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Nanotechnology and its Applications in Industry and Product Design

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Abstract

One of the most significant recent developments in all fields, particularly product design and manufacturing, is nanotechnology. This technology applies the science of difference to produce innovative, practical, and small-scale products that stand out for their advanced size. It also enhances the look and feel of industrial products by controlling matter or multiplicity on the atomic scale, where matter is controlled on the smallest scale, which ranges from 1 to 100, increasing the surface area to volume ratio significantly. Furthermore, because surface atoms are the most reactive, As a result, attributes are described in real-time, and this unit benefits in mechanical, chemical, and physical aspects. In the case of electricity, a new property is added, or a new substance known as nanomaterials is created with unique qualities that meet the demands of cutting-edge technology. In order to produce goods with cutting-edge qualities, it is crucial to research these novel materials created by nanotechnology and learn about their characteristics, possibilities, and industrial uses. This aims to highlight the significance of this technology in the fields of industrial design and product design, as well as the potential for production using the designer in the field of designing and manufacturing future products and their use by the designer, by working to improve products and their functions in the field of design and product manufacturing using nanotechnology

Keywords: Nanotechnology, Uses of Nanotechnology, Industrial and Product Design, Product Design field

Introduction

Because it can alter, improve, and enhance the qualities and appearance of materials and products in a favorable way, nanotechnology is one of the most significant technologies available today and in the future. It should be noted that the upcoming age might be dubbed the "Nano Era" due to its effects on all facets of society, particularly product design field and production. This method lengthens the industrial product's shelf life by enhancing its qualities, attributes, and look. So, Everyone has to be made aware of the value and beauty of technology, as well as how to modify it to better serve humankind, by industrial designers. An industrial designer's ability to detect what the consumer wants and use technology to create both useful and aesthetically pleasing products is a genuine measure of success.[1, 2]

One of the most significant technologies being employed today in many sectors, particularly product design and production, is nanotechnology. "Technological research and development at the atomic, molecular, or macromolecular levels using a length scale of approximately 1 to 100 nanometers" is the definition of nanotechnology.[3]

Nanotechnology is the term used to describe any technology that functions at the nanoscale and has real-world applications, such as using individual atoms and molecules to produce functional structures. Systems with structural properties ranging from single atoms or molecules to submicron dimensions are developed and employed in the field of nanotechnology, and the resulting nanostructures are incorporated into bigger systems.[4]

The use of molecules to create new, distinct, and unique products at prices that can occasionally drop

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to a tenth of current costs is the foundation of the massive scientific revolution known as nanotechnology, or extremely small technology, which the world is on the verge of today. This technique signals a major advancement in engineering and science across the board. The domains of contemporary healthcare, worldwide commerce, international affairs, and even the ordinary person's daily existence will just allow us to create everything we may envision by positioning matter particles next to one another in ways beyond our comprehension and at the most affordable price. The field of nanoscience is still very young. Under Nano microscopes and in labs, nanoscience is still a relatively new science. The ability of humans to create matter, systems, and technologies at the nanoscale one billionth of a meter is known as nanotechnology. Since this science is still relatively new, its researchers have faced many challenges because not all parties can access the advancements made in this field due to the somewhat monopolized nature of Nano programs. [5]

The Emergence and Evolution of the Nanotechnology Concepts.

Definition of Nanotechnology

Nanotechnology can be best described as "technology at the nanoscale". words defined as components of nanotechnology, such "nanofiber," also refer to the nanoscale; in fact, any word starting with "Nano," which we might write as "Nano X" in general, can also be defined as "nanoscale X." Therefore, without defining "nanoscale," we are unable to adequately characterize nanotechnology. Here, we note that the first definition of the nanoscale is thought to be between 1 and 100 nm. This is simply an agreement without a strong theoretical basis. **[6]**

The Greek word "Nano," which means "dwarf" or "very small," is used to represent one thousand millionth of a meter (10−9 m). It is important to differentiate between nanotechnology and nanoscience. The study of structures and molecules on nanoscales, which range from 1 to 100 nm, is known as nanoscience, and the technology that applies this knowledge to real-world objects like gadgets is known as nanotechnology. It is important to note that the radius of the DNA double helix is one nm, whereas the thickness of a single human hair is 60,000 nm. The field of nanoscience originated during the Greek and Democritus era in the 5th century B.C. Scientists were debating whether matter is composed of small, indivisible, and indestructible particles known as atoms, or if it is continuous and thus infinitely divisible into smaller pieces.**[7-18]**

- One billionth is called a Nano. One billionth of a meter, or roughly the space filled by five to ten atoms arranged in a straight line, is referred to as a nanometre.[19]
- In general, nanotechnology refers to the manipulation of incredibly small objects. About on the level of atoms.[19]

With the help of nanoscience, this technology seeks to create and produce practical methods, strategies, creations, and goods that are distinguished by their minuscule size. Additionally, it seeks to alter matter and investigate its characteristics and occurrences at the nanoscale. It depends on particles of sizes less than 100 nanometers, which endow the matter with novel characteristics and behaviors. Rearranging molecules and atoms and producing a wide range of new materials are ways that nanotechnology increases the efficiency of matter.[20]

Emergence and Evolution of the Nanotechnology

The Romans displayed one of the most intriguing instances of nanotechnology in antiquity in the fourth century AD, when they used nanoparticles and structures. One of the greatest accomplishments in the history of the ancient glass industry is the Lycurgus cup, which is housed in the collection of the British Museum. This is the first known instance of dichroic glass. Dichroic glass refers to two distinct varieties of glass that exhibit colour changes under specific lighting conditions. This indicates that the Cup is actually two colours: green in direct light and reddish-purple in light passing through the glass.[7, 21]

Ag, copper (Cu), or other nanoparticles were included in the luminous, dazzling "lustre" ceramic glazes that were utilized in the Islamic world and subsequently in Europe between the ninth and seventeenth centuries. During the sixteenth century, the Italians also used nanoparticles to create Renaissance ceramics. They were impacted by Ottoman methods: throughout the thirteenth and eighteenth centuries, carbon nanotubes and cementite nanowires were utilized to create "Damascus" sober blades, which offered durability, strength, and the capacity to retain a sharp edge. For centuries, the purposeful production of certain hues and material characteristics took place. Nonetheless, the source of these unexpected consequences was unknown to medieval forgers and painters.[7]

Michael Faraday investigated the creation and characteristics of colloidal "Ruby" gold suspensions in 1857. These are some of the most intriguing nanoparticles because of their distinct optical and electrical characteristics. Faraday gave an example of how varied lighting conditions cause liquids containing gold nanoparticles to become distinct colours. Figure 5 provides an overview of how nanotechnology has advanced as a result of the benefits of nanoscience. [7]

Numerous industry pioneers who helped shape the growth of this sector have come forward after Dr. Feynman's remarks. A chronology of some of the significant innovations in this field is provided below: [19]

- 1959-Dr. Feynman's Caltech Lecture
- 1971-Norio Taniguchi coins "nanotechnology"
- 1981-Scanning Tunnelling Microscope (STM) Invented
- 1986-Atomic Force Microscope (ATM) Invented
- 1989-IBM uses STM to write IBM with 35 Xenon Atoms
- 1991-Carbon Nanotubes discovered by Sumio Iijima
- 1993-Nanotubes synthesized
- 1995-Complex structures built from DNA
- 1996-Quantum Wire created by James Tour
- 1996-Computer Chip pattern 30 nm wide constructed by Harvard's George Whiteside
- 1997 - Nano mechanical device made by NYU's Seeman
- 1997 - Zyvex Founded - Company dedicated to the manipulation and formation of atoms
- 1999- Molecular Switch constructed by Yale/Rice researchers
- 1999-3D Structure of Ribosome determined
- 2000-$495 Million NNI plan proposed by President Clinton
- 2001-$738 Million invested by the Venture Capital Community in Nanotechnology
- 2002-Institute for Nanosoldiers created at MIT funded by U.S. Army

<u>**Nanotechnology and it's Connection to Different Fields**</u>

Use of Nanotechnology in Medical Fields

The use of nanotechnology in medicine has produced unexpected outcomes. Because biological structures are so small, dealing with them has always been difficult, but nanotechnology has made biomedicine possible at previously unheard-of levels. The aim of many of these applications, many of which have already begun, is to employ molecules for the diagnosis and treatment of diseases in injured tissues, such as bones, muscles, and nerves. entering the actual world. [8, 9, 12, 14, 22]

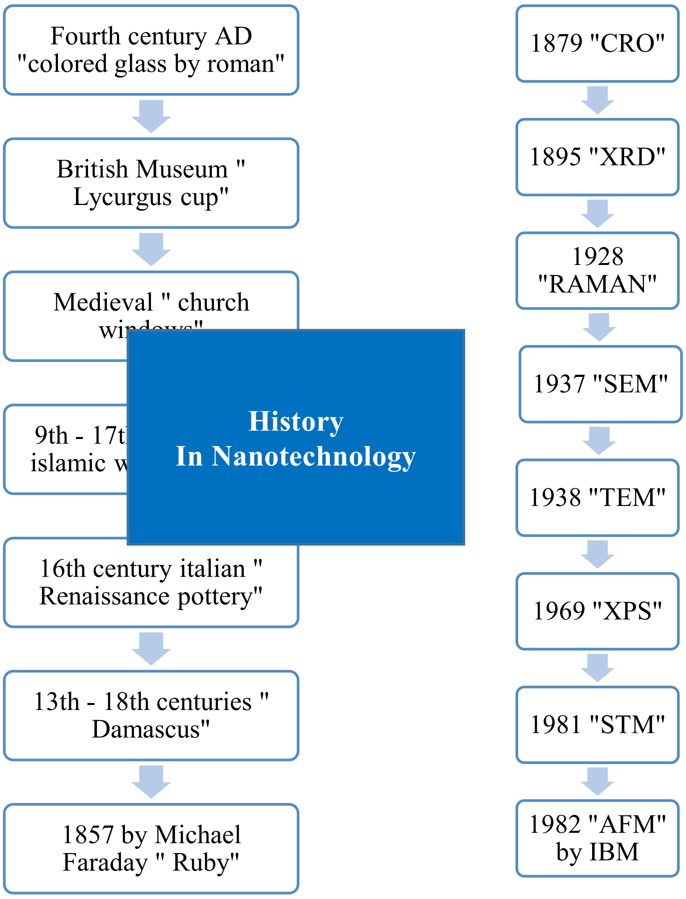

Figure 1: Progresses in Nanotechnology

Nanotechnology applied to medical fields is known as nanomedicine. Nanomedicine covers a wide range of subjects, including potential applications for molecular nanotechnology as well as nanomaterials and nanoelectronic sensors in medicine. However, understanding issues related to nanotoxicology and the impacts of nanomaterials on the environment remains one of the most important difficulties facing the field of nanomedicine today.[22]

Exciting opportunities arise when using nanotechnology to medicine. While some strategies are still in the testing phase or are in use now, others are only concepts. In the field of medicine, nanotechnology is being used to the production of nanoparticles and, on a larger scale, to studies including the use of produced nanorobots to perform cellular repairs.[23]

Because of their unique physicochemical and biological characteristics, nanomaterials are being researched as potential instruments for the development of drug and gene delivery systems as well as diagnostic biosensors. The way that nanomaterials interact with biomolecules and cells can be significantly influenced by a number of their features, including size, shape, chemical makeup, surface structure, surface charge, agglomeration, aggregation, and solubility. Moreover, one of the main concerns facing scientists working in the fields of biotechnology and medical research today is the creation of straightforward, safe techniques for the diagnosis and treatment of dangerous illnesses like cancer.[24]

Metal nanoparticles, such as Au (gold), Ag (silver), Cu (copper), and Zn (zinc) nanoparticles (NPs), have been the subject of much research over the past 20 years due to their unique chemical and optical properties. Nanotechnology has mostly been used in medicine to cure cancer and distribute medications. This happens as a result of functionalized NPs' protective ligands, which allow them to recognize and meld with a biological matrix. For many years, NPs have been investigated in the therapeutic domain to reduce the dosage of cancer drugs to mitigate their side effects.[24]

Need for Nanotechnology in the Medical field

The field of nanotechnology and nanodrugs has yielded a large array of findings. Significant advancements in nanomedicine have raised the medication to a new level with important implications for healthcare. Research on the enormous potential of nanotechnology in healthcare is necessary. In the medical field, a great deal of research is being conducted on optimal techniques and approaches, such as nephrology, cardiovascular disease therapeutic genes, and cancer therapy. The conventional therapy has seen a substantial advancement, and both nanotechnology and nanoparticle quality have improved and produced positive outcomes. Nanoparticle medications have also been utilized in gene therapy. Numerous studies concentrated on the use of viral vectors that were thought to be drug delivery systems.[25]

To make sure patients receive the right treatment, researchers collect data from smart tablets equipped with nanobots that target specific cancer cells. With the use of nanotechnology, in-vitro diagnostics may be possible by replacing current methods with more convenient and cost-effective ones. Within those devices, nanoparticles can work as molecular imaging agents and input genetic changes linked to cancer as well as functional characteristics of tumor cells. Furthermore, depending on the intended use, functional nanotechnology-based coatings typically contain the following nanomaterials: carbon black, titanium dioxide, silicon dioxide, iron oxide, zinc oxide, and silver. Tools and processes improve the safety, efficacy, and physio-chemical characterization evaluations of nanomaterials and nanosurfaces included into medical device engineering.[25]

Medication Administration

A recent medical use of nanotechnology is the delivery of medications, heat, light, or other chemicals to target cell types (e.g., cancer cells) via nanoparticles. In order to directly treat damaged cells, particles are designed to be drawn to particular cells. This method enables early illness identification and lessens harm to the body's healthy cells. The three main tenets of drug delivery are (a) effective drug encapsulation, (b) successful drug transport to the intended site of the body, and (c) successful drug release from the targeted site of the body.[23]

In order to increase medication bioavailability, nanomedical techniques to drug delivery focus on creating tiny particles or molecules. The term "bioavailability" describes a drug's capacity to enter the body where it is most required and beneficial. The goal of drug delivery is to maximize bioavailability at certain sites in the body as well as over an extended period of time. This may be accomplished by using nanoengineered devices to target molecules.[23]

Use of Nanotechnology in Military Applications

Global armies are searching for a war outfit fit for the twenty-first century. In addition to stopping bullets, the gear must be able to identify chemical and biological weapons, monitor the vital signs of injured soldiers, provide rudimentary first aid, and communicate with headquarters. NT creates materials that are lighter, stronger, and perfect for use in military applications. The following material functions in uniforms and equipment are made possible by nanomaterials (CNT): making them lighter and stronger might result in materials that resemble nanofibers and break off from uniforms and equipment and penetrate the body and environment.[26, 27]

For application in military and aerospace systems, nanotechnology primarily offers benefits in the areas of armament, protection, and communication. Using nanotechnology, military buildings, equipment, and materials may be made more compact, lighter, intelligent, robust, affordable, precise, and clean. In order to increase the effectiveness of military armament and lower manufacturing and transportation costs, nanotechnology can also be employed in military systems to decrease weaponry or utilized as weaponry (such as microfusion missiles). Nanotechnology can be utilized to create body armor that is both solid and robust enough to withstand the impact of a bullet fired at a high rate of speed, while also being light and thin.[28]

One of the most crucial criteria for nations in the modern period is military strength. Research on nanotechnology has become more widespread in the military sector globally. Numerous military applications have profited from nanotechnology, which will be the cause of armies' supremacy over rivals.[22]

Use of Nanotechnology in Electronic Industries and Communication

One of the most applications and one of the areas that has profited from nanotechnology applications is the electronics and communications sectors. This enormous number of transistors could not have been achieved in a single CPU, and IBM was unable to take use of the useful nanotechnology-based methods. By reducing the transistor's size to 40 nanometers, a corporation was able to double the number of transistors and double the processor's capacity. Transistors will undoubtedly eventually reach a threshold where further downsizing is impossible, necessitating the creation of other technologies, given the rapid progress made in this area. How to replace electrons in electrical circuits with light is now one of the most formidable difficulties, which drives scientists to develop and discover alternative industrial technologies based on nanotechnology.[8, 12, 22, 29-31]

In the fields of electronics, communication, biomedical, and photonics engineering, nanotechnology is a major player and has revolutionized many elements of wired and wireless communication technologies. [32]

Wireless Technology

The new science of communication nanotechnology will drastically transform the telecommunications industries. The operation of both cellular and core wired networks will be greatly impacted by nanotechnology. It will also be more dominating than earlier traditional technologies due to its ultrafast speeds, improved influence on sensor functioning, and added security features.[32]

Mobile Devices

The introduction of microsystems and nanotechnology principles into mobile devices will transform handheld electronics such as cell phones, computers, and communication devices, opening up entirely new avenues for computation and data transfer. Modifications may be made to these nano devices to enable them to perform certain functions, such as self-determination, environmental awareness, and intelligent communication with other mechanical or electrical systems. The carbon nanotube, which is a subset of nanotechnology, will improve cellular phones. Since cell phones include 700 nm circuit boards made using nanotechnology, they are referred to as nano devices in the fifth generation of mobile systems.[32]

Furthermore, for a mobile device with a high degree of processing and communication to be effective in a communications system, it must be able to communicate with other people. When equipped with this feature, mobile devices ought to be simple to use and capable of independent operation. These portable electronics may be connected to a range of human environments, including homes, workplaces, and public areas. A necessary condition for the effective integration of these devices on a global scale is their environmental adaptability. It can facilitate the creation of novel perceptive nanosensors and nanodevices that can interact with these organic frameworks for applications in nanotechnology.[33]

Nano-Communication Systems

Mechanical devices that use nanoscale components are known as nanomachines. A nuclear machine is a mechanical device that illustrates the sub-nuclear framework and uses nanometer-scale parts to show an acceptable limit. It is capable of carrying out data generation, transportation, processing, and recognition, as well as of activating additional networks.[34]

The most basic strategy for connecting microelectronic devices is to use electromagnetic waves, which can be produced wirelessly with a little loss or using cables. Molecular communication is the exchange of information between nanoscale devices and is defined as the sending and receiving of data encrypted in molecules. Several nanomachines can be interconnected via molecular transmission, leading to the creation of nanosystems that employ communications that are encrypted in molecules. Molecular encoding is the coding technique used to represent the data in nanosystems.[35]

Use of Nanotechnology in the field of Environments

It is anticipated that the creation of a new generation of environmental sensing systems would be made possible by the special qualities of nanoscale materials. Furthermore, the development of a thorough knowledge of the interaction and destiny of anthropogenically produced and naturally occurring nanoscale and nanostructured materials in the environment is probably made possible by advancements in measuring science and technology. Integrated processes and bottom-up assembly, two forms of sustainable manufacturing based on the application of nanoscale science and nanotechnology, have the ability to meet human requirements while achieving high compatibility with the local ecosystems and people.[36]

nanoscale dimensions are essential for comprehending the impacts on health since they govern particle transit in human tissue. Combining research on nanostructured materials and device design with studies of environmental interactions has yielded significant advances. Significant advancements have been made in the last few years in the production of nanoscale materials useful for environmental investigation. [36]

Use of Nanotechnology in Industerial Design

You can tell that the next era is the era of nanotechnology because of modern technology. Nanotechnology is one of the most significant and cutting-edge frontiers of the present and the future. It is present in many fields, particularly in product design and production, where a large number of goods rely on nanotechnology to enhance their qualities and look. novel technologies These goods came with new features.[2]

The home industry products encompasses a wide range of sectors, including sports, automobiles, professional athletes, home appliances, and more. This list excludes a set of industrial items that directly improve technology, either in use, during the design phase, or in the creation of the first prototype.[37]

Applications of nanotechnology in Industrial and Product Design field

Applications of nanotechnology in Cars (automobiles)

Compared to other modes of transportation, such as air or water transportation, the automotive industry is the focus of the majority of nanotechnology-based research and development. Body parts, emissions, car interiors, chassis and tires, electrics and electronics, engines, and drive trains are all areas where nanotechnology is used. Figure 4 shows the key components of cars that are influenced by nanotechnology.[16, 38-41]

Body Sections

Paint coatings, lightweight components, self-cleaning, and scratch-resistant nanopolymers are among the uses for body parts.[38]

Paint Coatings

Each body component is painted using a distinct color and technique. The primary purposes of painting are ornamental and protective. Three layers of paint are often applied to automobiles: primer, basecoat, and clear coat. But generally speaking, it has four to six layers to provide it different features.

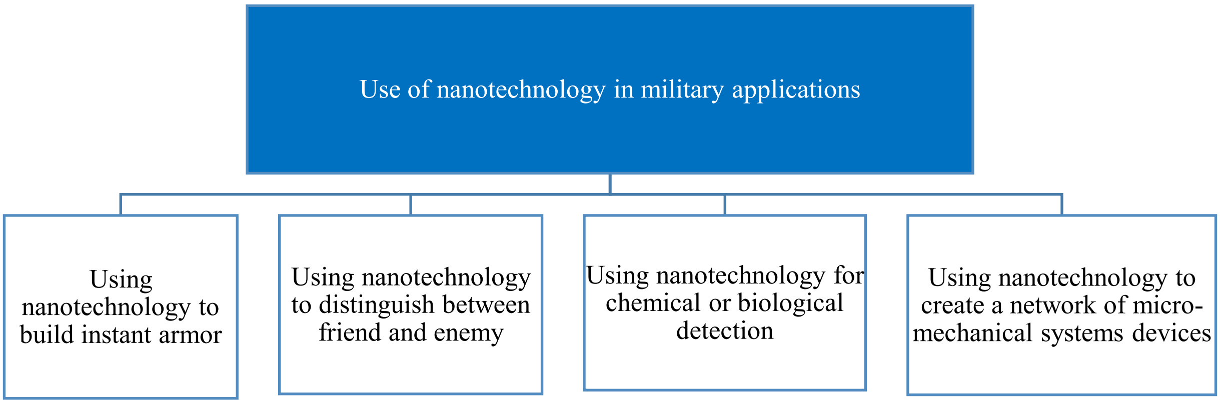

Figure 2: Nanotechnology methods in military applications

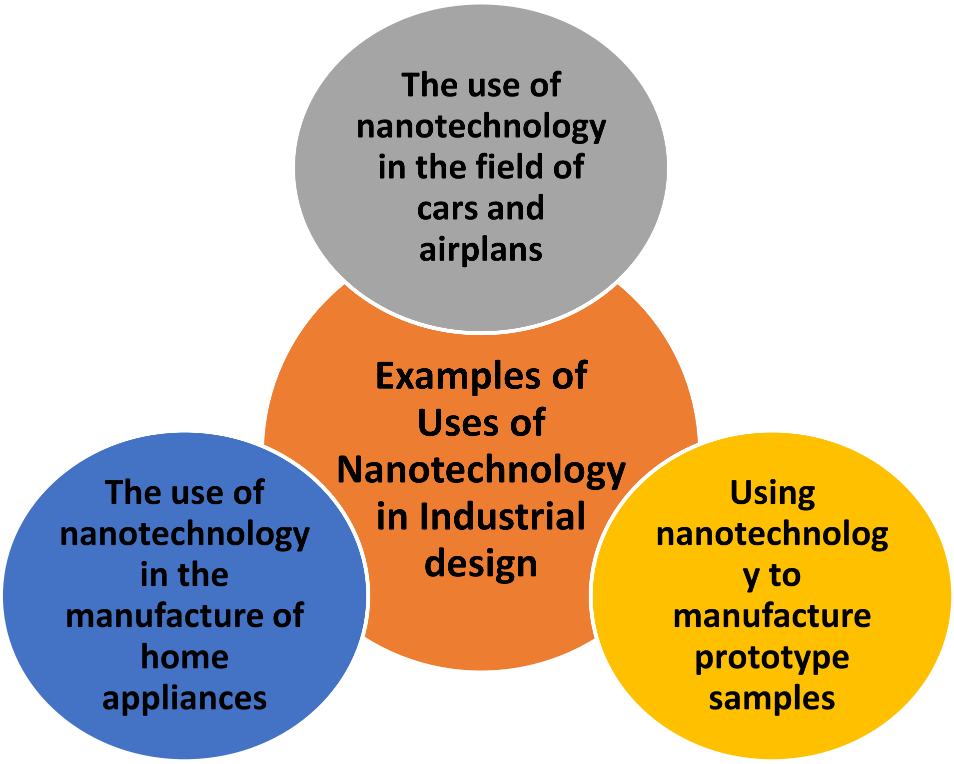

Figure 3: Examples of Uses of Nanotechnology in Industrial design[22]

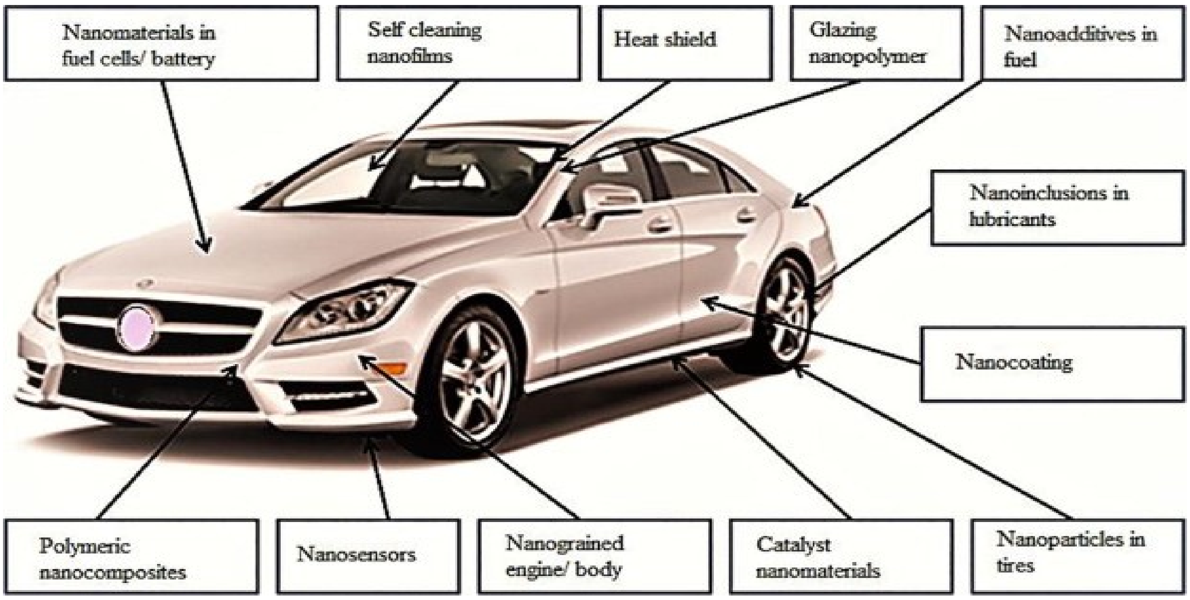

Figure 4: Various parts of automobile in which nanotechnology is applied (Not representing the actual vehicle. [42]

Car coating technologies are driven by critical performance variables such as corrosion protection, aesthetic qualities, economic and environmental requirements, ease of mass manufacturing, appearance, and durability. The five basic phases of a modern automobile coating process are pretreatment, electrodeposition, primer, sealer, and topcoats. The pretreatment process eliminates surplus metals and creates a suitable surface to facilitate the adhesion of layers that prevent corrosion.Next, the electrodeposition process is used to deposit the corrosion protective layer. The purpose of sealer is to stop water leaks and reduce chipping and vibration sounds. Poly Vinyl Chloride is the most often used sealer (PVC). Promoting adhesion between the basecoat and the surface as well as imparting anti-chipping qualities are the primary goals of a primer.[43]

Promoting adhesion between the basecoat and the surface as well as imparting anti-chipping qualities are the primary goals of a primer.[43]

The primer serves as a leveler and protection, making the application of the basecoat simpler. Its purpose is to shield the body from stone shards, bumps, rust, and ultraviolet (UV) radiation. The substance that provides the color effects and aesthetic qualities is called basecoat. The glossy, transparent coating with an environmental interface is called a clear coat. It is chemically stable and may be dissolved in water or used as a solvent.[44]

Concentrates of nanosized magnesium aluminum layered double hydroxides (LDH) can be added to flame retardant coatings to improve their mechanical and chemical characteristics. The coating's ability to resist fire and create char is enhanced when a certain quantity of LDH nanoparticles is mixed into the paint mixture. When the nano LDH burns, it absorbs heat and releases carbon dioxide and water, which lowers the surface's temperature and increases the production of char.[45]

Scratch Resistance with Nano-Varnish

A car's body shell should still seem brand new even after several washes and years of use. Surface scratches and/or abrasions will harm the coatings. They could also harm the layers of coating underneath. Creating coatings that are resistant to abrasion and scratches without compromising their other qualities is a difficult task for scientists and researchers. By adding a lot of cross links to the coatings' binder, the traditional approach can increase their scratch resistance, but because of their reduced flexibility, the coatings have very little resistance to impacts. Conversely, fewer cross-linked coatings will be less resistant to abrasion and scratches but will perform better in areas like anti-fingerprint and impact resistance. Therefore, without losing certain other features, we are unable to achieve effective scratch and abrasion coatings. This is where nanotechnology comes into play.[46]

Because of their tight bond, the binders and inorganic nanoparticles have great strength and flexibility. The paint gains its scratch resistance from the densely packed nanoparticles.[47]

Light Weight Body Parts

In the world of automotive development, one of the most talked-about topics is vehicle weight reduction. One way to improve fuel economy, lower CO2 emissions, and lower production costs is to reduce weight. A 10% weight reduction in a car is thought to result in a 7% increase in fuel efficiency. However, there will be issues with stability, crash resistance, and smooth operation when weight is reduced, which poses a serious risk to the vehicle's safety. Numerous advancements had been made in this area, such as employing lighter components and lowering the number of engine components, but they were unable to balance efficiency and safety. However, there will be issues with stability, crash resistance, and smooth operation when weight is reduced, which poses a serious risk to the vehicle's safety. Numerous advancements had been made in this area, such as employing lighter components and lowering the number of engine components, but they were unable to balance efficiency and safety. [48, 49]

Because nanoscale clay has strong thermal characteristics, it may be added to a polymer matrix to create a nanocomposite that is used to make automotive parts close to the engine. The most widely used polymer nanocomposites are clay nanocomposites containing PP (polypropylene), PA (polyamide), PB (poly butylene terephthalate), and PC (polycarbonates).[50]

The flame retardance and heat resistance of polymers will rise when these nanoscale clays are combined with them.Nanoscale reinforcements scattered throughout magnesium and its alloy have demonstrated enhanced mechanical qualities without significantly compromising other attributes.[44, 51]

Engines

About 10 to 15 percent of the fuel energy in modern cars is used up by friction from the engine's moving mechanical components. The main components of the engine that cause friction are the piston, cylinder wall, crank drive components such as the connecting rod, crank shaft, and bearings, and valve drive system components such as the cam shaft and valves. Piston and cylinder wall aggregate comprise the majority of mechanical frictional loss among them. Another issue with cars is the heat that the engine and its cooling system produce.[52]

Currently, engine oils are used between moving components to minimize friction and coolant and radiator to lower heat generated and cool the engines in order to address these issues. The use of nanotechnology can improve the performance of the coolant, radiator, and engine oils.[52]

We can lower cylinder wall abrasion and friction, which lowers fuel consumption, by covering the wall with nanocrystalline materials. Research initiatives are underway with the goal of directly coating metal crankcase tracks with nanomaterials. Engine components are coated with 50–120 nm-sized iron carbide and boron dioxide nanocrystals, which produce a highly hard surface with very little friction. The engine's heat is removed via the radiator. We employ common heat transfer fluids for this purpose, such as mineral oil, ethylene glycol, and water.[53]

Tyres

The most often mentioned application of nanotechnology in automotive technology is on tires. Tires aren't only comprised of one substance; instead, a variety of materials are mixed and combined, including rubber, steel threads, reinforced fillers, and more. Rubber mixes display important tire qualities. As a pigment and reinforcing component, carbon black was the first nanomaterial used to the tire. The two most crucial components utilized in tires as reinforcing elements are silica and soot. Because nanoscale soot has a rougher surface than regular tires, it may be added to promote improved fuel efficiency and longer durability. Because of their high surface energy, soot nanoparticles interact with the natural rubber in tires in a way that improves rolling resistance and lowers internal friction.[54, 55]

Ultra Reflecting Mirrors and Glasses

Glass and polymer components are used to make the car headlights and mirrors. When sunlight enters our eyes through the car's mirrors and glasses, it causes pain for us to drive. The lights from the car across from us that shine in our eyes during a nighttime drive present a serious issue. Because of the intensity of the light falling on our eyes, we are unable to see the road or other cars effectively, which might result in accidents. A number of studies and trials are being conducted in this area, and coating glasses with solar shielding is one way to lessen the issue.[47]

The glasses' or the mirrors' optical characteristics alter when they are fitted with functional layer nanocomposite with electrochromic capabilities. A certain voltage is produced when light strikes glass or mirrors, and this voltage causes the charges to migrate to the intermediate layers. As a result, just a little amount of light is reflected back from the electrodes, where it is absorbed by the color centers of the ions.The glass's integrated sensor will gauge and regulate the amount of light hitting the mirror. Upon the disappearance of this light, the mirror will return to its initial state.[47]

Applications of Nanotechnology in Aerospace

Numerous businesses depend on air transportation because it can move huge volumes of cargo and passengers around the globe in a fraction of the time required by other forms of transportation. Aerospace industries place a high value on security and precision since even minor flaws in production or operation might endanger the lives of many people. As a result, these businesses spend heavily and exercise extreme caution.[56]

The materials used in airplanes should have low density, have a high tensile strength, and be resistant to corrosion. The creation of lightweight, highly durable materials and the development of environmentally friendly, efficient engines are the two main areas of contemporary aerospace R&D attention. Low weight nanocomposites, high strength nanomaterials, enhanced electronics and displays with lower power consumption, multifunctional materials with sensors, sophisticated air purification filters and membranes, and many more are examples of how nanotechnology is being used in aircraft.The aircraft industry already uses some nanoparticles that have been combined with bulk metals.[38, 56]

In addition to giving the composite panel more strength, CNTs also improve its conductivity, which enables electricity to flow through it and into the nearby structures. Because of this characteristic, the aircraft is less vulnerable to electrical discharge damage.[57]

Applications of Nanotechnology in Marine Transportation

Marine transportation serves a variety of purposes, including cargo hauling, passenger transit, and armament carrying platforms. The primary issue with marine transportation is atmospheric and seawater corrosion. The high salinity of seawater exacerbates metal corrosion and fouling in ships. Even though stainless steel is very resistant to corrosion in ordinary environments, it will partially corrode in seawater. All of these will have a negative impact on the ship's dependability, environmental adaptability, hull life, and sea survival.Numerous advancements are being made to stop fouling and corrosion, but they don't seem to be very successful. Nonetheless, studies and research on the use of nanotechnology in this sector offer promising outcomes.[58]

Researchers in the US have discovered that improved material for light and durable applications may be obtained by processing aluminum using the cutting-edge nanoscience technique known as "cyromilling." By introducing nanosized aluminum into conventional aluminum, the cyclomilling process creates nanoscale aluminum oxide and nitride particles, strengthening and stabilizing their microscopic structure and orientation. This makes them an effective substitute for aluminum hulls in applications where high strength and low weight are highly desired. These materials are typically utilized to create stronger ship hulls and sails. In order to provide electromagnetic shielding, explosion-proof constructions, and safety harnesses—particularly for load-bearing applications and different marine rigs—carbon nanotubes are added to polymers. When compared to conventional zirconia coatings, the ship's outfit's nanostructured zirconia coatings offer longer-lasting scratch and abrasion resistance.[58, 59]

Application of Nanotechnology in Prototype Samples

A model of the product is created as the first sample in order to test a particular idea or procedure and gain insight from it throughout the design phase. The materials required to create quick models are improved by the use of nanomaterials. They may be used to quick manufacturing procedures as well. The 3D printer has used nanomaterials to produce The initial sample showed improvements in terms of the sample's quality and accuracy of details as well as an improvement in surface finishing quality.[22]

Application of Nanotechnology in Manufacture of Home Appliances

Silver is recognized to be a deadly substance for bacteria, fungus, and microbes. The Arabs utilized it to cleanse water in the past by putting bits of silver metal into goatskin water jugs. During the caravan's voyage, the water bottle vibrated, causing the parts to brush against one another and generate a super-fine powder that dissolved and killed germs without harming humans. Samsung has introduced a new line of cutting-edge home goods that adhere to the strictest health regulations by shielding household appliances from bacteria through the use of ultra-fine Nano-Silver technology.More than a hundred brand-new vacuum cleaner, air conditioner, refrigerator, washing machine, and air sterilizer designs are included in the collection.[2, 22]

Nano silver technology is the best option for safeguarding public health and maintaining environmental integrity. In order to guarantee that consumers are protected from germs in a safe and secure manner, the firm covers the major components within the new goods, which have the potential to directly damage health, with a tiny layer of silver solution. Silver was the material of choice for the corporation since it is perfect for sterilizing and eliminating bad smells from surfaces that come into close touch with it. Skin and nourishment.[2, 22]

Conflict of Interest

The authors declared no competing interests in the publication of this article

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تكنولوجيا النانو وتطبيقاتها في صناعة وتصميم المنتجات

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المستخلص:

واحدة من أهم التطورات الحديثة في جميع المجالات، وخاصة في تصميم المنتجات والتصنيع، هي تكنولوجيا النانو. تطبق هذه التكنولوجيا علم الفروق لإنتاج منتجات مبتكرة وعملية وصغيرة الحجم تتميز بحجمها المتقدم. كما أنها تعزز مظهر وملمس المنتجات الصناعية عن طريق التحكم في المادة أو تعددية المادة على مقياس ذري، حيث يتم التحكم في المادة على أصغر مقياس يتراوح بين 1 و 100، مما يزيد بشكل كبير نسبة السطح إلى الحجم. وعلاوة على ذلك، نظرًا لأن ذرات السطح هي أكثر الذرات تفاعلية، فإن الخصائص يتم وصفها في الوقت الحقيقي، ويستفيد هذا الوحدة في الجوانب الميكانيكية والكيميائية والفيزيائية. في حالة الكهرباء، يتم إضافة خاصية جديدة، أو إنشاء مادة جديدة تعرف باسم المواد على مستوى النانومترات وتتمتع بصفات فريدة تلبي متطلبات التكنولوجيا الحديثة. من أجل إنتاج سلع ذات خصائص متطورة، من الضروري البحث في هذه المواد الجديدة التي تم إنشاؤها بواسطة التكنولوجيا النانو ومعرفة خصائصها وإمكانياتها واستخداماتها الصناعية. يهدف هذا إلى إبراز أهمية هذه التكنولوجيا في مجالات التصميم الصناعي وتصميم المنتجات، وكذلك الإمكانات المتاحة للإنتاج باستخدام التصميم في مجال تصميم وتصنيع المنتجات المستقبلية واستخدامها بواسطة المصمم، من خلال العمل على تحسين المنتجات ووظائفها في مجال التصميم وتصنيع المنتجات باستخدام تكنولوجيا النانو.

الكلمات المفتاحية: تكنولوجيا النانو ، استخدامات تكنولوجيا النانو ، التصميم الصناعي والتصميم المنتجات ، مجال تصميم المنتجات..