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Nano materials: Extensive approach for sustainable advancement

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Abstract
Nanomaterials have opened many doors for research to modified the traditional way of living into a high- tech era. New concepts of smart homes, smart city, low- cost energy saver, smart transportation, high performance sensors for pollutant detection are become possible only due to nano materials. The importance of nano materials is coming into light because of its amazing properties those decided by their size and geometry at nanoscale. This size effect is known as aspect ratio that is the surface to volume ratio.
Synthesis and characterization of Nanomaterials are the main important part of the research to enhance their applicability in different and advanced field. In this paper, we will provide the detailed discussion on type, synthesis and application of nanomaterials. This article would be helpful for the new researchers and technologist in the field for sustainable development to understand the basic of nanomaterials by which they can used their knowledge regarding nanomaterials in various applications.

Keywords: Nanomaterials, sustainable development, nanoscale

1. Introduction
In last decade, Nanotechnology has touched all sectors due to its excellent and evident impacts, which generates research and technologist community numerous breakthroughs for sustainable development in different field [1-3]. This technology deals with the materials at a nanometer scale. Nanomaterials are defined as the smallest structures that developed and manipulated, having size of 1 to 100 nm. More specific, nanomaterials are those that have geometry and structure with one dimension at least less than 100 nm. Nanomaterials (NMs) are the best option to prominence in technological breakthroughs due to their changeable chemical and physical properties which make these superior over other bulk materials [4]. Nanomaterials are available in different forms and shapes.
Sustainable development means inclusive growth which includes development of both mankind and environment (nature), in other words, sustainable development deals with an eco-friendly approach of development where eco-friendly means both economic friendly and ecological friendly. In September 2015, food and agriculture organizations of United Nations had also adopted 17 sustainable development goals (SDGs) for 5P (people, planet, prosperity, peace and partnership) [5].
Nanotechnology and nanomaterials act as a magical tool for eradicating challenges and progressing developing sustainable. Nanomaterials not only provide monetary advantages but also provide ecological advances. They provide better and effective alternative for agriculture, energy generation, communication, industrial production, transportation, health, electronic goods etc. and work on zero waste budget technique. Their biological approach of synthesis is cost effective and leave minimal waste.

2. Nanomaterials

Nanomaterials are those materials whom said to have dimensions that of a nanometer i.e., between 1 nm to 100 nm (1 nm = 10^{-9} m). These materials can be synthesized with the technology known as Nanotechnology [6]. In other words, the science which involves the alteration of atoms and molecules for synthesis of a new material is known as Nanoscience and the technology involved is said to be known as Nanotechnology.

2.1 Classification of Nanomaterials

Nanoamaterials can be categorised in many types on the bases of dimension and shape. On the bases of dimension, nanomaterials are classified into four types:

A. Zero-dimensional Nanomaterials
B. One-dimensional Nanomaterials
C. Two-dimensional Nanomaterials
D. Three-dimensional Nanomaterials

A. Zero-dimensional Nanomaterials

These materials have uniform particle array with core shells. They have nano-dimension in all the directions. The most common nanomaterial in zero-dimensional nanomaterial are quantum dots, quantum clusters, quantum spheres, atomic clusters, filaments, cluster assemblies, particles, powders, fullerenes, etc.

Quantum dots are nanoscale sized semiconductor particles. Their optical behavior depends on their size, shape, and constituent particles. Due to their light emitting strength they are used as luminescent materials. This is a perfect example of a nanoparticle.

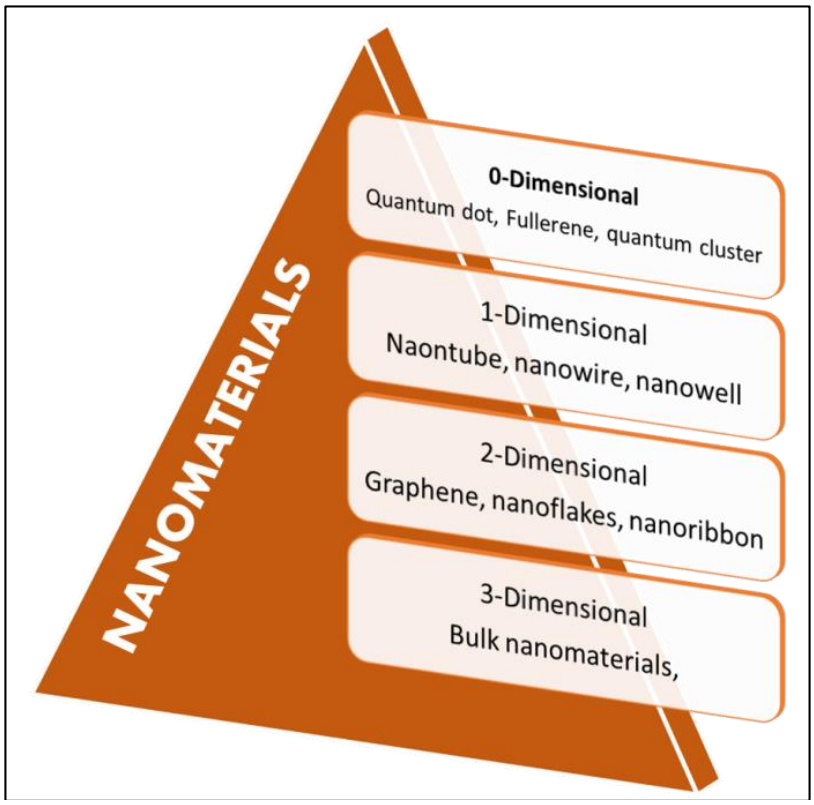

Fig 1: Type of Nanomaterials

B. One-dimensional Nanomaterials

In this type the one dimension of the material will be outside nanoscale. These include nanorods (rigid cylinder), nanotubes (hollow cylinder), nanowires, quantum wires.

Nanotubes are hollow quantum cylinders whose diameter is in nano-range. Optical absorption and Raman spectra depend on band structure of nanotubes. They are strong material with good thermal conductivity. Apart from carbon nanotubes, non-carbon nanotubes also make their contribution in different aspects. They found their application in electronic devices in FETs (Field Effect Transistors), voltage inverters, logic circuits, thermometer, etc [7].

C. Two-dimensional Nanomaterials

In these types of materials two dimensions are outside nanometer range. In these materials the surface area can be outside nanoscale range but thickness should lie in nano-range. These can be crystalline or amorphous. These include ultra-thin films, fine over grained layers or buried layers. They are also referred as Quantum well.

D. Three-dimensional Nanomaterials

When all the dimensions of a material lie outside the nanometer range then it is said to be a three-dimensional material. These include bulk of individual nanomaterial. For example- bundles of nanowires, nanorods and nanotubes as well. These are also referred as Nanophase materials.

3. Methods of Fabrication

There can be two methods of fabrication of nanomaterials [8-9]:

A. Top-down approach
B. Bottom-up approach

The one way for synthesis of nanomaterials can be start with taking a particle and breaking it unto nanoscale size. In this case the result will be crystalline or polycrystalline shaped

particle. The biggest hurdle in top-down approach is that it creates imperfections of surface structure which changes surface chemistry which leads to physical changes as well. This is performed mostly on solids or on dispersed solids.
Another way can be making the desired result from the scratch i.e., adding atoms to get the desired particle and size. But the result may or may not be crystalline rather it has some distortions. But the advantage of this method will be that one can add atoms and modify particle according to our need. It is more economical and it creates less waste. It is a widely acceptable method for synthesis of nanomaterials. This is performed in gaseous or liquid phase.

3.1 Green synthesis for sustainable development

It is a method of synthesis of nanoparticles using surface reducing and stabilizing agents generated from nature i.e., plants, seeds, fruits, fungi, algae, etc. It is a method having minimum or no toxicity as it replaces dangerous solvent with green and eco-friendly solvents. Green synthesis of the nanoparticles is the best approach for the sustainability for our environment, society and also for ecosystem [10]. According to type of agent used green synthesis are of many types: Plants, microorganism, fungi, bacteria etc.
The method which involves microbes as its agent are very costly and hence not very economical. The fabrication method involving plants as its agents are cost effective. Thus, green synthesis improves catalytic efficiency and selectivity and is cost effective as well [11].

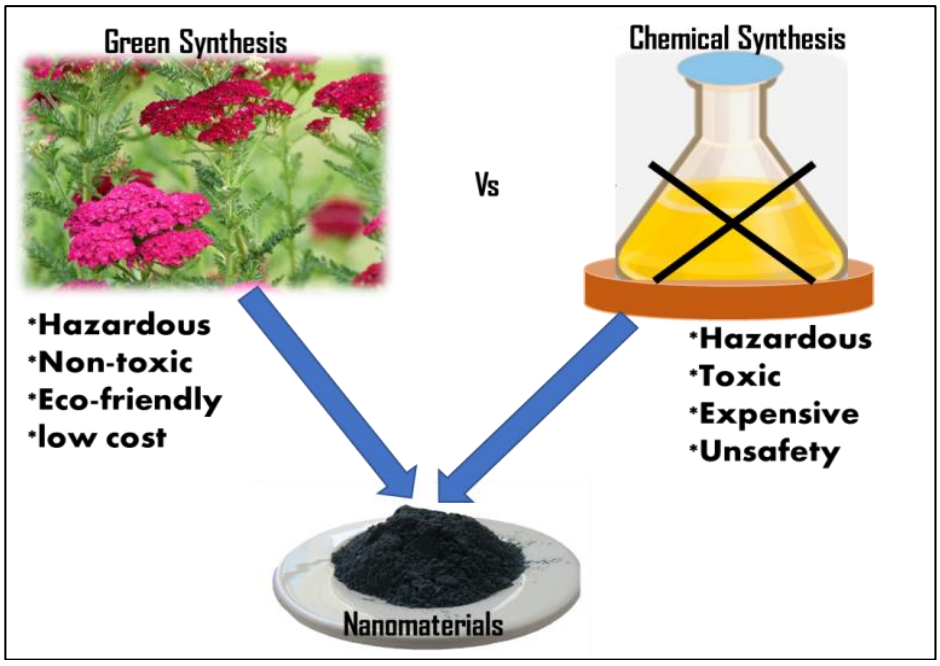

Fig 2: Green Vs Chemical synthesis for sustainable development

4. Conclusion

The worldwide sustainability challenges are becoming a complex and involve multiple interdependent areas. The best option for the remedies is the nanotechnology and it has emerged as a versatile are for the technological development. In present times, electronics, industry are enjoying various application of nanomaterials. In batteries, chips, fuel cells, photovoltaic cells, double layer capacitors, lasers etc which provide better efficiency for device sustainably. On the other hand, with an ever-growing population, the demand for food is also increasing at an alarming rate. The food needs to be approach interms of both quantity and quality food and also improve overall health of soil which makes nanomaterials a better choice for sustainable development.
Smart materials by using nanotechnology are manufactured that respond to specific temperature and size change. Nano building are constructed for residential, commercial, hospitality, military purposes which are not only user friendly [in terms of safety, comfort, self-cleaning, high living standard] but are environment friendly as well. Apart from these nuclear plants in some countries are also constructed by using nanotechnology and nanomaterials. Finally, we hope that nanotechnology could be a critical component of sustainability development to offer the potential application in different field.

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