IJARSCT ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252 Volume 2, Issue 7, June 2022

Nano Technology

Rohini Krishnagar Shinde[1], Mrs. Sarojini Vinay Naik[2], Ms. Archana Shatrughna Gaikwad[3]
Lecturer, Department of E&TC[1,2,3]
Pimpri Chinchwad Polytechnic, Pune, Maharashtra, India

Abstract: *Nanotechnology is the study of extremely small structures, having size of 0.1 to 100 nm.Nanotechnology is considered to be an enabling technology that is likely to have a great impact on our lives over the coming decades. Nanotechnology is truly interdisciplinary; it involves manipulating and controlling individual atoms and molecules to design and create new materials, nanomachines, and nano devices for application in all aspects of our lives. Recent advances and envisioned developments in enabling nanotechnology provide challenges to academia in educating and training a new generation of skilled engineers and competent scientists.Nanotechnology is the technology of manipulation of matter at the nano-meter scale,Nanotechnology has been applied in various sectors including electronics, medicine, diagnostics, military, food industry etc.*

Keywords: Nanocomposite, Nanotechnology, Exfoliated Clay, Polymer Layered Silicates, Economic Security, Nanotechnologies, Strategy, Development, Use, etc.

I. INTRODUCTION

The field of nanotechnology is one of the most popular areas for current research and development in all technical disciplines. This obviously includes polymer science and technology which covers a broad range of topics - microelectronics or nanoelectronics, polymer-based biomaterials, nanoparticle drug delivery, mini emulsion particles, fuel cell electrode polymer bound catalysts, layerby-layer self-assembled polymer films, electro spun nanofibers, imprint lithography, polymer blends and nanocomposites.

Polymer nanocomposites are materials in which nanoscopic inorganic particles are dispersed in an organic polymer matrix in order to significantly improve the performance properties of the polymer. For instance, the layer orientation, polymer-silicate nanocomposites exhibit stiffness, strength and dimensional stability in two dimensions. Due to nano-meter length scale which minimizes scattering of light, nanocomposites are usually transparent. Polymer nanocomposites represent a new alternative to conventionally filled polymers. Because of their nano-meter sizes, filler dispersion nanocomposites exhibit markedly improved properties when compared to pure polymers or their traditional composites or blends which include increased modulus and strength, outstanding barrier properties, improved solvent and heat resistance and decreased flammability.

These materials are endowed with many important properties such as nonlinear optical properties, electronic conductivity and luminescence, and have been proposed for their use in various applications including chemical sensors, electroluminescent devices, electro catalysis, batteries, smart windows and memory devices.

Nanotechnologies positioned as new basis innovation [2], and nano industry is considered as a system of interrelated innovative processes in the framework of transition to 6th technology revolution. Nanotechnologies are also considered as future of such spheres as energy production, electronics, medicine, biology and pharmacology, chemical production, space and defence. Even today obtained with the use of nanotechnologies products stand for 0,01% of world GDP (2010), it is expected that it will increase to 2% by 2015 [3]. Potentialities of nanotechnologies in terms of competitiveness of the country, its technological leadership and national security interests demand active approach to their development and commercialization. The results of nanotechnology rivalry determine the place of the country in world division of labour and its role in world financial system which assigns "technological" rent to the countries-leaders in innovative development.

Besides structural applications, polymer nanoparticle compounds have very interesting functional applications. For instance, y-FezO polymer nanocomposites are used as advanced toner materials for high quality colour copiers and printers and as contrast agents in NMR analysis, memory devices.

Advancement in the field of nanotechnology and its applications to the field of medicines and pharmaceuticals has revolutionized the twentieth century. Nanotechnology [1] is the study of extremely small structures. The prefix "nano" is a Greek word which means "dwarf". The word "nano" means very small or miniature size. Nanotechnology is the treatment of individual atoms, molecules, or compounds into structures to produce materials and devices with special properties. Nanotechnology involve work from top down i.e.,reducing the size of large structures to smallest structure e.g., photonics applications in nano electronics and nano engineering, top-down or the bottom up, which involves changing individual atoms and molecules into nanostructures and more closely resembles chemistry biology

II. FUNDAMENTAL CONSIDERATIONS

In recent years, growing environmental awareness has led to increased pressure on manufacturers andusers ofmaterials to consider the environmental impact of material products. Nanotechnology is no exception. Life cycle assessment (LCA) has recently emerged as a powerful holistic tool for the assessment of the environmental impacts of nanotechnology [3]. Application of LCA to nanotechnology highlights both the positive and negative impacts of nanotechnology on the environment throughout the whole life cycle of nano-products. The life cycle includes all aspects of activities during the life of a product 'from the cradle to the grave', such as the extraction of raw materials and resources, production processes and facilities, the usage of products, and post-use management of the product including recycling and disposal. LCA helps to identify the potential risks associated with nanomaterials and nano-enables products in advance. LCA can also clarify the risk-benefit balance during the entire life cycle of the nano-products. However, the LCA of nanotechnology is still in its infancy. The slow progress in the LCA of nanomaterials is due to the many challenges it faces. The major obstacles include the uncertainty arising from the immature nature of the technology and markets, lack of risk-associated information, a high number of nano-specific properties to be considered, and the fast development pace of technology commercialization.

Applications of Nanotechnology The different fields that find potential applications of nanotechnology are as follows: a. Health and Medicine b. Electronics c. Transportation d. Energy and Environment e. Space exploration.

Main part in economic literature economic security is defined as "sufficiency in ensuring of needed level of national security by means of necessary resources, formation of favourable conditions for development of competitive economy, protected state of personal, social and state economic interests from internal and external threats" [7]. Economic security can be understood, on the one hand, as complex system consisting of different sub-systems (scientifictechnological, energy, financial securities etc.) [8]. In formation of innovative economy scientific technological and resource securities play prioritized role.

On the other hand - as special steady state of national economy which is characterized by constantly improved set of its parameters and abilities allowing to function efficiently in constantly changing medium. The algorithm of formation of economic security suggests stage-by-stage finding out of economic interests and economic challenges. Analysis of economic security state suggests identification of indicators systems and study of its threshold values. Nanotechnologies and nanotechnological activity are considered as one of the key factors influencing national economic security in conditions of globalization. Development of nano-industry in pro-active mode demands scientifically grounded optimization of strategic regulation. In developed countries (leading countries which claim for nanotechnologies superiority - the USA, Japan, EU countries – Germany, Finland, Sweden, South Korea - strategic conceptual approaches have been developed to ensure economic security while developing and use of nanotechnologies with due regard to national particularities and priorities of economy.

Elements of strategic management of nano-industry development 1. Ensuring safe development of nanotechnologies necessitates evaluation of: potential risks for human health, environment and labour safety; ethic, legislative and social effects of nanotechnologies' development [9]. While developing nano-industry the following factors must be taken into account: 1) productivity of nanotechnologies; 2) long-term scenarios of economic development; 3) scenarios of social development and convergent technologies; 4) threats to national security; 5) ethics, risks and uncertainty; 6) legal and international aspects; 7) interaction with public, development of human resources.

III. PUBLIC PERCEPTION OF RISKS AND BENEFITS

Over the past few decades, a new technology has emerged called “nanotechnology”. It has entered the lives of millions of people already and is projected to keep doing so more and more. Nanotechnology is the manipulation of matter on a molecular or even atomic level (Drexler, 1992) and due to its wide range of possible applications in food and packaging for example, its use is likely to increase over the coming years (Kuzma &VerHage, 2008). Aside from food, nanotechnology can also add to care products (e.g., sunscreens) (Shatkin, 2013), or various types of medicine (Maynard, 2006). Public perception of new technologies can beinfluential for their application (Köhler &Som, 2008), and the sales of genetically modified (GM) foods, for example, were adversely affected by a negative outlook from the public (Ferber, 1999; Gaskell, Bauer, Durant, & Allum, 1999). Knowing the public’s perception on nanotechnology’s risks and benefits is therefore of great importance. This study was conducted to see whether nano-additives in either food, care products, or medicine were perceived differently from other additives. Using nano-additives in different product categories could also possibly unveil differences in perception among nano-products, so this was taken into account as well.

Nanotechnology can be used for a wide range of applications, e.g., military purposes, machinery, the environment, medical purposes, or food (Cacciatore, Scheufele, & Corley, 2011). Some current and proposed applications of nanotechnology include self-cleaning and air-purifying surface coatings, self-healing coatings, static and wrinkle-free fabrics, and contaminant detection in drinking water (Shatkin, 2013). However, these possible benefits do not exclude the possibility of accompanying risks, as several studies have pointed to potential risks from producing and using nano-materials (Arnall, 2004; Dreher, 2004; Hoet, BrüskeHohlfeld, &Salata, 2004). It is likely that some nano-particles may be released into the environment during or after the production or consumption of products using nano-materials. By either inhalation, ingestion, or dermal penetration it is possible for nano-particles to get into the human body (Maynard, 2006, Oberdörster, Oberdörster, &Oberdörster, 2005). When considering medical devices and drugs there are two additional means of entry – injection (Oberdörster et al., 2005) and release from implants (Maynard, 2006). It is not yet possible to say what the actual effects of decades of using nanotechnology will or might be on human health and the environment, even if current tests deem it to be safe. The technology has not been in use long enough yet to gather enough data on this.

IV. RISK PERCEPTION

Perceptions about risks and benefits, and subsequently the consumers’ willingness to use nanotechnology, are influenced by several factors. Epstein (1994) distinguishes two separate ways in which people assess risk. One mode of thinking, the experiential system, bases its assessment on affect, associations and connections, past experiences, and encoding reality into images, metaphors, and narratives. This process is rapid and validated through “experiencing is believing”. The other mode of thinking, the analytic system, is based on logic and reason, and encodes reality into abstract symbols, words, and numbers. It’s a slower process and requires justification through logic and evidence. Finucane, Alhakami, Slovic, and Johnson (2000) show how affect comes before, and also directs, judgments of risks and benefits. For example: information stating that a risk his high for a certain technology or activity leads to a decrease in perceived benefits and vice versa. The same holds true when it is states that a technology or activity has low risk.

The benefits will be inferred to be high. Information about high benefits also suggests low perceived risks. People use trust as another shortcut when making decisions when they lack knowledge or information. People trusting the industry using and applying, and the agencies checking and regulating nanotechnology, assessed nano-applications more positively than the people lacking trust (Siegrist et al., 2007a; Siegrist, Keller, Kastenholz, Frey, &Wiek, 2007b; Siegrist et al., 2008).

Cobb &Macoubrie (2004) found that amount of trust was not significantly related to knowledge about nanotechnology, but it was associated with perceptions of more specific potential risks and benefits. Less trust also resulted in more participants responding that risks would outweigh benefits. Nanotechnology has been considered to be more risky than more conventional ways of enhancing products. Granted that higher perceived risks are associated with lower trust; the first hypothesis will be: nanoadditives will have lower perceived trust than nano-additives. Here, trust is defined as the confident expectation or reliance upon something with more trust, meaning being more hopeful or confident in a positive outcome.

V. GENERAL FRAMEWORK OF NANOTECHNOLOGY

In the simplest terms, the subject of nanoscience technology is defined as the science and technology of the direct or indirect manipulation of atoms and molecules into functional structures, with applications that were never envisioned before. The prefix "nano" corresponds to a basic unit on a length scale, meaning 10^{-9} meters, which is a hundred to a thousand times smaller than a typical biological cell or bacterium. At thenano-meter length scale, the dimensions of the materials and devices begin to reach the limit of 10 to 100s of atoms, wherein entirely new physical and chemical effects are observed; and possibilities arise for the next generation of cutting-edge products based on the ultimate miniaturization or so called "nanoization" of the technology. The earliest impetus to the scientific and technological possibility of coaxing individual atoms into the making of useful materials, devices and applications was given by the late Nobel-prize winning physicist Richard Feynman, in a land mark lecture: "There's Plenty of Room at the Bottom," delivered at the American Physical Society (APS) meeting at Cal Tech in 1959, in which he said, "The problems of chemistry and biology can be greatly helped if our ability to see what we are doing, and to do things on an atomic level, is ultimately developed - a development which I think cannot be avoided". Indeed, scanning probe microscopes (SPMs), in recent years, have already given us this ability in limited domains, and spurred a tremendous growth in the pursuit of nanotechnology in the last two decades. A series of scientific and technological discoveries and progresses in a variety of areas in 1970s and 1980s, and the enunciation of visionary scenarios by Eric Drexler in a possible molecular nanotechnology-enabled world, have revived the field in the 1980-90s.

VI. SOURCES OF NANO-TECHNOLOGY

Nanotechnology is a broad field of modern science and also engineering, which creates, potentially, endless possibilities. This term is most often defined as the preparation and use of structures in which at least one dimension is expressed in nano-meters. Usually, the dimensions of these structures are in the range from 1 to 100 nm (more often up to several hundred nm).The term nano-technology was used first time in 1974 by Japanese scientist Norio Taniguchi. He used the term to describe semiconductor processes. His definition of nano-technology was as follows: "Nano-technology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule" [1].

Taniguchi considered nanotechnology as a technology of precision manufacture with nano-meter tolerances. Such an approach implied from Tanguchi's background – he had studied the developments in machining techniques. The vision of nanotechnology, however, has deeper roots. The first ideas appeared several years earlier. On December 29, 1959, at California Institute of Technology, Feynman gave a lecture titled "There's Plenty of Room at the Bottom" [2]. In lecture, he considered the possibility of direct manipulation of individual atoms as a more powerful form of synthetic chemistry than those used at the time. Feynman also suggested that it should be possible, in principle, to make very tiny machines that are able to arrange the atoms the way we want, and do chemical synthesis by mechanical manipulation. At the end of his talk, Feynman announced two challenges and funded price for each one.

The first task involved the construction of a very small motor, such small that would fit inside a cube 1/64 inches (0.4 mm) on each side. The second one was much more difficult – to find a way to scale down letters small enough so as to be able to take the information on a page of a book and put it on an area 1/20000 smaller in linear scale.

The concepts, as well as tasks presented by Feynman were very abstractive at that time; nevertheless, they gave to researchers a strong motivation to work. In November 1960, to Feynman's surprising, an electrical engineer William McLellan, presented an electric motor which size met posed assumptions. The motor was pure handcraft engineering. McLellan, to fabricate it, did not use any cut-edge apparatus but typical tools and his experience. Among his tools was a sharpened toothpick which pushed the miniature components into place - appropriately presaging the atom-fine tips of atomicforce microscopes [3]. To meet the second challenge took a little more time. In 1985, Tom Newman, a Stanford graduate student, successfully reduced the first paragraph of A Tale of Two Cities by 1/25,000, and collected the second Feynman prize [3]

VII. CHARACTERIZATION

The vigorous development of polymeric science and extensive utilization of polymeric materials in technology has led in recent years to the increased interest in the preparation and characterization of polymer and its composite films. Characterization is an essential part of all investigations dealing with materials. The important aspects of characterization are chemical composition, compositional homogeneity (chemical homogeneity), structure, identification and analysis of defects and impurities influencing the properties of the materials. Thus, Characterization describes all those features of composition and structure of a material that would suffice for reproducing the material. The advances made in the last few years in characterization techniques, especially in the structure elucidation, have been stupendous and have opened new vistas in solidstate materials. Among the several characterization techniques, X-ray diffraction (XRD), scanning electron micrography (SEM) and infrared (IR) spectroscopy and Thermal analysis are main important techniques.

Taniguchi considered nanotechnology as a technology of precision manufacture with nano-meter tolerances. Such an approach implied from Tanguchi's background – he had studied the developments in machining techniques. The vision of nanotechnology, however, has deeper roots. The first ideas appeared several years earlier. On December 29, 1959, at California Institute of Technology, Feynman gave a lecture titled "There's Plenty of Room at the Bottom" [2]. In lecture, he considered the possibility of direct manipulation of individual atoms as a more powerful form of synthetic chemistry than those used at the time. Feynman also suggested that it should be possible, in principle, to make very tiny machines that are able to arrange the atoms the way we want, and do chemical synthesis by mechanical manipulation. At the end of his talk, Feynman announced two challenges and funded price for each one. The first task involved the construction of a very small motor, such small that would fit inside a cube 1/64 inches (0.4 mm) on each side. The second one was much more difficult – to find a way to scale down letters small enough so as to be able to take the information on a page of a book and put it on an area 1/20000 smaller in linear scale. The concepts, as well as tasks presented by Feynman were very abstractive at that time; nevertheless, they gave to researchers a strong motivation to work.

VIII. CYBER AND VIRTUAL INNOVATIONS

Dr. Sean Brophy, Purdue University, and Dr. Miriam Heller, Computing Research Association The nanoscience and nanotechnology centers have spawned several valuable cyberinfrastructure resources, some targeting education. The NanoEducation and STEM education communities need to become more aware of these cyberinfrastructure resources. Also, these cyberinfrastructure resources must become more integrated with each other for easier discovery. For instance, despite nanoHUB's widespread use with over 92,000 annual users, many workshop participants were not familiar with it or its capabilities. NanoHUB capabilities need to be better publicized regarding accessibility, content and updates, targeted user levels, customizability to targeted audiences and individual user interface, interoperability with other systems, and end-user.

IX. APPLICATIONSOF POLYMER-BASED NANOCOMPOSITES

Polymer composites comprising nanoparticles are often investigated where reinforcement of the polymer matrix is achieved. While the reinforcement aspects are a major part of the nanocomposite investigations reported in the literature, many other variants and property enhancements are under active study and in some cases commercialization.

The advantages of nanoscale particle incorporation can lead to amyriad of application possibilities where the analogous larger scale particle incorporation would not yield the sufficient property profile for utilization. These areas include barrier properties, membrane separation, UV screens, flammability resistance, polymer blend compatibilization, electrical conductivity, impact modification, and biomedical applications. Examples of nanoparticle, nanoplatelet and nanofiber incorporation into polymer matrices are listed in Table along with potential utility where properties other than mechanical property reinforcement are relevant.

Application of Nanotechnology in Modified Medicated Textiles

Using nanotechnology newer antibacterial cotton has been developed and used for antibacterial textiles. Developmental works using nanotechnology, new modified antibacterial textiles have been developed. Application of conventional antimicrobial agents to textiles has been already reported. This technique has been advanced by a focus on inorganic nano structured materials that acquire good antibacterial activity and application of these materials to the textiles.

Applications of Nanotechnology in Cancer:

A Literature Review of Imaging and Treatment Niranjan Bhandare* and Ashwatha Narayana Department of Radiation Oncology, Greenwich Hospital/Yale New-haven Health system, Greenwich, CT, USA *Corresponding author: Niranjan Bhandare Department of Radiation Oncology, Greenwich Hospital/Yale New Haven Health system, Greenwich, CT, USA, Tel: 203-863-3743; Fax: 352-265-0759;Received date: May 12, 2014, Accepted date: Oct 27, 2014, Publication date: Oct 31, 2014 Copyright: © 2014 Bhandare N, et al. This is an open-access article distributedunder the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract Recent advances in the application of nanotechnology in medicine, often referred to as nanomedicine, may revolutionize our approach to healthcare. Cancer nanotechnology is a relatively novel interdisciplinary area of comprehensive research that combines the basic sciences, like biology and chemistry, with engineering and medicine. Nanotechnology involves creating and utilizing the constructs of variable chemistry and architecture with dimensions at the nanoscale level comparable to those of biomolecules or biological vesicles in the human body. Operating with sub molecular interactions, it offers the potential for unique and novel approaches with a broad spectrum of applications in cancer treatment including areas such as diagnostics, therapeutics, and prognostics. Nanotechnology also opens pathways to developing new and efficient therapeutic approaches to cancer treatment that can overcome numerous barriers posed by the human body compared to conventional approaches. Improvement in chemotherapeutic delivery through enhanced solubility and prolonged retention time has been the focus of research in nanomedicine.

The sub microscopic size and flexibility of nanoparticles offer the promise of selective tumour access. Formulated from a variety of substances, nanoparticles are configured to transport myriad substances in a controlled and targeted fashion to malignant cells while minimizing the damage to normal cells. They are designed and developed to take advantage of the morphology and characteristics of a malignant tumour, such as leaky tumour vasculature, specific cell surface antigen expression, and rapid proliferation. Nanotechnology offers a revolutionary role in both diagnostics (imaging, immune-detection) and treatment (radiation therapy, chemotherapy, immunotherapy, thermotherapy, photodynamic therapy, and anti-angiogenesis). Moreover, nanoparticles may be designed to offer a multifunctional approach operating simultaneously as an effective and efficient anticancer drug as well as an imaging material to evaluate the efficacy of the drug for treatment follow-up. In recent years, nanomedicine has exhibited strong promise and progress in radically changing the approach to cancer detection and treatment. Keywords: Nanotechnology; Cancer treatment; Imaging Introduction Carcinogenesis is associated with progressive modifications/ alterations in the cellular, genetic, and epigenetic characteristics that results in uncontrolled cell division, ultimately leading to the formation of a malignant mass. Cancer is identified by unregulated, uncontrolled tissue growth.

X. CONCLUSION

Novel polymer nanocomposites can be prepared by varying two parameters; first by optimizing polymer to clay or polymer to layered silicate ratio and second by varying the processing techniques [1 & 3]. An exploration in making the polymer nanocomposites with different clays, surfactants and polymers is a continuing subject of research and interest to both academia and industry.

Fundamental studies in nanotechnologies sphere are of strategic character. In long term their results will be used as foundation of significantly transformed high-tech industries which to a great extent will determine innovative, economic and defense potential of the country. So, nano-industry becomes one of the most important industries which set the pace of innovative development of global economy. Category of nanotechnologies security is vague and must be considered in complex terms. But every element of it can be analyzed separately. Economic security is a state of protection of economy which would provide competitiveness of scientific researches and inventions in the sphere of nanotechnologies and nanotechnological production in internal and world markets, ability of economy for sustainable development and compare negative factors which take place in world markets. By now the threats to national security in nanotechnologies sphere must be formulated. We can use statistics and different indicators for evaluation of the level of security in Russia and foreign countries: indicators of the situation in scientific sphere (mainly it is financing of R&D); investments into fixed assets, use of studies' results and inventions in economy. Development, realization and constant improvement of measures to provide state control over the spread of nanotechnologies including export control.

ACKNOWLEDGMENT

I would like to acknowledge HOD A.V.Raipure, Principal Dr. V.S.Bykod of Pimpri Chinchwad polytechnic for their constant encouragement to finish this work.An exploration in making the polymer nanocomposites with different clays, surfactants and polymers is a continuing subject of research and interest to both academia and industry.

REFERENCES

[1] ArunkumarLagashetty, A Venkataraman; Polymer Nanocomposites; Resonance July 2005.
[2] ShadpourMallakpour,Zahra Rafiee; New developments in polymer science and technology using combination of ionic liquids and microwave irradiation; j.progpolymsci.2011.03.001.
[3] Zhang M, Fang S, Zakhidov AA, Lee SB, Aliev AE, Williams CD, et al. Science 2005;309:1215-9.
[4] Colin Harwood and Anil Wipat, Microbial Synthetic Biology, Academic Press, 2013.
[5] Marianne Manchester and Nicole F. Steinmetz, Viruses and Nanotechnology, Springer, 2008.
[6] James Chapman, Timothy Sullivan and Fiona Regan, Nanoparticles in Antimicrobial Materials: Use and Characterization, Royal Society of Chemistry, 2012.
[7] N. Taniguchi, "On the basic concept of 'nano-technology'," in Proc. Intl. Conf. Prod. Eng., 1974.
[8] R. Feynman, "There's plenty of room at the bottom," Eng. Sci., vol. 23, no. 5, pp. 22- 36, 1960.
[9] J. R. Gribbin and M. Gribbin, Richard Feynman: A life in science. Dutton, 1997, p. 301