**International Journal of Research in Engineering and Applied Sciences (IJREAS)**

Vol. 6 Issue 9, September 2016, pp. 5~14

ISSN(O): 2249-3905, ISSN(P) : 2349-6525 | Impact Factor: 6.573 | Thomson Reuters ID: L-5236-2015

# *STUDY OF NANOMATERIALS AND THEIR APPLICATIONS*

**Er.Harpreet Kaur Channi**

Assisstant Professor,

Department of Electrical Engineering

Chandigarh University Gharuan, Mohali India

## Abstract

Nano science and innovation is the present day world idea which depends on the exploration of small molecule inside the size extent no less than one measurement estimated from 1 to 100 nanometers. Nonmaterial are material science based way to deal with nanotechnology. In nano scale size all materials have a significant substantial surface zone to volume proportion. This single trademark clears route for new quantum mechanical impacts. Because of these impacts the span of the molecule decreases, which causes an adjustment in the electronic properties of the strong. At the point when the span of the material gets to be miniaturized scale, there won't be any impedance of the quantum impact. Be that as it may, the impact will begin its play when the material gets to be nano-sized. There will be changes in the physical and chemical exercises of the material. When the material changes from large scale to nano-scale accordingly, it is comprehended that there is a radical change in properties. These progressions can be exceptionally one of a kind and can be utilized for an assortment of uses. This paper gives a study of different nonmaterial and their applications.

***Keywords:*** *tiny; electronic; micro; interference; catalytic; drastic*

## I. INTRODUCTION

The term nanomaterial incorporates all nano sized materials that can be built or found in nature. Nanotechnology can be depicted as the innovation of composite utilitarian frameworks at the nano size of the materials. Nanotechnology manages creation and control of the matter on a nuclear, sub-atomic and supra molecular level. Supramolecular structure is vast atoms which are conglomerated with littler particles. Nanotechnology is going to cut a corner in wide and broadened field of science including miniaturized scale manufacture, semiconductor, surface science, medicine and natural science and so forth as appeared in fig 1.They are imperative since they show one of a kind properties which are essentially not quite the same as their traditional mass partner. The National Nanotechnology Initiative (NNI) depicts the property of nanomaterials as "At the nanoscale, the synthetic, the physical and organic properties of materials contrast in principal and significant courses from the properties of individual particles or mass matter and atoms.

## II. LITERATURE SURVEY

**R. Khademolhosseini et. al [1]** portrayed that as of late use of nano/bio materials for upgraded oil recuperation (EOR) has been inspected by couple of analysts, however there exists vague ideas about synchronous infusion of nano-particles/biomaterials. In this manner, in this study they investigated heavy oil removal systems utilizing synchronous infusion of nano silica/bio-surfactant in a glass micro model. To better outline the impact of nano/bio material diverse flooding situations containing refined water, nano silica/refined water, biosurfactant/refined water and nano silica/biosurfactant/refined water have been directed.

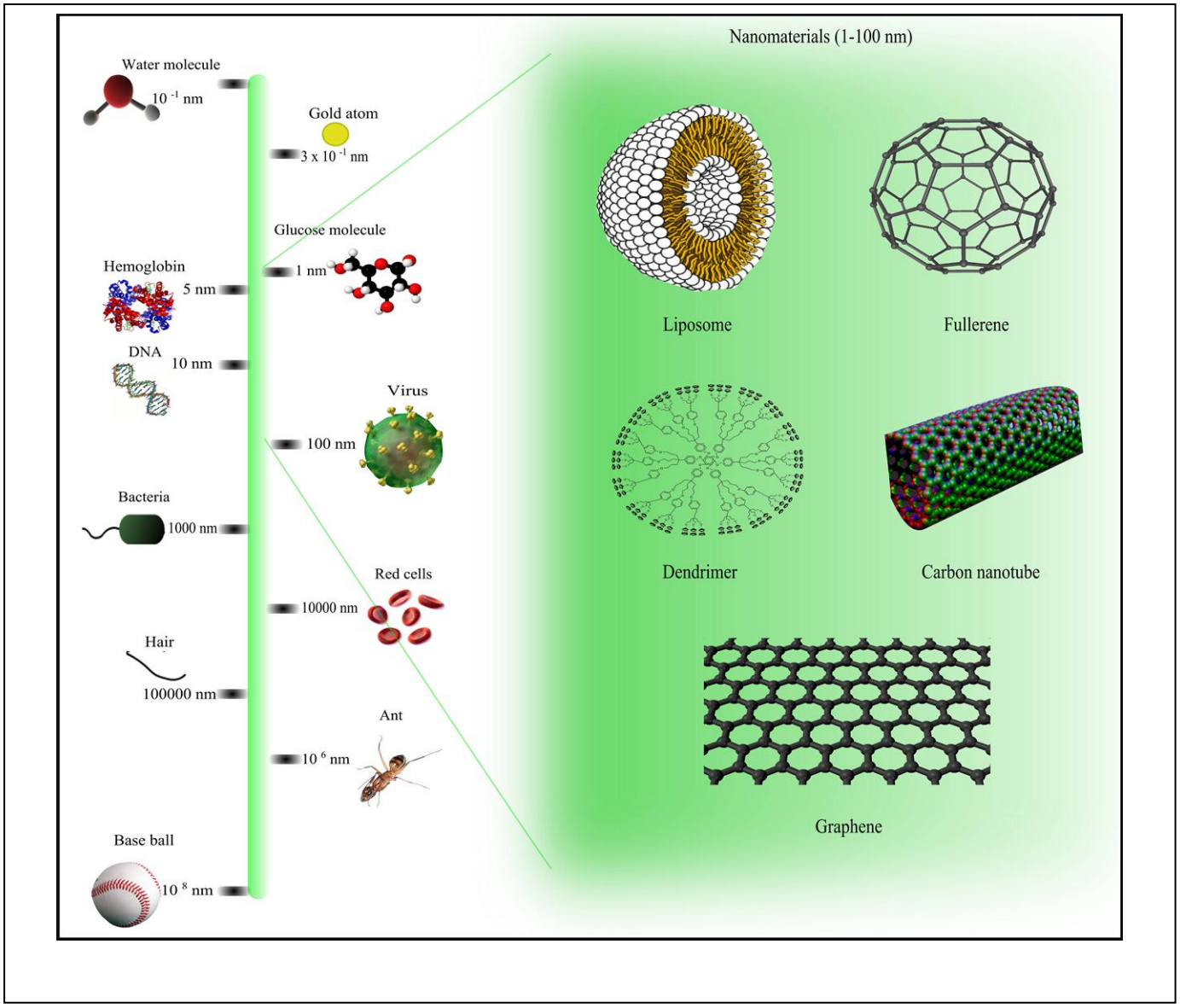


Fig. 1 Natural Nanomaterials (Source: en.wikipedia.org)

Test results showed that concurrent nearness of nanoparticles and bioproducts have collaboration on each other and in view of IFT decrease, enhancing the portability proportion and expanding the infused liquid consistency; the oil recuperation can be accomplished around 58%. Moreover, nanoparticles can play as an inhibitor to maintain a strategic distance from asphaltene precipitation.

**Sudipta Naskar et. al [2]** clarified that bond based cement can be supplanted by low calcium fly-cinder based geopolymer concrete with respect to the unfavorable impact of the assembling of conventional Portland concrete on environment. These days, nano innovation has an essential part in the field of development businesses. It has been seen that few properties of bond based cement are affected by various nano materials. As low calcium fly-slag based geopolymer cement is an alternate choice for bond based cement, nano materials may likewise have impact on it. A trial program has been taken up on low calcium fly-fiery debris based M25 review geopolymer concrete having 16 (M) grouping of activator fluid. Diverse percentage of nanomaterials viz. nano silica, carbon nano tube, titanium di-oxide were used to investigate the impact of nano materials on geopolymer concrete. Geopolymer concrete with 1% titanium dioxide demonstrates calculable change in compressive quality despite the fact that pH remains almost same in all cases.

**Hongjian Du et.al [3]** examined the strength properties of cement containing nano-silica at measurements of 0.3% and0.9%, individually. Because of the nano-filler impact and the pozzolanic response, the microstructure became more homogeneous and less permeable, particularly at the interfacial move zone (ITZ), which drove to reduced penetrability. Tests on the strength properties checked the useful impacts of nano silica. The channels for unsafe operators through the concrete composites were incompletely filled and blocked. The pore size dissemination additionally demonstrated that the extensive slender pores were refined by the nano-silica, because of the consolidated commitment of the nano-filler impact and the pozzolanic response.

**Bibhuti Bhusan Mukharjee and Sudhirkumar V. Barai [4]** gave examination that arrangements the investigation of compressive quality and attributes of the Interfacial Transition Zone (ITZ) of cement containing reused totals and nano-silica. For this reason, compressive quality at 7, 28, 90 and 365 days are resolved for completely normal and reused total cement blends made with or without nano-silica. Notwithstanding above, Vickers miniaturized scale hardness test and backscattered-mode filtering electron minute investigation is conveyed to describe ITZ of cement blends. The consequences of study portrayed that full supplanting of normal coarse totals with reused ones have noteworthy impact on compressive quality and ITZ attributes of cement. Be that as it may, compressive quality and microstructure of cement blends enhances with the fuse of nano-silica.

## III. CLASSIFICATION OF NANOMATERIALS

Nanomaterials can be characterized principally into two sorts: Natural nanomaterials and misleadingly manufactured nanomaterials.

*A. Natural nano materials*: These incorporate nano materials that exist in natural frameworks; eg: viruses (capsid), substances in our bone network, and so forth as appeared in fig. 2.

*B. Artificial nano materials:* These are the ones that are created by various analyses. They can promote sub-isolated into 4 classes:

1. *Carbon Based:* These nano materials are made for the most part out of carbon, most regularly taking the type of an empty circles, ellipsoids, or tubes. Circular and ellipsoidal carbon nano materials are alluded to as fullerenes, while tube shaped ones are called nanotubes (carbon nanotubes (CNTs). These particles have numerous potential applications, including enhanced movies and coatings, more grounded and lighter materials, and applications in gadgets.

*2. Metal Based:* These nanomaterials incorporate quantum specks, nanogold, nanosilver and metal oxides, for example, titanium dioxide. A quantum spot is a firmly pressed semiconductor precious stone involved hundreds or a great many molecules, and whose size is on the request of a couple of nanometers to a couple of hundred nanometers. Changing the span of quantum dabs changes their optical properties.

3. *Dendrimers:* These nanomaterials are nanosized polymers worked from spread units. The surface of a dendrimer has various chain closes, which can be custom-made to perform particular concoction capacities. This property could likewise be valuable for catalysis. Likewise, in light of the fact that three-dimensional dendrimers contain inside depressions into which different atoms could be set, they might be valuable for medication conveyance.

4. *Composites:* Composites consolidate nanoparticles with different nanoparticles or with bigger, mass sort materials. The composites might be any mix of metal based, carbon based or polymer based nanomaterials with any type of metal, fired, or polymer mass materials.

Fig. 2 Natural Nanomaterials (Source: nanoyou.eu )

## IV. NANOMATERIAL SHAPES

As per the measurements nanomaterials can be isolated into zero dimensional, one dimensional, two dimensional and three dimensional nano materials as shown in fig.3.

A. *Zero dimensional (0-D):* These nanomaterials have Nano- measurements in all the three bearings. Metallic nanoparticles including gold and silver nanoparticles and semiconductor, for. example, quantum specks are the ideal case of this sort of nano particles.

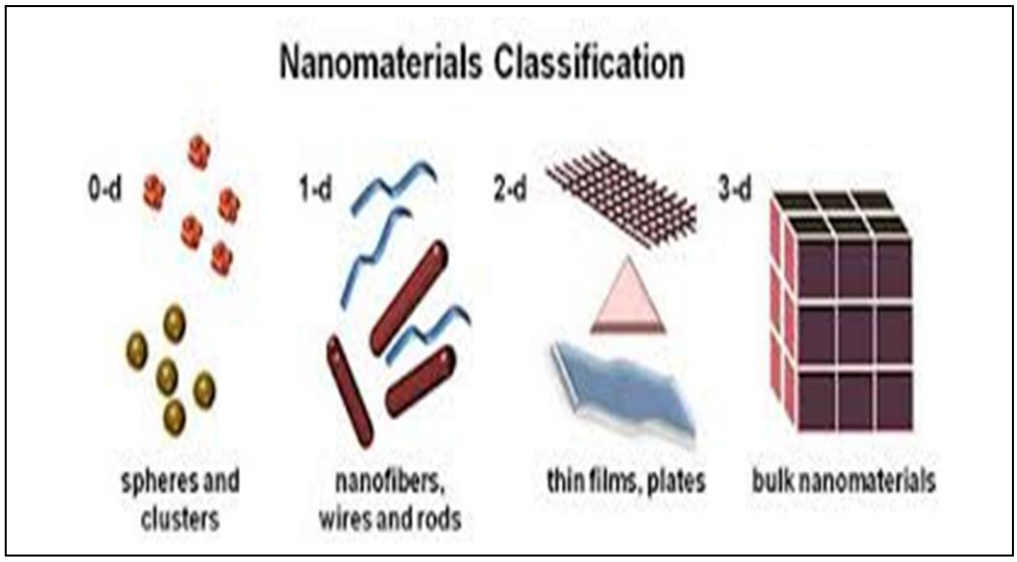


Fig. 3 Different dimensional Nanomaterials (Source: nanoyou.eu)

The majority of these nano particles are round in size and the breadth of these particles will be in the 1-50 nm range 3D squares and polygons shapes are likewise found for this sort of nanomaterials.

*B. One dimensional(1-D):* In these nanostructures, one measurement of the nanostructure will be outside the nanometer range. These incorporate nanowires, nanorods, and nanotubes. These materials are long (a few micrometer long), yet with measurement of just a couple nanometer. Nanowire and nanotubes of metals, oxides and different materials are couple of case of this sort of materials.

*C. Two dimensional(2-D):* In this sort of nanomaterials, two measurements are outside the nanometer range. These incorporate distinctive sort of Nano movies, for example, coatings and meager film-multilayers, nano sheets or nano-dividers. The region of the nano movies can be expansive (a few square micrometer), however the thickness is dependably in nano scale range.

D. *Three Dimensional(3-D):* All measurements of these are outside the nano meter range. These incorporate mass materials made out of the individual pieces which are in the nanometer scale (1-100 nm).

## V. NANOMATERIALS AND THEIR APPLICATIONS

A. *Nanomaterial Applications utilizing Carbon Nanotubes*

Applications being created for carbon nanotubes incorporate adding antibodies to nanotubes to frame microorganisms sensors, making a composite with nanotubes that curve when electric voltage is connected twist the wings of transforming airplane, adding boron or gold to nanotubes to trap oil slicks, incorporate littler transistors, covering nanotubes with silicon to make anodes the can expand the limit of Li-particle batteries by up to 10 times..

*B. Nanomaterial Applications utilizing Graphene*

Applications being created for graphene incorporate utilizing graphene sheets as electodes as a part of ultra capacitors which will have as much stockpiling limit as batteries yet will have the capacity to revive in minutes, joining strands of DNA to graphene to frame sensors for fast ailment diagnostics, supplanting indium in level screen TVs and making high strength composite materials.

*C. Nanomaterial Applications utilizing Nanocomposites*

Applications being created for nanocomposites incorporate a nanotube-polymer nanocomposite to frame a framework which speeds up substitution of broken bones, making a graphene-epoxy nanocomposite with high strenght-to-weight proportions, a nanocomposite produced using cellulous and nanotubes used to make an adaptable battery.

*D. Nanomaterial Applications utilizing Nanofibers*

Applications being created for nanofibers incorporate fortifying the generation of ligament in harmed joints, piezoelectric nanofibers that can be woven into dress to deliver electricty for mobile phones or different gadgets, carbon nanofibers that can enhance the preformance fire retandant in funiture.

*E. Nanomaterial Applications utilizing Nanoparticles*

Applications being produced for nanoparticles incorporate convey chemotherapy sedates specifically to growth tumors, resetting the resistant framework to anticipate immune system maladies, conveying medications to harmed districts of supply routes to battle cardiovascular illness, make photocatalysts that create hydrogen from water, lessen the expense of delivering energy components and sun based cells, tidy up oil slicks, water contamination and air contamination. Look at our Applications of Nanoparticles page to perceive how nanoparticles are being utilized.

*F. Nanomaterial Applications utilizing Nanowires*

Applications being created for carbon nanotubes incorporate utilizing zinc oxide nanowires as a part of an adaptable sun oriented cell, silver chloride nanowires to disintegrate natural atoms in contaminated water, utilizing nanowires produced using iron and nickel to make thick PC memory - called "race track memory.

## VI. PROPERTIES OF NANOMATERIALS

*A. Magnetic properties:*

- Magnetic nanoparticles are utilized as a part of a scope of uses like imaging, bioprocessing, refrigeration and in addition high stockpiling thickness attractive memory media.

- The extensive surface region to volume proportion results in a considerable extent of particles having diverse attractive coupling with neighboring molecules prompting contrasting attractive properties.
- Bulk gold and platinum are non attractive however at the nano size they go about as magnetic particles. Au nanoparticles get to be ferromagnetic when they are topped with the fitting particles, for example, thiol.

- Giant magnetoresistance(GMR) is a marvel saw in nanoscale multilayers comprising of solid ferromagnet (Fe,Co,Ni) and a weaker attractive or non attractive support (Cr,Cu).It is typically utilized in information stockpiling and detecting [5].

*B. Optical properties:*

- In little nano bunches the impact of diminished dimensionality on electronic structure has the most significant impact on the energies of most elevated involved sub-atomic orbital (HOMO) which is valence band and the least vacant sub-atomic orbital(LUMO),essentially the conduction band.

- The optical emanation and adsorption happens when the move of the electrons happen between these two states.

- Semiconductors and numerous metals indicate vast changes in optical properties, for example, shading, as an element of molecule size.

- Colloidal tension of gold nano particles have a dark red shading which turns out to be dynamically more yellow as the molecule size increments. Gold circles of 10-20 nm display red shading. Gold circles of 2-5nm display yellow shading. Gold circles of >20nm show purple shading. Thus, Silver particles of 40nm display blue shading. Silver particles of 100nm display yellow shading. Crystal molded Silver particles red shading. Other properties which may be affected by reduced dimensionality include photo catalysis, photocond-uctivity, photoemission and electroluminescence.

*C. Electronic properties:*

- The changes which happen in electronic properties as the framework length scale is diminished are connected mostly to the expanding impact of the wave-like property of the electrons (quantum mechanical impacts) and the shortage of diffusing focuses.

- As the span of the framework gets to be practically identical with the de Broglie wavelength of the electrons, the discrete way of the vitality states gets to be obvious by and by, in spite of the fact that a completely discrete vitality range is just seen in frameworks that are restricted in every one of the three measurements.

- In certain cases, directing materials get to be covers beneath a basic length scale, as the vitality groups stop to cover. Attributable to their inherent wave-like nature, electrons can burrow quantum mechanically between two firmly nearby nanostructures, and if a voltage is connected between two nanostructures which adjusts the discrete vitality levels in the DOS, resounding burrowing happens, which unexpectedly builds the burrowing current.

- Conduction in exceptionally restricted structures, for example, quantum spots, is extremely touchy to the nearness of other charge transporters and consequently the charge condition of the speck.

- These Coulomb bar impacts result in conduction forms including single electrons and thus they require just a little measure of vitality to work a switch, transistor or memory component.

- All these wonders can be used to deliver drastically distinctive sorts of segments for electronic, optoelectronic and data handling applications, for example, full burrowing transistors and single-electron transistors.

*D. Chemical Properties:*

Synthetic properties of nanomaterials additionally change at nanoscale. As the rate of surface particles in nanoparticles is expansive contrasted and mass articles, thusly reactivities of nanomaterials are more than mass materials. The accompanying are the portion of the compound properties are:

- The dominance of surface is a noteworthy explanation behind the adjustment in conduct of materials at the nanoscale. As up to half of the considerable number of atoms in nanoparticles are surface molecules, properties, for example, electrical transport are no more controlled by strong state mass marvel.
- The atoms in nanomaterials have a higher normal vitality than molecules in longer structures, in view of the bigger extent of surface particles. For instance, synergist materials have a more prominent compound action per molecule of uncovered surface as the impetus is lessened in size at the nanoscale.
- Defects and polluting influences might be pulled in to surfaces and interfaces, and connections between particles at those little measurements can rely on upon the structure and nature of synthetic holding at the surface.
- Molecular monolayers might be utilized to change or control surface properties and to intercede the connection between nanoparticles.

## VII. CONTEMPORARY SCENARIO OF NANOTECHNOLOGY DEVELOPMENT IN INDIA

The Indian nanotechnology activity is a multi-organization exertion and has solid likeness with US multi-office model. The key offices that have embraced real activities for limit creation are the Department of Science and Technology (DST) and Department of Information Technology (DIT). Different offices demonstrating significant association are the Department of Biotechnology (DBT), Council of Scientific and Industrial Research (CSIR), Ministry of New and Renewable Energy, Ministry of Health and Family Welfare, Indian Council of Agricultural Research, Indian Space Research Organization, Department of Atomic Energy, and Defense Research and Development Organization. Nanotechnology as an unmistakable territory of government examination support began with NSTI (Nano Science and Technology Initiative) in the Xth arrangement period (2001-2006) with an allotment of rupees 60 crores (approx. USD 12 million). NSTI was started and executed by the DST [6].

- NSTI helped in setting up units for creating research greatness in nanoscience, habitats for nanotechnology each went for application advancement and two national instrumentation/portrayal offices. On the whole, fourteen national foundations, including seven IITs and ten colleges have been bolstered under the NSTI.
- Different exploratory divisions/organizations likewise have their own assignments for nanoscience and innovation programs/exercises as appeared in fig 4. They have guided center to target key zones: for instance DIT (Nanoelectronics), DBT (Nano-Medicine), CSIR (Energy, Metrology, and Nanomedicine/Pharmaceutical), ARCI (Water, Textile, Smart Materials), NIPER (Nano-Pharmaceutical, Toxicology.

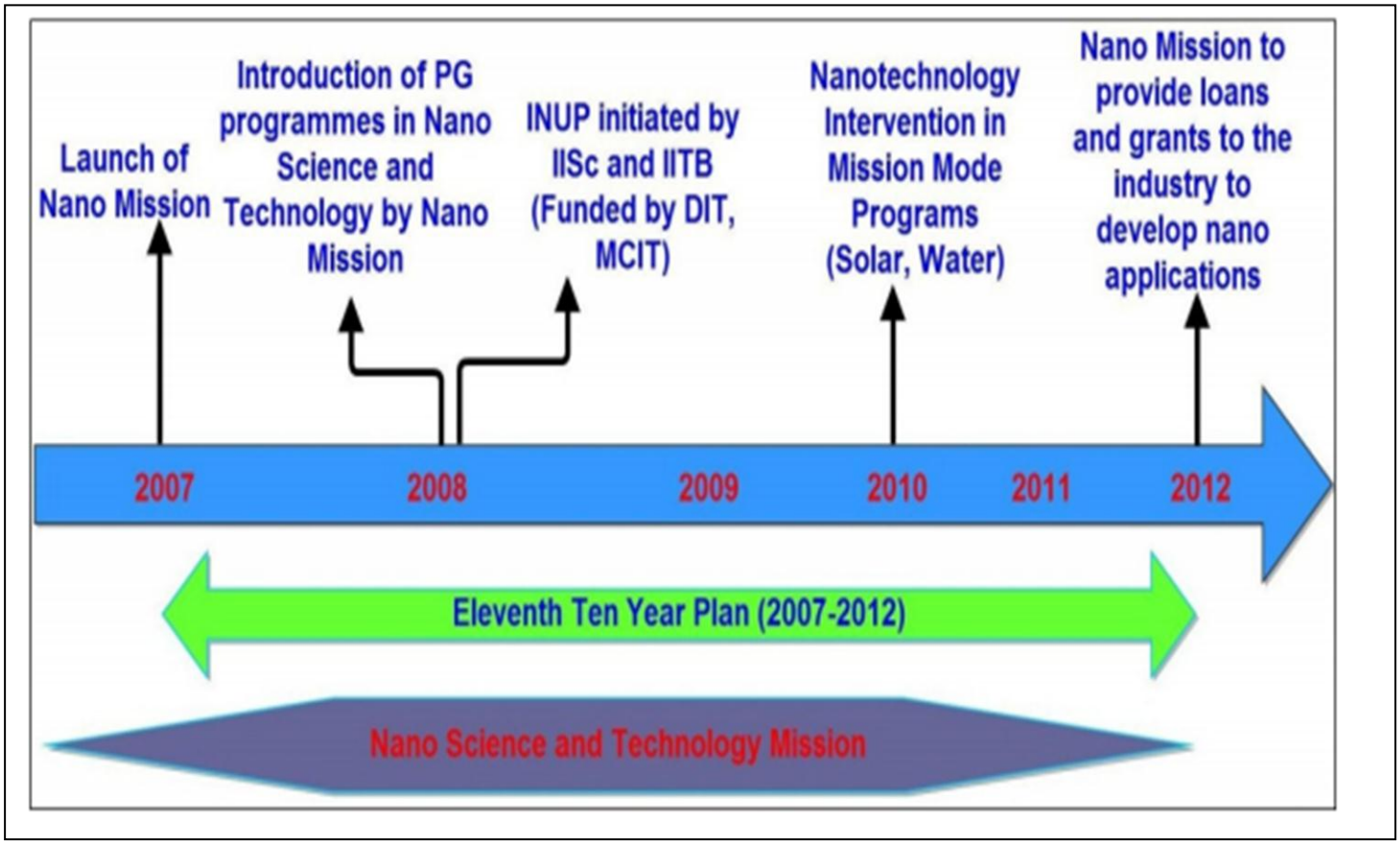


Fig 4 : Major Initiatives in Nanotechnology 2007-2012(Source: http://www.nistads.res.in/)

## VIII. CONCLUSIONS

The interesting properties of these different sorts of purposefully delivered nanomaterials give them novel electrical, synergist, attractive, mechanical, warm, or imaging includes that are very alluring for applications in business, medicinal, military, and natural parts. These materials may likewise discover their way into more intricate nanostructures and frameworks. As new uses for materials with these unique properties are

distinguished, the quantity of items containing such nanomaterials and their conceivable applications keeps on developing.

## REFERENCES

[1] R. Khademolhosseini, A. Jafari, M. H. Shabani, "*Micro Scale Investigation of Enhanced Oil Recovery Using Nano/Bio Materials*"5th International Biennial Conference on Ultrafine Grained and Nanostructured Materials, UFGNSM 15, Procedia Materials Science 11 ( 2015 ), pg no. 171 – 175.

[2] Sudipta Naskar, Arun Kumar Chakraborty, *"Effect of nano materials in geopolymerconcrete"* Perspectives in Science (2016) Science Direct.

[3] Hongjian Du, Suhuan Du , Xuemei Liu, *"Durability performances of concrete with nano-silica*" Construction and Building Materials 73 (2014) pg no. 705–712.

[4] Bibhuti Bhusan Mukharjee , Sudhirkumar V. Barai, "*Influence of incorporation of nano-silica and recycled aggregates on compressive strength and microstructure of concrete*" Construction and Building Materials 71 (2014) pg no. 570–578.

[5] Mohamed Amin , Khaled Abu el-hassan, *"Effect of using different types of nano materials on mechanical properties of high strength concrete"* Construction and Building Materials 80 (2015) 116–124.

[6] S. Abdalla, F. Al-Marzouki , A. Obaid , S. Gamal "Action of colloidal silica films on different nano-composites" Results in Physics 6 (2016) 209–214.

[7] http://en.wikipedia.org/

[8] http://nanoyou.eu/

[9] http://www.nistads.res.in/