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Potential Applications of Nanomaterials

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Abstract— Nanomaterials are the materials that are smaller than 100 nanometres. These materials exhibit many unique properties which make nanomaterials very promising material for different applications. Nanomaterials are coming into use in every field such as Biosensing, Medicine, Electronics, Electrical, Mechanical systems and many more. Integration of different fields with nanomaterials not only refines many properties of existing conventional equipments but also open it to various complex new oppurtunities. This device by the use of nanomaterial instead of material that is not at nanoscale outperforms conventional devices in many properties. This is contributed to the novel properties of these nanomaterials. This article gives a brief review of the properties of these materials, techniques to study these materials and their potential applications in some areas.

Keywords— Nanomaterials, Carbon Nanotubes, XRD, ED, TEM, SEM

I. INTRODUCTION

Nanomaterials are the materials of the size which range from 1 to 100 nanometers. The use of these materials has brought a revolution in the industry as these materials scale down to 10,000 times smaller than the diameter of a human hair. Nanomaterials possess many novel properties such as high mechanical strength, high current density, high thermal conductivity etc. Due to these properties, these materials are attracted in every field of development to enhance its performance parameters which leads to highly efficient systems.[1].

II. PROPERTIES OF NANOMATERIALS

Nanomaterials possess many novel properties. Some of the properties can chemical, physical and mechanical, electrical and electronic properties. Todays industry demands miniaturization. In this aspect, the circuits or the systems, such as active or passive componenets, MEMS are reduced in size. By reducing their size, these circuits can run much faster computations. Apart from minituarisation, nanomaterials provide materials with better thermal conductivity, high mechanical strength, high electrical conductivity , good precision and resolution, long span and high efficient operations.

III. CLASSIFICATION OF NANOMATERIALS

Nanomaterials are classified as Zero dimensional, one dimensional, two dimensional, three dimensional nanostructures as defined by Richard W. Siegel.

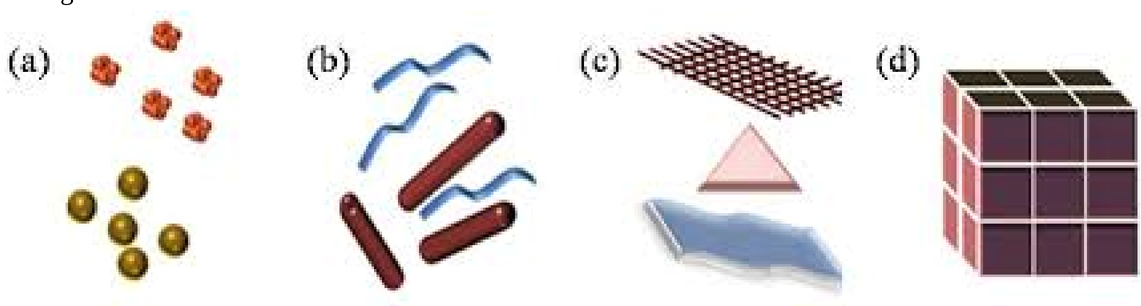

Fig. 1. Classification of Nanomaterials (a) 0D spheres and clusters, (b) 1D nanofibers, wires, and rods, (c) 2D films, plates, and networks, (d) 3D nanomaterials

IV. TECHNIQUES TO STUDY NANOMATERIALS

There are many techniques that can be used to study various nanomaterials. Their characterization can also be done to study their unique and promising properties. The characterization and the study for the bulk and the surface is done through various ways. [2] Some common techniques involved are:

X ray Diffraction (XRD): It is an analytical technique which gives the information regarding the structural arrangement.
ED(Electron Diffraction): It is defined as the scattering phenomena which gives the structural arrangement information.
Transmission electron microscopy (TEM): It is the microscopy technique which gives the information regarding the size and morphology.
Scanning electron microscope (SEM): It uses a focused beam of high-energy electrons and gives the information about the sample including morphology, chemical composition, crystalline structure and orientation of materials.
Differential scanning calorimetry (DSC): It is a thermo analytical technique which gives information regarding the structural arrangement.
Atomic-force microscopy (AFM): It is also called as scanning-force microscopy (SFM): It gives the information regarding the size and morphology.

V. APPLICATIONS OF NANOMATERIALS IN VARIOUS SYSTEMS

Some of the important areas in which addition of nanomaterials provide enhancement in the existing systems are:

A. Electrical Systems

These are defined as the group of electrical components connected to carry out some operation. Electricalsystems include solar cells, batteries, passive components etc. These systems can be a subsystems of larger systems or has a subsystems of their own. There are many systems that are using nanomaterials and by which they offer better performance parameters than the conventional electrical systems. Some of the common applications are given:[3,4]

1) Nanobatteries: Nanobatteries are fabricated batteries that employ technology at the nanoscale In contrast to conventional battery, nanobattery technology uses active materials, such as cobalt-oxide or manganese oxide, with particles that range in size between 5 and 20 micrometers (5000 and 20000 nanometers - over 100 times nanoscale). It is hoped that nano-engineering will improve many of the shortcomings of present battery technology, such as recharging time and battery 'memory'.

2) Surface Coatings Of Electrical Goods: Nanomaterials are now a days used as surface coatings in certain electrical goods because they have anti-microbial properties. These coatings used for anti microbial properties mainly contain silver nano-particles. Silver has natural anti-bacterial and anti-fungal properties and silver engineered into nano-particle size increases the surface area in contact with micro-organisms which, in turn, improves its bacterial and fungicidal effectiveness (Nanotech Plc 2006). Some commonly used products include refrigerators, vacuum cleaners, washing machines, mobile phones and computer mice.

3) Fuel cells: Nanomaterials offer application in this field also. Carbon nanotube technology contribute to the development of fuel cells, as a catalyst support, and also as a main component of bipolar systems (Endo et al. 2006). Other nanomaterials under investigation for use in fuel cells are nanoparticles of platinum and platinium alloys (Matsui 2005). Recent research on quantum dots suggested that they may also be used in fuel cells in the future (Weiss 2006).

B. Biomedical Systems[5]

The addition of nanomaterials in biomedical systems will help in improving the performance of existing systems in terms of early diagnostics, medical treatment, and prevention of deadly diseases and an overall efficient way to give medical aid through high precision advance devices. One of the common application reported is in the drug delivery: It is said that the nano drug delivery systems can convey the drugs more effectively to the patient with the increased patient compliance and giving higher product life cycle [6].

C. Electronics

Nanomaterials are very promising in the field of electronic applications. The excellent properties of these materials provide an unprecedented opportunity to enable nanomaterials for future applications in electronic devices. The most common nanomaterial used is graphene which is a two dimensional structure.Some of the devices that employ graphene as an active material includes communication devices, resonators, high frequency amplifiers, high performance sensors and field effect transistors. [7,8]

D. Energy Efficiency

Nanomaterials provide potential to enhance the energy efficiency. The various areas using these materials are: Power transmission, Fuel Cells, heat transfer systems, gas turbines, fossil fuels etc. The extraordinary properties of nanomaterials are utilized for these applications.[9]

VI. CONCLUSION

This paper concludes that the nanotechnolgical development provides more efficient and reliable systems of existence. The greater use not only leads to miniturisation of electronic devices but also faster computations of logic applications. To add further, these nano based systems in medicine also leads to early diagonosis and thus improves the life span of the patient. Also it meets the demand from sustainable energy requirement. Hence, in this paper, a brief review of introducing nanomaterials in various systems has been studied.

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