provides two sets of information: (i) the influence of carbon nanotube length on the resistance; and (ii) the resistances of the different nanotubes. As the nanotubes have different lengths, then with increasing protrusion of the fiber bundle an increasing number of carbon nanotubes will touch the surface of the mercury droplet and contribute to the electrical current transport.

**2. Mechanical properties:** Mechanical Properties of Nanoparticles deals with bulk metallic and ceramic materials, influence of porosity, influence of grain size, superplasticity, filled polymer composites, particle-filled polymers, polymer-based nanocomposites filled with platelets, carbon nanotube-based composites. The discussion of mechanical properties of nanomaterials is, in to some extent, only of quite basic interest, the reason being that it is problematic to produce macroscopic bodies with a high density and a grain size in the range of less than 100 nm. However, two materials, neither of which is produced by pressing and sintering, have attracted much greater interest as they will undoubtedly achieve industrial importance.

These materials are polymers which contain nanoparticles or nanotubes to improve their mechanical behaviors, and severely plastic-deformed metals, which exhibit astonishing properties. However, because of their larger grain size, the latter are generally not accepted as nanomaterials. Experimental studies on the mechanical properties of bulk nanomaterials are generally impaired by major experimental problems in producing specimens with exactly defined grain sizes and porosities. Therefore, model calculations and molecular dynamic studies are of major importance for an understanding of the mechanical properties of these materials.Filling polymers with nanoparticles or nanorods and nanotubes, respectively, leads to significant improvements in their mechanical properties. Such improvements depend heavily on the type of the filler and the way in which the filling is conducted. The latter point is of special importance, as any specific advantages of a nanoparticulate filler may be lost if the filler forms aggregates, thereby mimicking the large particles. Particulate filled polymer-based nanocomposites exhibit a broad range of failure strengths and strains. This depends on the shape of the filler, particles or platelets, and on the degree of agglomeration. In this class of material, polymers filled with silicate platelets exhibit the best mechanical properties and are of the greatest economic relevance. The larger the particles of the filler or agglomerates, the poorer are the properties obtained. Although, potentially, the best composites are those filled with nanofibers or nanotubes, experience teaches that sometimes such composites have the least ductility. On the other hand, byusing carbon nanotubes it is possible to produce composite fibers with extremely high strength and strain at rupture. Among the most exciting nanocomposites are the polymerceramicnanocomposites, where the ceramic phase is platelet-shaped. This type of composite is preferred in nature, and is found in the structure of bones, where it consists of crystallized mineral platelets of a few nanometers thickness that are bound together with collagen as the matrix. Composites consisting of a polymer matrix and defoliated phyllosilicates exhibit excellent mechanical and thermal properties.

3. **Magnetic properties:** Bulk gold and Pt are non-magnetic, but at the nano size they are magnetic. Surface atoms are not only different to bulk atoms, but they can also be modified by interaction with other chemical species, that is, by capping the nanoparticles. This phenomenon opens the possibility to modify the physical properties of the nanoparticles by capping them with appropriate molecules. Actually, it should be possible that non-ferromagnetic bulk materials exhibit ferromagnetic-like behavior when prepared in nano range. One can obtain magnetic nanoparticles of Pd, Pt and the surprising case of Au (that is diamagnetic in bulk) from non-magnetic bulk materials. In the case of Pt and Pd, the ferromagnetism arises from the structural changes associated with size effects. However, gold nanoparticles become ferromagnetic when they are capped with appropriate molecules: the charge localized at the particle surface gives rise to ferromagnetic-like behavior. Surface and the core of Au nanoparticles with 2 nm in diameter show ferromagnetic and paramagnetic character, respectively. The large spin-orbit coupling of these noble metals can yield to a large anisotropy and therefore exhibit high ordering temperatures. More surprisingly, permanent magnetism was observed up to room temperature for thiol-capped Au nanoparticles. For nanoparticles with sizes below 2 nm the localized carriers are in the 5d band. Bulk Au has an extremely low density of states and becomes diamagnetic, as is also the case for bare Au nanoparticles. This observation suggested that modification of the d band structure by chemical bonding can induce ferromagnetic like character in metallic clusters.

## IV. RECENT APPLICATIONS OF NANOMATERIALS

Nanomaterials presently applied in every fields list of these are as follows:Next-Generation Computer Chips, Kinetic Energy (KE) Penetrators with Enhanced Lethality, Better Insulation Materials, Phosphors for High-Definition TV, Low-Cost Flat-Panel Displays, Tougher and Harder Cutting Tools, Elimination of Pollutants, High Energy Density Batteries, High-Power Magnets, High-Sensitivity Sensors, Automobiles with Greater Fuel Efficiency, Aerospace Components with Enhanced Performance Characteristics, Better and Future Weapons Platforms, Longer-Lasting Satellites, Longer-Lasting Medical Implants, Ductile, Machinable Ceramics, and Large Electrochromic Display Devices, As well as Nanomaterial Applied in Carbon Nanotubes, Graphene, Nano composites, Nanofibers, Nanoparticles, Nanowires etc.

## V. SIDE EFFECT OF NANOPARTICLES

Inhaled Nanoparticle can create health problems and may sometimes cause inflammation and disease in the lungs. Risks include environmental, health and safety issues.

## VI. CONCLUSIONS

In this review, we have successfully illustrated several methods to develop nanoparticles including insulators, semiconductors, carbon nanotubes, and metals and magnetic Ferro fluids etc.

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