International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 8, August-2018

NANO ENGINEERING OF MATERIALS AND SURFACES

PRASAD GAMPALA[1], MOVVA BASAVA NAGALAKSHMI[2], VIGNALA MAHALAKSHMI[3]

[1,2,3]*Asst. Professor, Dept. of ME, VSM College of Engineering, Ramachandrapuram*

Abstract

Nano composites are multicomponent materials where one of the components is a nano-scale addition. The purpose of this special issue is to publish high-quality research papers as well as review articles addressing recent advances on nano composites with reinforcements or matrices, inter alia, of nano allotropes of carbon as well as nanotubes and graphen, mineral nanotubes, nanowires, nano bushes, nanoparticles, nano-powders, nano frames, and alternative morphological forms.

Nano technology:

The world is presently watching the advancement and development of a brand new multidisciplinary branch of technology, which is named as "Nanotechnology." As it deals with Nano scalegeometries. The ideas that seeded applied science for the 1sttime in 1959 by noted scientist Richard Phillips Feynman in his speak (Feynman 1961):

In that period, applied science said the likelihood of synthesis via direct manipulation of atoms and molecules for fabrication of macroscale merchandise. Within 1990, K. Eric Drexler and M. Minsky used the word "nanotechnology" in their book "Engines of Creation: the approaching Era of Nanotechnology" (Drexler and Minsky 1990), within which they planned grouping machines and devices on the size of molecules, many nanometers wide. Later on, as applied science became associate degree accepted the thought, then that means of the word shifted to comprehend technologies associated with creating any form of materials, structures, and devices in metric linear unit scale. A nanometer (nm) is one-billionth of a meter, hundred-thousandth the width of a human hair. There is a multidisciplinary convergence of science dedicated to the study of a world in such small scale. The North American nation National applied science Initiative (Roco 2011) has represented four generations of applied science development. the primary era may be a style of passive nanostructures and materials to perform only one task like nanostructured metals, aerosol. The second section ventured active nanostructures for multitasking, for instance, actuators, drug delivery devices, and sensors. The third generation featured Nano-systems, a kind of complex systems with thousands of interacting parts of nano scale. During this era, integrated nanosystems, hierarchic systems at intervals systems, are developed.

Scientists presently dialogue the longer term implications of applied science. applied science is also able to produce several new materials and devices with an enormous variety of applications, like in nanomedicine, nano physical science, biomaterials energy production, and shopper merchandise. On the opposite hand, applied science raises several of similar problems as any new technology, as well as considerations concerning the toxicity and environmental impact of nanomaterials, and their potential effects on international economic science, still as speculation concerning numerous doomsday eventualities. These considerations have crystal rectifier to a dialogue among support teams and governments on whether or not special regulation of applied science is secure.

Application of Nanotechnology in Different Fields:

The expectations from technology as a key technology of the present century for innovative merchandise and new market potentials area unit high. a number of these potential applications of nanotechnology-based merchandise area unit bestowed during this section.

- Nanotechnology in Biotechnology
- Nanotechnology in oil Industries
- Nanotechnology in Material Science
- Nanotechnology in biological science
- Nanotechnology within the Energy Sector
- Nanotechnology in alternative Specific Fields

Dwelling Nanotechnology into Nano engineering:

Commercial production and applications of nanostructure materials (nanomaterials) have not yet been completely taken shape .A great majority of scientists and engineers are attempting to resolve the challenges posed by synthesis, processing, application, purification and characterization of these new materials. The innovations and developments in these aspects of the nanomaterials are fueled by the progress in all fields of engineering, science and technology. However, development and improvement in the nanomaterials production in large scale lie on engineering principles, in a specific manner on chemical engineering. For instance, design of new manufacturing processes of effective catalysis and improved separation and purification methods will pave the road for commercial production of nanostructures. In addition, simulation and modeling of processes help to understand and hence to optimize the process including chemical reactions and regeneration cycle systems. Although processes applied for synthesis of nanostructures are somehow complicated, these complex processes can be dynamically simulated and optimized with the aid of computer. The key parameters of processes determined from models can be applied in practice to control the process, for instance, to produce even more quality in the end products. Accordingly, development of theoretical framework as well as advanced engineering knowledge to increase understanding of structures and behaviors of nanostructures is strongly required. Besides, a practical framework capable of new process design and improvement in the performance or controlling the existing processes are vital. In this respect, an integrated program comprised of theoretical model accompanied with numerical or analytic solution of the model equations, and comparison with experimental data on both dynamics and structure of such systems is essential.

Nano engineering:

Nanoengineering is the application of engineering on the nanoscale. It gets its name from the micromillimetre, a unit of measuring equal to one billionth of a meter. Nanoengineering is basically an equivalent word for engineering, however, emphasizes the engineering instead of the pure science aspects of the sector.

The first nanoengineering program was started at the University of Toronto within the subject field program in the concert of the choices of study within the final years. In 2003, the city Institute of Technology started a program in Nanoengineering. In 2004, the faculty of Nanoscale Science and Engineering at SUNY engineering school was established on the field of the University at Albany. In 2009, the University of Toronto began giving all choices of study in subject field as degrees, conveyance the second nanoengineering degree to a North American nation. Rice University established in 2016 a Department of Materials Science and NanoEngineering (MSNE). DTU Nanotech - the Department of Micro- and engineering - may be a department at the Technical University of the Scandinavian nation established in 1990.

In 2013, Wayne State University began giving a Nanoengineering college boy Certificate Program that is funded by a Nanoengineering college boy Education (NUE) grant from the National Science Foundation. The primary goal is to offer specialized undergraduate training in nanotechnology. Other goals are:

1) To teach emerging technologies at the undergraduate level,

2) To train a new adaptive workforce

3) To retrain working engineers and professionals.

Nano engineering Techniques:

- Scanning tunneling microscope (STM) - Can be used to both image, and to manipulate structures as small as a single atom.
- Molecular self-assembly - discretional sequences of a polymer will currently be synthesized cheaply in bulk, and accustomed produce custom proteins or regular patterns of amino acids. Similarly, polymer strands will bind to alternative polymer strands, permitting easy structures to be created.

Nano materials:

Nanostructures defined as materials with at least one dimension of their structure in the nanometer scale. Nanostructures possess new and unique chemical and physical properties compared to their corresponding bulk or isolated atoms and molecules. Nanostructures have a limited number of atoms (or molecules) in which their arrangement can be controlled during synthesis. Therefore, their chemical, mechanical, optical, electronic and magnetic properties of nanostructures can be significantly altered. For example, the color or absorption spectrum changes dramatically with size when the size is small compared to the de Broglie wavelength or the Bohr excitation radius of the electron (Cao 2004). When a metal particle such as gold is smaller than 10 nm, it essentially exists in a state that is neither liquid nor solid. When a common liquid such as water is confined to a space that is only a few nanometers in dimension (for example, when water flows in a nano-channel), its properties are significantly different from those of the liquid water and solid ice that we are familiar with (Cao 2004).

The technological importance of these nanostructures is well demonstrated in various applications, including in catalytic process, biotechnology, and medical and biomedical, photonic, energy-storage, etc. It is worth mentioning that the nanostructures properties are dependent not only on size but also on morphology and spatial organization. Factors like microstructures of nanoparticles, their size distribution, order of orientation, presence of defects and contaminants also significantly change the suitability of a nanostructure for integration of any material or devices. Accordingly, the feature size, shape of nanostructures and its purity need to be well controlled to attain the properties and functions that have been already established.

The nanomaterials field includes many subfields that are developed by study materials having distinctive properties arising from their nanoscale dimensions.

- Nanomaterials with quick particle transport square measure connected conjointly to nanoionics and nanoelectronics.
- Nanoscale materials also can be used for bulk applications; most current industrial applications of applied science square measure of this flavor.
- Progress has been created in victimization these materials for medical applications; see Nanomedicine.
- Nanoscale materials like nanopillars square measure generally utilized in star cells that combat the value of ancient atomic number 14 star cells.

Nano surfaces:

Surface engineering of silicon nanoparticles NPs made of silicon (Si-NPs) that exhibit quantum confinement properties (attractive for optoelectronic conversion and particularly for photovoltaic applications . Si-NPs also present many advantages that include low toxicity, abundance in nature and possibility of carrier multiplication . As a consequence, the study and understanding of the synthesis and surface engineering of Si-NPs is an important step to produce Si-NPs with accurately controlled properties. Among other techniques (e.g.,), Si-NPs can be derived from porous silicon: Canham discovered in 1990 that porous silicon, which consists of nano-scale crystalline particles, exhibits efficient photoluminescence (PL) at visible wavelengths. After this discovery there has been a considerable amount of research for the development of Si-NPs and their integration in application devices . However, a few basic challenges still need to be resolved to make Si-NPs functional elements for efficient optoelectronic conversion; in particular, an in-depth understanding and control of Si-NPs surface characteristics is of paramount importance. Surface terminations have a drastic impact on the excitonic dissociation, carrier transfer and energy band gap ..have shown the possibility of Si-NPs surface engineering by AMP processing or by laser fragmentation in liquid . Specifically, laser fragmentation in water has proved that the hydrophobic character of SiNPs can be changed to hydrophilic and this is thanks to induced surface chemistry in the laser-based process.

The AMP system shown in Figure 4a has been used here to modify the surface characteristics of Si-NPs that were pre-synthesized by electrochemical etching. Si-NPs were first produced by electrochemical etching of a silicon wafer (p-type boron doped, 100, 0.1–0.3 Ω cm, thickness 0.525 mm) followed by mechanical pulverization yielding a powder of Si-NPs . Si-NPs have then been collected and exposed to air at ambient conditions for about 24 h. The Si-NPs (2.5 mg) have then been added to 5 mL of water, however due to the hydrogen terminations, the SiNPs are highly hydrophobic and do not disperse in water remaining at the water-air interface. The helium flow was 10 sccm and the distance between the stainless-steel tubing and the liquid surface was initially adjusted at 0.9 mm. A Ni wire of ∼2 mm diameter was used as the anode immersed in the solution. Microplasma processing has been applied for three times, each time for 20 min of continuous processing. The voltage was initially set at 1.9 kV with a current of ∼5 mA. After the AMP treatment the Si-NPs have been found to disperse in water as shown in Figure 8b.

The FTIR measurements of Si-NPs before and after microplasma processing. Electrochemically etched Si-NPs show typical surface characteristics with absorption peaks related to various Si-Hx bonds (around 600 cm−1 and around 2150 cm−1). It can be observed that in the same ranges, the microplasma-treated Si-NPs do not exhibit Si-Hx vibration peaks which indicates the absence of H-terminations. On the other side, the broad peak around 3300 cm−1 that is associated with the O-H bonds is more pronounced and suggests the formation of a back-bond oxide thin layer at the surface.

Absorption measurements for SiNPs before processing were however wetted with ethanol first to allow for easier dispersion in water. The broad shoulder absorption peak of the Si-NPs around 385 nm without microplasma processing (red line, bottom graph) is indicative of surface defect states possibly caused by strained bonds and/or Si-dimers. After microplasma processing, the broad absorption tail disappears due to surface passivation of defects and by replacing H-terminations and Si-dimers with oxygen and OH-terminations. Possibly the oxide has also progressed to reduce the core of the Si-NPs producing a peak shift toward UV. The microplasma process provides a way to accelerate and control the surface oxidation process which would otherwise form undesired surface defects.

Advanced Nano engineering Materials:

Nanocomposites are multicomponent materials where one of the components is a nanoscale addition. The purpose of this special issue is to publish high-quality research papers as well as review articles addressing recent advances on nanocomposites with reinforcements or matrices, inter alia, of nano allotropes of carbon as well as nanotubes and graphene, mineral nanotubes, nanowires, nano bushes, nanoparticles, nanopowders, nano frames, and alternative morphological forms. Expected nontypical properties result from the mixture of every element.

Nanocomposites are classified as follows:

MMNC (Metal matrix nanocomposites), CMNC (Ceramic matrix nanocomposites), and PMNC (chemical compound matrix nanocomposites).In order to enhance the properties of those materials nanomaterial reinforcements are introduced , as well as mineral , nanowires, nano bushes, nanoparticles, nanopowders, carbon nanotubes, carbon nano allotropes and nanoframes. Nanoreinforcements will have completely different morphological forms and in terms of their form is, inter alia, linear, plate, and powder.These nanoreinforcements can implement or improve mechanical, thermal, optical, electrical, electronic, optoelectronic, magnetic, and catalytic properties, hydrophobic and hydrophilic balance, chemical stability, biocompatibility, specific properties for application in sensorics, medicine, and dentistry, and photovoltaics, for fuel cells and more. In terms of interests, there are also films and thin films composed of the aforementioned materialographic structure components, which together form layered composite materials. These materialographic structure components may also be a reinforcing matrix by others of them such as carbon nanotubes decorated with precious metal nanoparticles. Those are more sophisticated and tailored to the needs of research using the most advanced methods to harness all of the emerging opportunities ahead of this highly innovative group of nanostructured composite materials.

Original, high quality contributions that are not yet published or that are not currently under review by other journals or peer-reviewed conferences are sought.

Potential topics include but are not limited to the following:

- Designing of new kinds of nanocomposites and products using advanced informatics technologies and artificial intelligence methods
- Obtaining the advanced technologies and processes of nanocomposites and products
- Application of advanced research methods of the structure and properties of nanocomposites
- The areas of applications of the advanced nanocomposites
- Development prospective of the advanced nanocomposites and their application areas

Advantages of Nanotechnology

- To enumerate the benefits and drawbacks of engineering, allow us to initial run through the great things this technology brings:
- Nanotechnology will truly revolutionize tons of electronic product, procedures, and applications.
- Nanotechnology may profit the energy sector. the event of simpler energy-producing, endoergic , and energy storage product in smaller and additional economical devices is feasible with this technology. Such things like batteries, fuel cells, and star cells will be designed smaller however will be created to be simpler with this technology.
- Another business which will enjoy engineering is that the producing sector that may want materials like nanotubes, aerogels, nano particles, and alternative similar things to supply their product with. These materials square measure typically stronger, additional sturdy, and lighter than people who aren't made with the assistance of engineering.
- In the medical world, engineering is additionally seen as a boon since these will facilitate with making what's known as sensible medicine. These facilitate cure individuals quicker and while not the facet effects that alternative ancient medicine have. you'll additionally realize that the analysis of engineering in drugs is currently specializing in areas like tissue regeneration, bone repair, immunity and even cures for such ailments like cancer, diabetes, and alternative life threatening diseases.

Conclusion

The technological importance of these nanostructures is well demonstrated in various applications, including in catalytic process, biotechnology, and medical and biomedical, photonic, energy-storage, etc. It is worth mentioning that the nanostructures properties are dependent not only on size but also on morphology and spatial organization. Factors like microstructures of nanoparticles, their size distribution, order of orientation, presence of defects and contaminants also significantly change the suitability of a nanostructure for integration of any material or devices. In this paper all the important topics are discussed breafly in the order of importance and relation.

REFERENCE

1) Narayan, R. J.; Kumta, P. N.; Sfeir, Ch.; Lee, D-H; Choi, D.; Olton, D. (2004). "Nanostructured Ceramics in Medical Devices: Applications and Prospects". JOM. 56 (10): 38–43. Bibcode:2004JOM....56j..38N. doi:10.1007/s11837-004-0289-x.
2) Jump up^ Kerativitayanan, Punyavee; Carrow, James K.; Gaharwar, Akhilesh K. (May 2015). "Nanomaterials for Engineering Stem Cell Responses". Advanced Healthcare Materials. 4(11): 1600–27. doi:10.1002/adhm.201500272. PMID 26010739.
3) Jump up^ Gaharwar, A.K.; Sant, S.; Hancock, M.J.; Hacking, S.A., eds. (2013). Nanomaterials in tissue engineering: fabrication and applications. Oxford: Woodhead Publishing. ISBN 978-0-85709-596-1.
4) Jump up^ Gaharwar, A.K.; Peppas, N.A.; Khademhosseini, A. (March 2014). "Nanocomposite hydrogels for biomedical applications". Biotechnology and Bioengineering. 111 (3): 441–53. doi:10.1002/bit.25160. PMC 3924876 . PMID 24264728.
5) Narayan, R. J.; Kumta, P. N.; Sfeir, Ch.; Lee, D-H; Choi, D.; Olton, D. (2004). "Nanostructured Ceramics in Medical Devices: Applications and Prospects". JOM. 56 (10): 38–43. Bibcode:2004JOM....56j..38N. doi:10.1007/s11837-004-0289-x.

6) Cho, Hongsik; Pinkhassik, Eugene; David, Valentin; Stuart, John; Hasty, Karen (31 May 2015). "Detection of early cartilage damage using targeted nanosomes in a post-traumatic osteoarthritis mouse model". Nanomedicine: Nanotechnology, Biology and Medicine. Elsevier. 11 (4): 939–946. doi:10.1016/j.nano.2015.01.011. Retrieved 25 July 2015.
7) Kerativitayanan, Punyavee; Carrow, James K.; Gaharwar, Akhilesh K. (May 2015). "Nanomaterials for Engineering Stem Cell Responses". Advanced Healthcare Materials. 4 (11): 1600–27. doi:10.1002/adhm.201500272. PMID 26010739.
8) Gaharwar, A.K.; Sant, S.; Hancock, M.J.; Hacking, S.A., eds. (2013). Nanomaterials in tissue engineering: fabrication and applications. Oxford: Woodhead Publishing. ISBN 978-0-85709-596-1.
9) Gaharwar, A.K.; Peppas, N.A.; Khademhosseini, A. (March 2014). "Nanocomposite hydrogels for biomedical applications". Biotechnology and Bioengineering. 111 (3): 441–53. doi:10.1002/bit.25160. PMC 3924876 Freely accessible. PMID 24264728.
10) Akia, M., Yazdani, F., Motaee, E., Han, D., &Arandiyan, H. (2014). A review on conversion of biomass to biofuel by nanocatalysts. Biofuel Research Journal, 1(1), 16–25.
11) Almao, P. P. (2012). In situ upgrading of bitumen and heavy oils via nanocatalysis. The Canadian Journal of Chemical Engineering, 90(2), 320–329.
12) Anandan, S., Pitchumani, S., Muthuraaman, B., &Maruthamuthu, P. (2006).
13) Heteropolyacid-impregnated PVDF as a solid polymer electrolyte for dye-sensitized solar cells. Solar Energy Materials and Solar Cells, 90(12), 1715–1720.
14) Antonovič, V., Pundiene, I., Stonys, R., Česniene, J., &Keriene, J. (2010). A review of the possible applications of nanotechnology in refractory concrete. Journal of Civil Engineering and Management, 16(4), 595–602.
15) "Welcome to Nanotechnology Engineering at UW". Department of Nanotechnology Engineering. Retrieved 2008-10-07.