Role of nanotechnology to improve products properties and increase its life time

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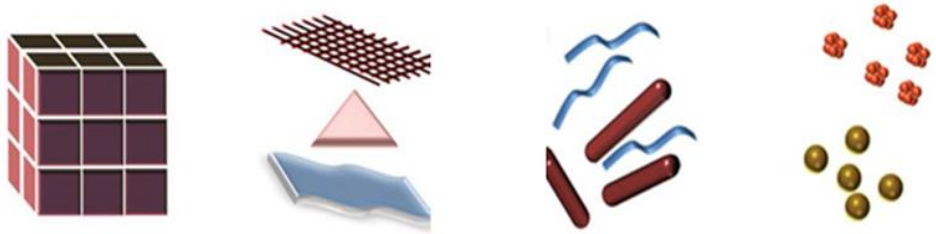
Summary:

Nanotechnology has become one of the most important technologies that are used recently in all fields, especially the field of products design and manufacture, as this technology applies to the application of Nano-science for the purpose of creating and producing means, techniques, inventions and useful products that are characterized by their infinitesimal size in addition to improving the appearance, characteristics and quality of the industrial product and thus increase its life. The hypothetical is through controlling or manipulating the material on the atomic scale, where the material is processed on the smallest scale, which ranges from 1 to 100 nanometers[2], thus the ratio of surface area to volume is much higher and since the surface atoms are the most reactive, so the properties of the material change in unexpected ways. The physical, chemical and mechanical properties of these small particles change, or a new feature is added or a new material is produced, which improves the properties and functions of the products and thus increases its life time. Nanomaterials have multiple shapes depending on the purpose of their use, each of them has lengths, diameters, composition and distinct characteristics. Therefore, the research aims to focus on the importance of nanotechnology in improving the properties of the product and thus increasing its life span. To achieve this goal, the research follows the descriptive analytical deductive approach by studying the concept of ***nanotechnology***, which has been defined as: "Research and technological development at the atomic, molecular levels. The large scale using a scale of length from 1 to approximately 100 nanometers is the ultimate technique concerned with designing and manufacturing materials at the nanometer scale, as it aims to change the material and explore its properties and phenomena at the nanometer scale and depends on particles less than 100 nanometers in size that give the material new properties and behaviors; ***Nanomaterials*** that have been classified according to their dimensions as defined by Richard W. Siegel into zero nanostructures (atomic clusters, strings, and clusters), one-dimensional multi-layered (Nanofibers), and two-dimensional micro-layers (Nanofilms, Nanoparticles, and Nanomesh) , and with three dimensions (Nanomaterials consisting of Nanometer sized particles of equal size), as shown in Figures (1/a, b, c, and d)



a) **(b)** **(c)** **(d(**

Figure (1 / a, b, c, and d) shows the classification of nanomaterials according to Siegel
)a) Spheres and clusters (zero diameter) b) One-dimensional nanofibers
)c) Nanofilms, Nanopanels and 2D Nanofibers d) 3D Nanomaterials

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Nanomaterials have been classified according to the composition of their constituent materials into two main types, which are fullerenes and inorganic nanoparticles. Nanomaterials have many shapes depending on the purpose of their use. Each of them has lengths, diameters, composition and distinct characteristics. Nanomaterials can be classified according to their shape into *nanotubes*, such as carbon nanotubes, silicon tubes, and titanium tubes. Nanotubes are characterized by strong strength and durability because they do not corrode or burn under normal conditions and can be added to plastic to make it conductive; *nanoparticles* have several shapes and one of its dimensions is less than 100 nanometers and may be in the shape of a cube, sphere or oval, and the change in the nanoscale dimensions affects the electronic properties; *Nano-composite*, which are materials to which nanoparticles are added during their manufacture, which leads to a significant improvement in their properties such as the distribution and diffusion of nanotubes of carbon inside bite plastic materials to obtain a Nano compound with superior properties; *Nanofilms* are a thin layer of a specific material with a thickness of less than 100 nanometers, and these thin layers are used in the field of semiconductors such as silicon and gold alloys; *Nanorods* are similar to nanotubes except that they are solid and shorter, such as gold rods. Platinum; *nanowires*, which are wires with a diameter of less than one nanometer and have different lengths, and are considered one-dimensional materials, it is better than conventional three-dimensional wires and *Nanofibres* and the most famous nanofibers made from polymer atoms, fullerene, and its most important forms are conical fullerene, tube fullerene and spherical fullerene. One of the most important characteristics of nanomaterials is the high degree of hardness of metallic materials and their alloys and their increased resistance to stresses and loads on them, ceramic materials are given a large percentage of durability, formability and bearing stresses that were not available, which means the creation of new types of these materials, increasing their ability to conduct electric current which helps to use these materials in the manufacture of micro-sensors and electronic chips, the optical properties that are used in the field of manufacturing high-resolution, ultra-high-contrast and pure-color screens such as television screens, computers and mobile phones, the lower melting points of nanomaterials than regular materials as a result of the minimization of the dimensions of the granules. The material increases the strength and effectiveness of its magnetic capabilities, enabling it to be used in ship engines, large electric generators, magnetic resonance imaging and the manufacture of high-precision analyzers. ***Nano coatings*** are one of the most important applications in the field of nanomaterials, which is the process of applying a very thin surface layer of polymeric chemicals to a variety of surfaces including metals, glass, ceramics and polymers as they are used to transfer certain chemical and physical properties to the surface of the material to be coated so that it improves the properties of the surfaces. To be coated, such as resistance to scratching, friction, corrosion, water, oil, ultraviolet rays, viruses and bacteria, improving the durability and hardness of the material, and the coating is in liquid and solid form, and the nanoparticles used in the coating industry are titanium dioxide, which has photocatalytic properties, and silicon dioxide which works to be the painted surface Self-Cleaning, iron oxide and zinc oxide which work to protect against ultraviolet rays, and silver in its nanoscale form, which works to resist bacteria and viruses. **Many products have appeared that rely on nanotechnology** and nanomaterials, whose properties have been improved through the use of Nanocoatings in car paint with Nano-ceramic coatings that protect the surface of the car’s

body and make it resistant to scratching or rust and corrosion and prevent dust and water from sticking to the surface of the car as shown in the figure. (2)

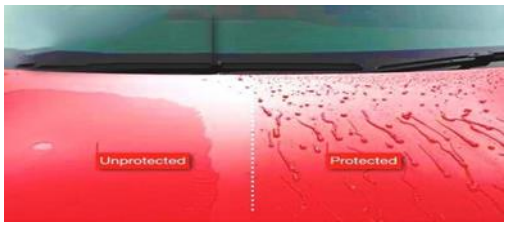


Figure (2): shows the effect of Nano-ceramic coatings on the car body

It also works to protect the car paint from changing the color due to exposure to sunlight and ultraviolet rays, which improves the properties of color fastness and glossiness, and for tires, carbon black particles are added as a strengthening and pigment, and soot, silica and organic silica as strengthening elements. They are added with a nanoscale to the rubber mixture to improve the properties and extend the life span, and by adding a very thin reflective layer of aluminum oxide with a thickness of less than 100 nm on the surface of the mirrors and headlights of the car, it works to avoid the intense lights from the opposite or rear cars, which reduces accidents and achieves the safety factor as shown in Figure (3)

Figure (3): shows the effect of adding a very thin reflective layer of aluminum oxide to car mirrors

The inner surfaces of engine cylinders are coated with nanomaterials of aluminum oxide and Nano zirconium oxide to increase the life of the engine and prevent it from rusting, and nanotechnology has been used to protect car structures from corrosion and thus we find that the use of nanotechnology in the automotive industry results in more streamlined designs as well as easy manufacturing and producing lighter exterior and stronger materials. And improving the surface characteristics of aircraft and spacecraft structures through the use of nanoparticles in the coatings that cover their structures, which works to prevent the extension of any cracks located on the body and stop its progress, which preserves the safety and durability of the aircraft in addition to increasing its default life by rates ranging between 200: 300% Nano coatings have also been applied to improve the properties of sunglasses through the use of Nano coatings to produce high-efficiency and scratch-resistant Nano glasses. Improving the properties of baseball bats, tennis, hockey, golf balls and bicycle tires through Nano additives in the polymer composites used to manufacture them, such as carbon nanotubes and graphene, making them lightweight, more durable and more flexible. And improving the efficiency of wind turbine blades in increasing the amount of electricity they can generate through the use of carbon nanotubes containing epoxy to make wind turbine blades, making them longer, stronger and lighter than other blades. The mechanical properties have been improved and the durability of some mechanical components of cars, trains, airplanes and shuttles increased through the use of nanoparticles in coating the inner surfaces of the engine cylinders with nanomaterials of aluminum oxide and Nano zirconium oxide to

increase the life of the engine and protect it from rust as a result of contact with metallic components during operation. And also improving the properties of shoes by placing nanofibers from silver metal inside the shoe, which works to prevent the formation of foot fungi and bacteria from growing while wearing the shoe. ***The most important future products that depend on the nanotechnology*** is GINA Light Visionary Model, as BMW presented it in 2008 as shown in Figure (4), which began working on it since 2001, using nanotechnology through the use of carbon fibers. Nanoparticles to give some elements of the car body mobility as shown in Figure (5), which is a car that is expected to be used first as a sports car in the race tracks, and it is a car characterized by being variable in shape as it is characterized by a flexible external surface, which makes some elements of the infrastructure movable and the driver can move it through the control tools, Electro-hydraulic and electrical, and looking at the exterior of the car, we find that the front and sides of the car, including the doors, were manufactured as a single body that is not separate and forms a single optical and structural unit, as it was manufactured from flexible materials of Nano carbon fibers, where the traditional metal and plastic were replaced by the outer bodies of cars that are coated with leather A semi-transparent waterproof fabric coated with polyurethane as shown in figure (6), and it consists of two layers. The first layer is an inner fixation layer made of alum. Wire mesh and the outer layer is heat and weather resistant, which makes its outer body expandable and curves around a metal frame of aluminum wires supported by carbon nanofibers that give the car's structure strength and durability in addition to flexibility in changing the shape of the car, as shown (7). The model was designed by a group of designers under the leadership of American auto designer Chris Bangle, but BMW has yet to start with production plans.

Figure (4): shows the car GINA

Figure (5): shows the elements of the car's body mobility

Figure (6): shows the translucent leather

Figure (7): shows the metal car body

Nokia Morph is a future device based on nanotechnology, which is a joint project between the Nokia Research Center and the Nanoscience Center at the University of Cambridge in Britain to use nanotechnology in the manufacture of mobile phones to improve their future properties so that they are flexible by weaving fiber proteins into a three-dimensional network that supports thin flexible structures. It is also variable and expandable, so that it can expand in the form of a large screen for browsing purposes, as shown in Figure (8), or shrink to a small size

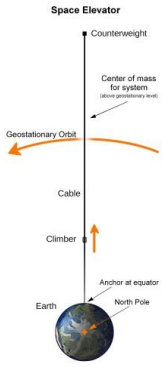
when used in regular calls, and this is done through a network of nanofibers that control the expansion when the device is folded and it also has the ability to Self-cleaning, where surfaces with nanostructures such as "Nanoflowers" resist water, dust and even fingerprints, which ultimately reduces corrosion and extends its life. One of its future features when folded and placed in the pocket is that it can be used as a traditional telephone handset as shown in Figure 9.) A watch or a bracelet as shown in Figure (10), and for the energy that will be used, surfaces will be cells that can benefit from sun's rays through a layer called Nanograss. Batteries are becoming slimmer, more energy-efficient, quick to charge, and capable of withstanding many recharges. Nokia is still looking for materials for a new battery to power Nokia Morph, which is still under design and development.

Figure (7): shows the flexible material of the phone

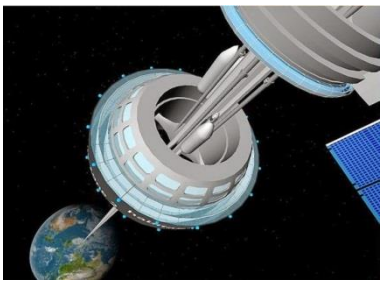
Figure (8): shows the phone's expandable screen

Figure (9): shows how to use the phone as a headphone. Figure (10): Explains the use of the phone as a bracelet

The idea of a space elevator appeared as shown in Figure (11 / a, b, c)



(a)



(c)

(b)

Figure (11 / a, b, and c) illustrates the idea of the space elevator

Which depends on nanotechnology through carbon nanotubes and its idea is based on a cable connected to the ground on a floating platform in the equator and on the other side suspended in space beyond the orbit as shown in figure (11 / a, b, c) and it can be ascended by mechanical means and the proposal fails because there was no strong enough material to construct the proposed cable, the space elevator idea was not realistically applicable until after 1991 when carbon nanotubes were discovered by Japanese researcher Sumulijima. Where the first elevator into space was designed to reach a height of 36 thousand kilometers while its speed reaches 200 kilometers per hour. The company, which is responsible for the project, said that the elevator will be ready at the beginning of the year 2050, and the main problem facing scientists in implementing the space elevator is that they need cables of up to tens of thousands of kilometers long (nanotubes), as Chinese researchers at Tsing Khua University in Beijing were able to manufacture tubes of only half a meter in length. Researchers confirm the possibility of obtaining these cables in the required lengths, as research in the field of carbon nanotubes achieves tremendous development.

Through the previous analysis, it can be concluded how designers will benefit from nanotechnology in the field of designing and manufacturing future products as follows

- Designing and creating products with variable shapes, dimensions and usage through the use of nanoscale carbon fibers, which work to give some flexibility in the movement of parts and components of design elements.
- Design and innovation of products that are characterized by the transparency of some parts and components.
- Design of products that can expand and fold through the use of a network of nanofibers.
- Design and manufacture of products characterized by strength and durability through the use of carbon nanotubes.
- Designing and creating self-cleaning products by taking advantage of the feature of distributing and spreading Nanocarbon tubes inside some plastic materials.
- Design and creation of products that change color when exposed to different types of lighting.
- Design and innovation of nanoscale products.
- Design and manufacture of products that are resistant to external weather factors such as corrosion, scratching and friction.
- Design and manufacture of anti-reflection products by adding a very thin reflective layer of aluminum oxide with a thickness of less than 100 nm on the surfaces of these products.
- Design and manufacture of products that can withstand high temperatures by coating the surfaces of these products with nanomaterials of aluminum oxide and nanoscale zirconium oxide.
- Design and manufacture of products characterized by strength and flexibility in addition to light weight.
- Design and manufacture of food containers resistant to perisation through the use of coatings containing titanium dioxide nanoparticles that block ultraviolet rays.
- Designing products that feature self-treatment of use defects, which reduces the maintenance of the product and extends its life time.
- Creating new products based on utilizing the properties of nanomaterials.

Through the analysis of previous studies and conclusion, the following results can be reached:

1) Nanotechnology works to improve the properties of current products in terms of durability, hardness, corrosion resistance to various weather factors in addition to the ability to self-clean surfaces and improve their appearance, which extends their life time.

2) Nanotechnology has helped the emergence of ideas and innovations for new future products such as flexible, transparent, expandable and foldable cell phones, and a space elevator.

And the most important recommendations are:

1) Emphasis on design and production students on the need to study nanotechnology in its various fields and how to benefit from it in the field of product design and manufacture.

2) The interest of designers and technologists in all the research presented in the field of nanotechnology and the identification of all new materials and new characteristics that contribute to the improvement and development of industrial products.

3) The necessary of cooperation between designers and researchers in the field of nanotechnology to facilitate the process of utilizing nanotechnology in raising the value of the product and extending its life time.

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