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RESEARCH ARTICLE

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Nanostructures and applications

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ABSTRACT

Nanotechnology is an interdisciplinary area that studies materials and structures of billionths in size and their uses. Nanomaterials are the keystones of nanotechnology and have exclusive electrical, magnetic and optical properties. What makes nanotechnology so stimulating is that materials perform contrarily in this dimension than in the macro world. The weight/power proportion, magnetic and optical possessions as well as conductivity alter meaningfully as you change from the macro dimension to the nano dimension. In this investigation, after giving overall data about nanomaterials, nanosystems, nanomachines, nanorobots and nanosystems from nanostructures were examined. Then, from nanostructure applications to the automotive industry, energy. defense and environmental applications were examined. Finally, nanofuture for nanostructures is discussed.

1. INTRODUCTION

Nanotechnology is the control and engineering of technical consequences subsequent from the appearance of new possessions of substance at the nanoscale (billionth of a meter). Nanoscale is an approximate material scope. At the nano level, the chemical, biological and physical properties of matter vary essentially and expressively. There are fundamental variations in the possessions of separate atoms, molecules and mass.

About arrangement, nanomaterials have tremendously trivial dimensions and as a minimum one dimension is 100 nm or smaller. Nanomaterials can be nanoscale in one, two or three dimensions. They can be found in single, fused, clustered or clustered forms with tubular, spherical and uneven forms [1]. Communal kinds of nanomaterials comprise fullerenes, nanotubes and quantum dots. Nanomaterials have uses in the area of Nanotechnology and show dissimilar physical chemical properties from normal chemicals such as Silver Nano, Fullerene and Silica) [2].

Perspectives on nanostructures essential to encompass the insights and boundaries of numerous systematic disciplines. It has been stated that the benefit of nanostructures will be its application in catalysis, but the chemist is also investigating nanoscale materials and must ensure that quantum detention effects are displayed. Nanometer-sized materials are best articulated in optical or electronic technology, where the nanostructure can be insulated from the molecules encountering, thus avoiding any chemistry risks [3].

The aim of this study is to critically examine nanostructures and their applications. Within nanostructures, nanomachines, nanorobots as well as nanosensors have been explained and critically discussed. Then, nanostructure applications in the automotive industry, energy, defense and environmental fields are systematically explained, and finally, a future-oriented perspective on nanostructure is given to motivate young generations to research and to point out the deficiencies in the related field of study.

2. NANOSTRUCTURES

Nanostructures are synthetic and are structures ranging from 1 nm to 100 nm. Nanostructures can

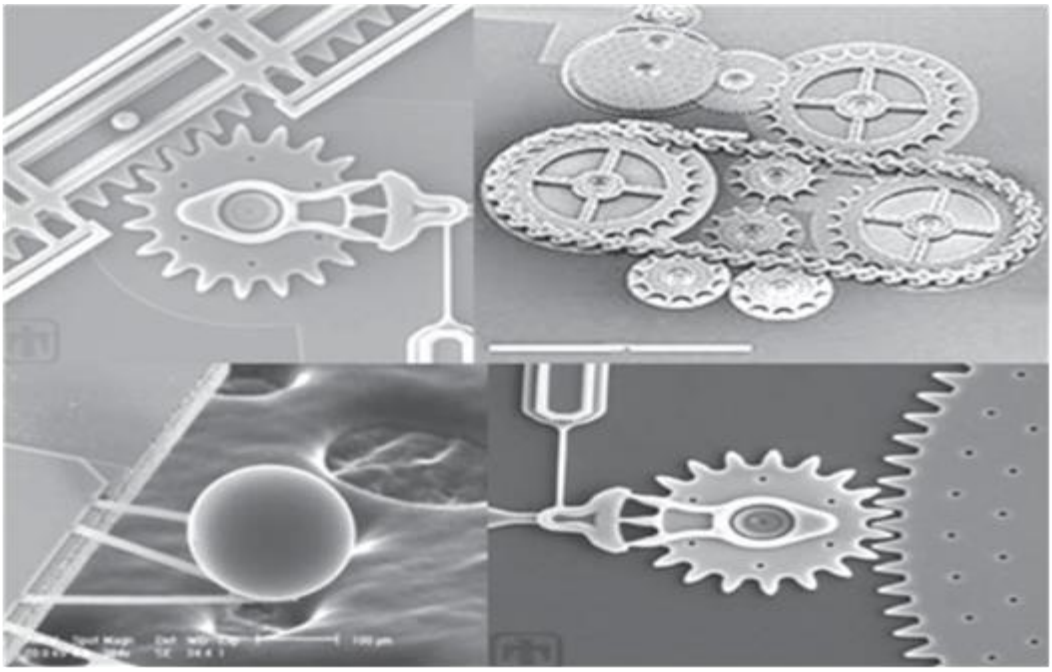

Figure 1. Various examples of gear wheels and motor components at the nanoscale [4]

be designed according to a wide variety of physical properties such as nanosurfaces and cylindrical nanotubes.

2.1. Nano-machines

Nanomachines, the smallest of which are the size of a virus, are much lesser than a human cell, often dignified in micrometers (millionths of a meter). Investigators turned to natural biological technology for motivation when emerging nanorobots because most robotic construction techniques at this scale would be impossible. We previously have billions of organic nanobots within us powering many functions of our cells. For instance, ribosomes are organic nanoscale forms of organic devices. The nanites are not your typical mechanical robots. They are not made of metals that come to attention when you think of a robot. As an alternative, nanomachines are constructed from DNA or other biological substances that flawlessly interrelate with biological surroundings in certain ways to achieve specific results.

The microscopic size of nanomachines means high working velocity. This is an outcome of the natural propensity of all machines to run faster as they get smaller in size. Nanomachines can be programmed to work synergistically to replicate themselves or create larger machines or nanochips. Particular nanomachines named nanorobots could be designed to not only identify but also treat illness states, maybe by finding and destroying occupying bacteria and viruses. In Figure 1, several examples of gear wheels and motor components at the nanoscale are given.

Additional benefit of nanomachines is that the individual units need very little energy to work. Resilience is extra potential advantage; nanites can last for centuries before deteriorating. The main difficulty lies in the production methods. It has been recommended that some nanomachines could be grown in a manner alike to how plants change from seeds.

Medicine is continually developing and new technologies are constantly being incorporated into the diagnosis and treatment of patients. Numerous nanomachines and other nanoobjects presently under study in medical investigation and diagnostics will soon find application in medical practice [5].

The biological and physical disciplines have a mutual attention in minor constructions. For the physical sciences, "nano" proposes quantum phenomena and extraordinary physical possessions. Biology enhances extremely advanced nanomachines that work completely with

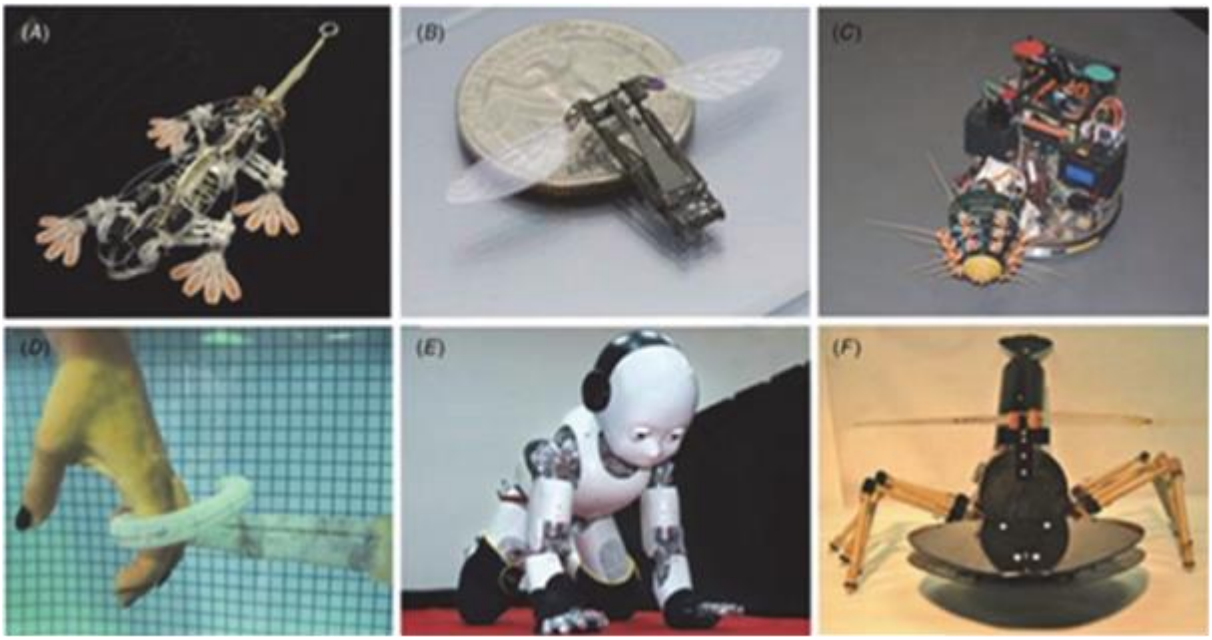

Figure 2. Examples of microrobotics inspired by Bio Organisms [4].

classical molecular mechanisms. To the biological disciplines, "nano" suggests a new framework—from most physical disciplines—on which to hang thoughts about new tools and useful sets that will be needed to assemble an intangible model of life [6].

2.2. Nano-machines

Nanorobotics is one of the most important technology areas of the last period. It can be characterized as the design, development and manufacture of nano/micro scale machines by using robot systems or components at nanometer scale and/or approximate sizes.

Nanorobotics is the engineering discipline that includes the design and construction of nanorobots. It covers the construction of devices, tools and systems with nanoscale components or molecular components in 0.1-10 micron sizes.

In this field, besides "nanorobots", there are also denominations such as "nanobots", "nanoids", "nanites", "nanomachines" or "nanomites". In Figure 2, illustrations of microrobotics inspired by Bio Organisms are shown.

"Nanorobots", the first applications of which began to be seen in the field of medicine and health, can be defined as nanoassemblies that protect the human body against pathogens and keep it in balance.

Their approximate diameter is designed to be around 0.5-3 microns. Intensive research programs are carried out on nanorobots, whose components, parts and sub-mechanisms are planned to be 1-100 nanometers in size.

Nanorobotics enable controlled operation of schemes at the nanometer scale. The ability and behavior of cooperating in sync with the algorithms and control methods put on individual robots is described as "swarm behavior", just like in bees and ants. With these algorithms, it is possible to control the collective movements of hundreds or even thousands of robots. In Figure 3, similar "hive behavior" is of great importance in nanorobots, just as the synchronized movement of bees around a hive.

Small doses of drugs or chemicals can be carried in a suitable chamber on the nanorobots. The nanorobot can release the drug directly into the diseased area or wound. Nanorobots can also be used directly in cancer treatment by carrying chemotherapy chemicals. Smaller amounts of drugs/chemicals that can be secreted directly onto the cancerous tumor will be more effective than conventional chemotherapy treatment.

Figure 3. Similar "hive behavior" is of great importance in nanorobots, just as the synchronized movement of bees around a hive [4].

Within the Probe, Knives and Chisels, Lime is used for cutting out clots and obstacles. At the same time, equipment is needed to break up the clots into small pieces.

Also known as bionanorobotics, this field deals with nanorobots inspired directly from biological organisms. In bionanorobotics, the dimensions are at the micrometer level, and they are formed by using and mounting nanoscale components in these systems on a large scale. The main topics covered in bionanorobotics can be classified as design, construction, programming and control.

Based on this, nanorobots represent an integrated integrity that includes systems with actuation, sensing, signal processing (transmission-reception), information processing, intelligent and/or hive behavior capabilities.

Some of the main purposes targeted with nanorobots can be listed as follows:

Cloning of organs and their use for change in diseased bodies;

Repairing skin cells that cause aging with nanorobots placed in the body; meanwhile, it is also aimed to repair diseased cells or organs.

In this process, nanorobots will be able to develop new chemical compounds and building-building materials and create new electronic components.

They will be able to transform the substance for food purposes. As a result, it will be possible to cope with hunger and diseases on earth.

The ozone layer can also be used effectively to eliminate environmental problems, especially global warming problems.

In the medical field, nanorobots are considered to be designed to perform a wide range of tasks, such as diagnosis, monitoring and treatment of deadly diseases:

- Drug Release (drug delivery)
- In-house Tracking-Tracking
- Dentistry
- Cancer Detection and Treatment
- Diagnosis and Treatment of Diabetes
- Precision Surgeries
- Gene Therapy

These nanorobots deliver drugs or chemicals to specific target areas within the human body.

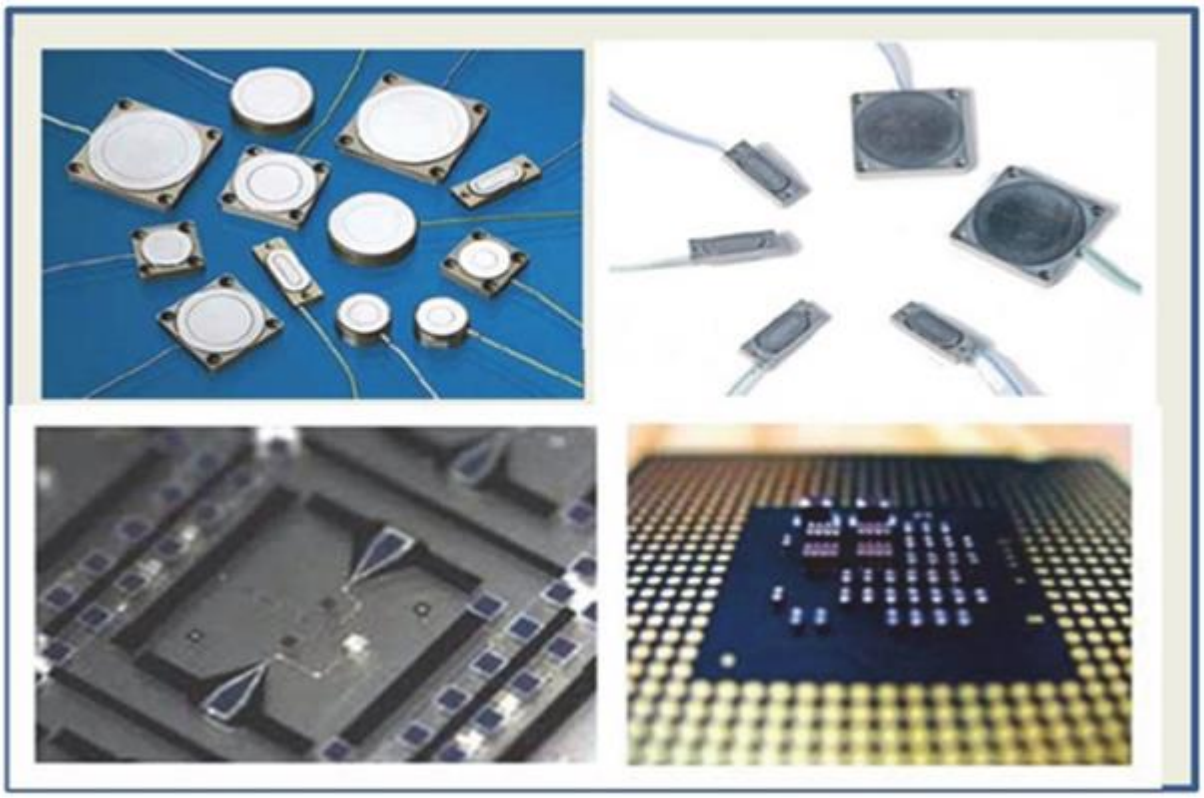

Figure 4. Various types of nanosensors.

2.3. Nano-sensors

The nanosensor transforms the data and information obtained from the atomic scale and nanoparticles into analyzable macro scales. Its biggest advantage is that it can work in small places that macro- and micro-sensors cannot reach; require less power in their operation; higher precision and adaptability for specific purposes. In Figure 4, numerous types of nanosensors are illustrated.

Nanosensors are devices and mechanisms that are nanoscale (one billionth of a meter), extremely small in size and capable of detecting and diagnosing physical stimuli (stimuli). These physical warnings can be listed as follows: chemical and biological substances, movement, mass, acoustic, force, force, electromagnetic, thermal-heated.

Application areas of nanosensors are as follows: Medicine, pharmaceuticals, health technologies, ecology, environment, security, defense and military, industrial, aerospace, daily life, white goods, transport, communication, integrated circuits, building and facilities. Recently new investigations have been reported on drug delivery [7] and sensor applications [8] to detect disease site and cure it with appropriate drug delivery application.

In addition to the progress reached in biosensor technology, fully automatic, real-time, high-sensitivity, label-free and multilayer biomolecular detection and diagnostic sensors have brought important applications with the advantage of nanotechnological developments. Thus, with these technologies, the possibility of early diagnosis of all possible abnormal data has emerged with routine health checks at home. In Figure 5, In_2O_3 nanowire based nano biosensors are displayed.

3. APPLICATIONS

Nanostructures can be applied in many places. In this part, few of them including automotive industry, energy, defense as well as environmental applications will be described.

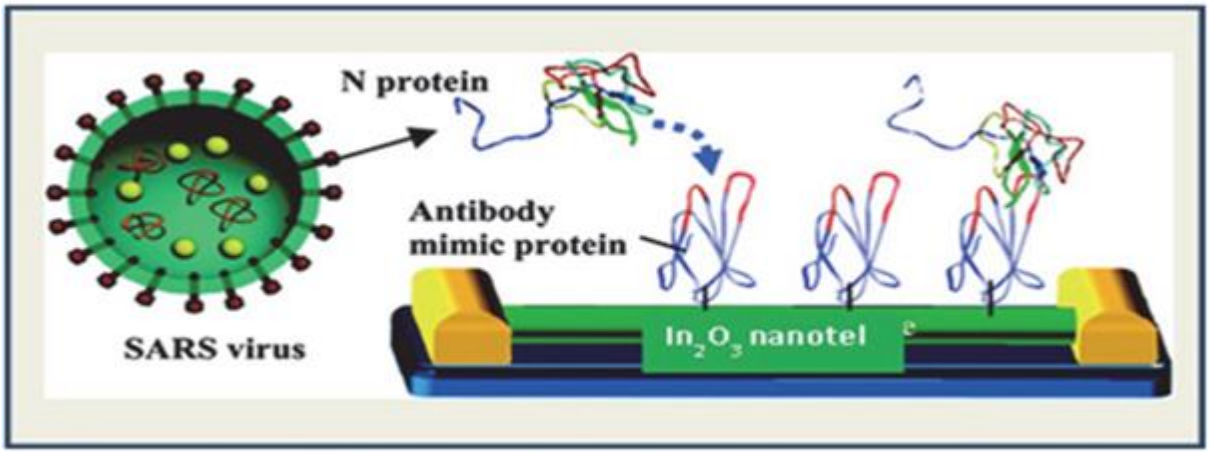

Figure 5. In_2O_3 nanowire based nano biosensors.

3.1. Automotive industry

Nano-structured substances, one of the most significant zones of nanotechnology, are of countless significance for the car production.

Initially, besides vehicle safety and security, nanomaterials will play a serious part in struggles to decrease automobile mass, advanced strength and more flexible constructions.

Steel is the most significant structural material utilized in vehicle bodies in the automotive production.

The utilize of high-strength steels in car bodies is being investigated. Nevertheless, there are deviations in the shaping of the steel in the cold state, in the dimensioning of the car frame.

This issue was tried to be overwhelmed with hot forming. Though, due to the high temperature, there is a problematic of scale creation on the surface.

Here, this can be eliminated with a multifunctional coating on the surface with nanotechnology. Glued and linked nanosized glassy substances together with aluminum form a robust layer on the surface.

With nanotechnology, scratch-resistant, dirt-proof and self-repairing car paints can be smeared on the vehicle external.

This is done with nanoparticles in the nanocoating technique, with layers that are flexible, fast-adhesive, corrosion-resistant and antimicrobial.

Amongst the systems shown in the figure on the other page, anti-fogging, antifungal, anti-reflective coatings are also flattering extensive thanks to nanotechnologies.

3.2. Energy

World-wide energy wants are fossil-based fuels, which are supplied equal to about 210 million barrels per day. 85 million barrels of this is delivered by oil (40%). At this point, the quantity of renewable energy is little. It is unspoken that this state will increase slowly when the world's energy needs are taken into account, and the associated CO_2 release to the atmosphere will reach alarming proportions.

With pyroelectric ZnO nanowires, in the change founded on temperature change, time-dependent temperature alterations can be converted into electricity with impulsive polarization. This energy change takes place with the semiconductor and pyroelectric properties of ZnO. The nanogenerator advanced here is balanced and will be able to encounter the energy supplies of nano expedients by changing waste energy.

Nanotechnologies have countless potential for cleanser, effectual and ecologically kindly energy production. Energy-related technologies in which nanotechnologies can play significant roles are given as follows: heating, lighting, convection, renewable energy, fuel cells, energy storage, hydrogen production and storage. Nanostructures

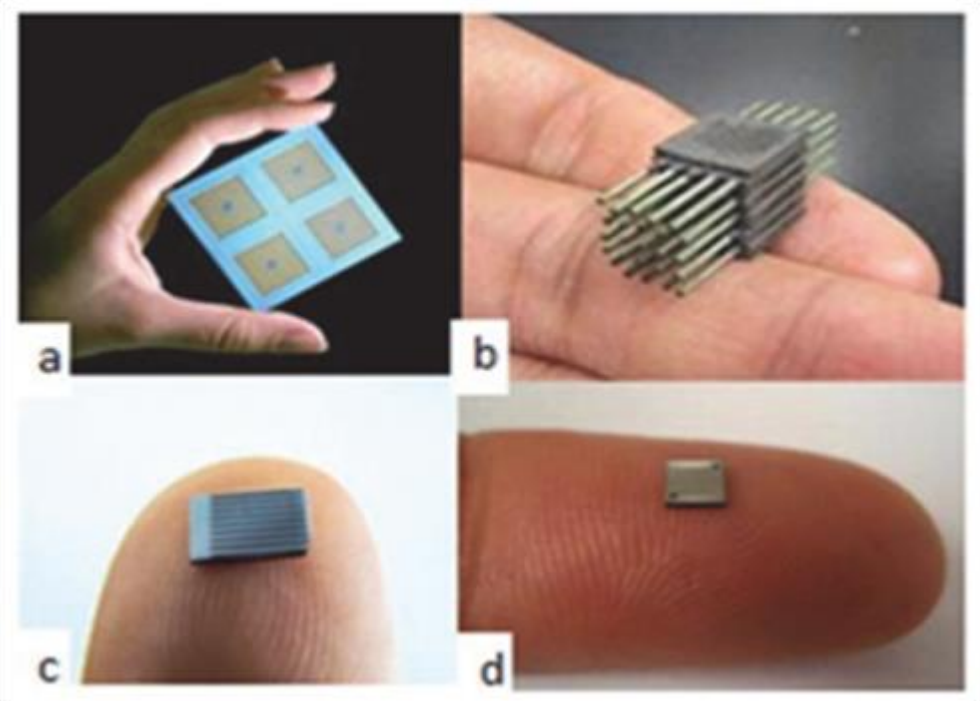

Figure 6. New generation fuel cells with nanotechnology applications.

are recently used in energy conversion and storage applications [9].

Nanofluids are shaped by mixing the CNTs added into the water. With the heat transfer of nanofluids, 10% higher efficacy can be attained in central heating schemes.

Contingent on the substances in the fuels, more efficient energy use is possible with nanotechnology. Additional effectual batteries and accumulators can be advanced with lighter and stronger materials. With such materials, an important upsurge in efficacy and success can be achieved in the conveyance industry. Here,

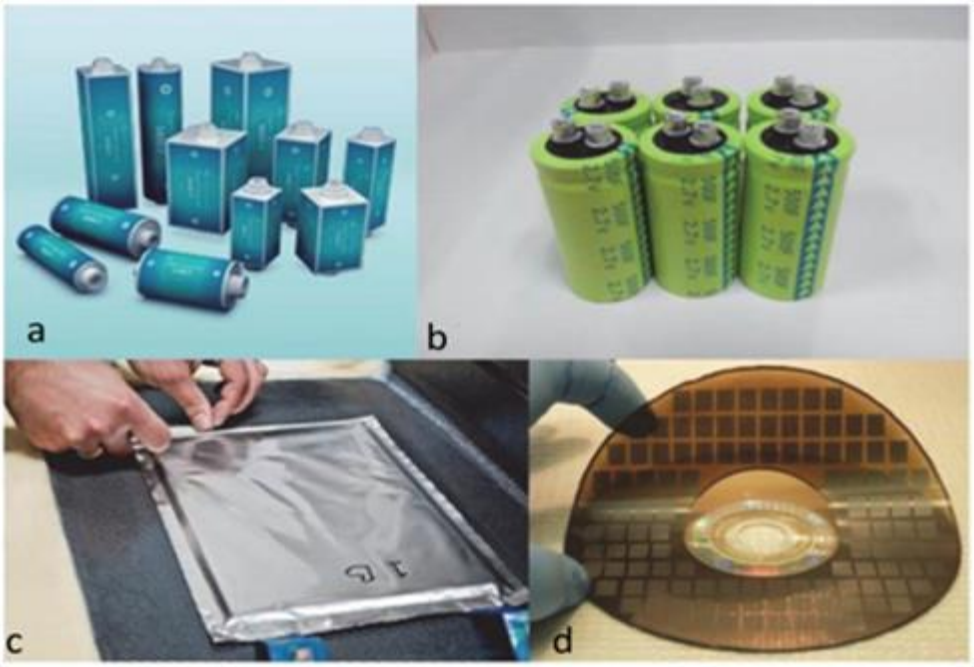

Figure 7. Various battery and energy storage examples with nanotechnology.

lightness and durability are especially significant for more effectual energy usage. In Figure 6, fuel cell applications and in Figure 7, battery and energy storage examples are shown. Selenium semiconductor structures are used in energy storage area such as rechargeable batteries [10]. Also, solar and thermal energy conversion expedients are applied for outdated photovoltaic, solar thermal, and solar thermo-photovoltaic expedients [11].

3.3. Defense

Nanotechnological progresses have led to the appearance of textile goods that have significant purposes in textile science and machineries. Combat uniforms with the subsequent features and qualities, with nanotechnological developments that can meet the necessities anticipated from uniforms and war clothes for defense technologies, camouflage covers and nets, clothes were industrialized.

Today, Unmanned Aerial Vehicles are extensively utilized for both observation and attack and annihilation purposes. Different mini-vehicles are being developed for military units and special units, marching, flying and naval at the micron level for even smaller and instantaneous short-range and short-range reconnaissance and observation. Observation tools containing different land-air-sea nanocomponents for reconnaissance-observation purposes are shown in Figure 8.

It is perceived that numerous novelties in nanosciences and nanotechnology have started to be implemented in land, air, sea and space vehicles, which are the most planned zones in defense fields. Defense vehicles all over the world are flattering zones where nanotechnology is utilized in every feature as progressive technology stages in a tremendously diverse and wide range. The illustration on the other page shows the defense utensils wherein dissimilar nanotechnologies are smeared and which attract attention particularly with their "stealth" structures. The latest warplanes, helicopters and war boats and warships developed with ghost stealth structures are exposed in Figure 9.

Nanosciences and nanotechnological innovations have started to be used in areas involving the security of society as well as military areas. Especially in the period following the September 11 attacks in the USA, there have been important developments in the concept of "homeland security" in terms of providing the highest level of security with advanced technological opportunities and capabilities.

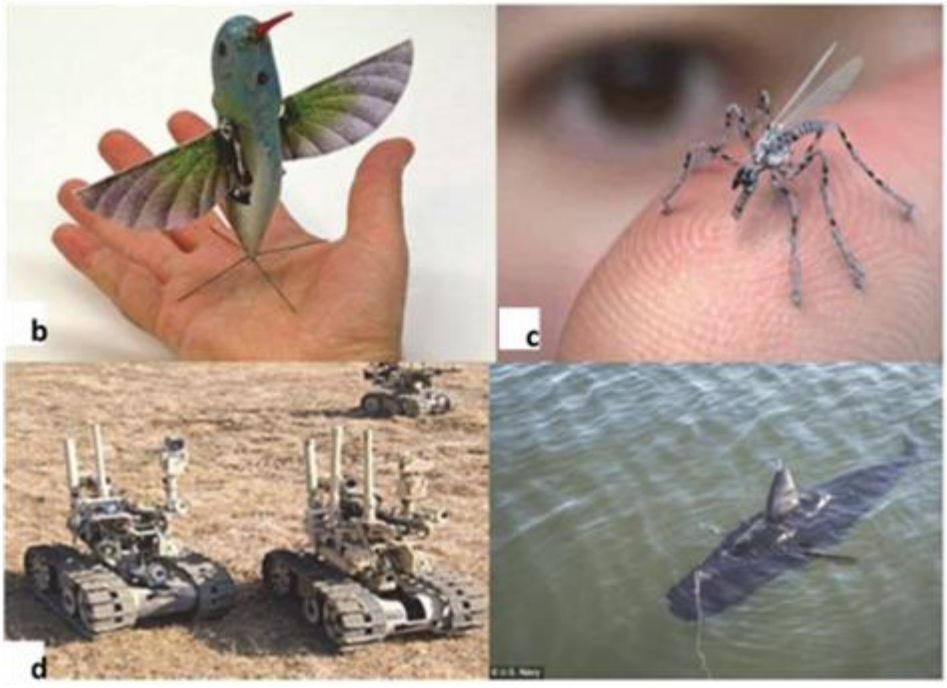

Figure 8. Observation tools containing different land-air-sea nanocomponents for reconnaissance-observation purposes.

Figure 9. The latest warplanes, helicopters and war boats and warships developed with ghost stealth features.

For the first time in the early 90s, the University of California, USA, Prof. Dr. In the "smart dust" technology introduced by Pister, the aim is to reduce the dust, grain (rice grain size), small stone-sized platforms to extraordinarily small (nano) sizes for the purpose of collecting, evaluating and transmitting news and data anytime, anywhere, to create a highly effective security network. aims to establish. The first examples are the size of a matchbox and capable of continuous data communication (including video images) from a distance of approximately 13-15 km, and they are placed in cities, on lands, in the atmosphere, and used for observation-exploration and monitoring purposes.

3.4. Environment

Nanosensor applications that can unceasingly measure air, water and environment pollution and give warning and alarm in case of nonconformity from the given threshold values are becoming

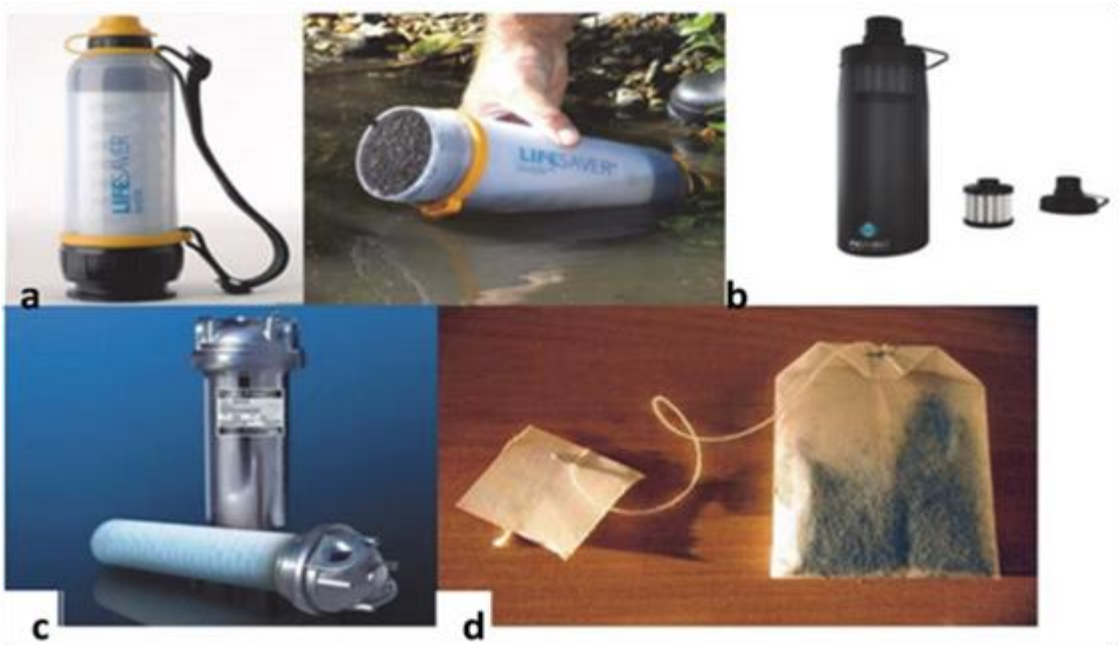

Figure 10. Nanotechnological water purification, filtering and purification application examples.

Figure 11. Airgel and silica-airgel specimens that can efficiently spotless against water, sea-ocean, and ground oil spills.

widespread. Nanosensors have a crucial part in observing the ecological quality of air, water and environment with full and sensitive data. Different nano-structured materials have been advanced for the discovery of dissimilar mechanisms.

Potable, clean water is one of the most important needs of almost every society and is often limited. It has been determined that approximately 780 million people have significant problems in accessing drinking and clean water resources. It is of great importance to develop innovative, inexpensive and practical methods with nanotechnology against the known possibilities of obtaining drinking water from sea water. Examples of nanotechnological water purification, filtration and purification applications are shown in Figure 10.

Environmental cleaning (remediation) consists of parting and other procedures, as well as works that are free from chemical and radiological pollutants and will not imperil human health. With nanomaterial applications, quicker and more cost-effective spring-cleaning and cleansing is possible. The most suitable method in nanotechnological approaches is discrimination and cleaning and removal of organic/inorganic contaminants. In Figure 11, airgel and silica-airgel samples are shown that that can efficiently spotless against water, sea-ocean, and ground oil spills.

3.5. Others

Silicon carbide [12], peptide [13] and hybrid [14] nanostructures have been reported in the use of biomedical applications, respectively. Also, self-assembled [15] and aptameric-functional DNA structures [16] are reported to use in biomedical and biological applications, respectively. Furthermore, copper sulfide nanostructures are investigated and reported the outcomes. CuxSy nanostructures are talented materials for both detecting and bio-imaging requests [17]. The usage of CuxSy NPs is not restricted to cancer, but can also be utilized in the treatment of many in vitro antibacterial diseases. This review mainly focused on the synthesis, properties and applications of CuxSy nanostructures as biosensors and their usage in cancer analysis and treatment.

4. FUTURE PERSPECTIVE

Although it is science-fiction, human beings have always wondered about the future based on their imagination. The general view of the world that will be shaped in the future as a foresight or foresight other than prophecy has been the subject of many studies graphically. Figure 12 shows the rapid

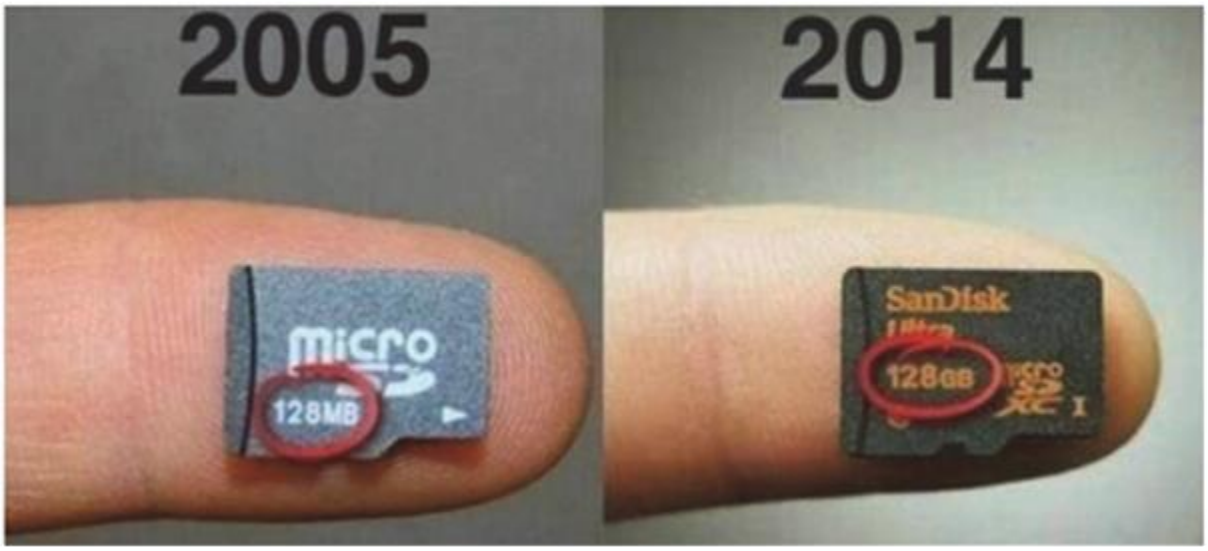

Figure 12. The development of flash drives is very fast: 128 MB capacity in 2005, 128 GB in 2014, 1 TB in 2020.

evolution of flash drives from 128 MB capacity in 2005 to 1 TB in 2020.

Cities of the future are expected as follows:

a. Astronomically high skyscrapers in cities with population growth; "megacities",

b. Due to the increasing traffic density, transportation must be made from the air at short distances; flying automobiles or transportation vehicles;

c. The absolute representation of the green image as a cause for concern; “green cities” where a more environmentally friendly and sustainable environment is created;

d. Undoubtedly, providing the energy source with non-polluting, recyclable and environment-friendly technologies;

e. The unavoidable pace of everyday life, ever increasing;

f. Cities built on mobile platforms or on water-sea or submarine/underground.

The vehicles of the future are expected to:

- Self-driving cars (Google has such a tool) and smart highways;
- Flying cars; anti-gravity devices;
- Flying, turbo and wheeled boats;
- Smart vehicles that are sensitive to the environment and can respond to different conditions;
- Electric vehicles that do not require charging; “solar” cars powered by solar cells.

Undoubtedly, humanity wants to see an environment of peace, a peaceful and war-free world in their dreams for the future. In general, various innovations and technologies awaiting the society of the future are listed below: the digital currency era; disappearance of cash; making "transhuman" (robocop!) with improvements in the human-machine interface; placement of implants in the body for identification, follow-up, monitoring; the aging of generations with the prolongation of life expectancy.

The following technological predictions are in question in the developments in medicine, health and life sciences that will affect the lives of individuals in the future world: average life expectancy above 100 years; healing of all kinds of diseases by DNA repair and manipulation; organ regeneration; designed dolls, bodies, organs; immediate pain relief, artificial muscles for maximum empowerment. In Figure 13, some possible examples of future medicine and health technologies are displayed.

A rapidly changing “Nano World” with developments, innovations and new discoveries in nanosciences and nanotechnology may take shape in our future. It is calculated that nanotechnologies, together with their key roles and rapidly combining with information-communication, biology and cognitive (brain and perception) sciences, will create vast innovation opportunities in all other science and technology fields.

Figure 13. Examples of future medicine and health technologies.

5. CONCLUSIONS

The subsequent deductions can be drawn from the current investigation:

a. Nanotechnology uses the results from the emergence of new properties of matter at the nanoscale. At the nano level, the chemical and physical properties of matter differ considerably. Nanosensors, Nanomachines and nanorobots are important systems used in nanostructures.

b. Nanomachines, the smallest of which are the magnitude of a virus, are much lesser than a human cell and are usually measured in micrometres. There are already billions of organic nanobots within us that power many functions of our cells. Nanomachines are fabricated from DNA or other biological materials that flawlessly interrelate with biological environments in certain ways to achieve specific results. One benefit of nanomachines is that the separate units involve very little energy to operate. For example, nanites can last for periods before deteriorating. The chief difficulty lies in the production approaches.

c. "Nanobots", the first applications of which began to be seen in the field of medicine and health, can be defined as nano-mechanisms that protect the human body against pathogens and keep it in balance. Small doses of drugs or chemicals can be transported on nanorobots in a suitable chamber. The nanorobot can deliver the drug directly to the diseased area or wound. Nanorobots can also be used directly in cancer treatment by carrying chemotherapy chemicals.

d. The nanosensor transforms data and information from the atomic scale and nanoparticles into analyzable macroscales. Its biggest advantage is that it can work in small places where macro and micro sensors cannot reach; require less power in their operation; higher precision and adaptability for specific purposes. Application areas of nanosensors are as follows: Medicine, medicine, health technologies, Ecology, environment, Security, defense and military, Industrial, aviation, Daily life, white goods, Transportation, Communication, integrated circuits, buildings and facilities.

e. Nano-structured materials are of great importance for the automotive industry with their reduction in vehicle weight and their more flexible and durable structures. In addition, with nanotechnology, anti-scratch, dirt-proof and self-healing vehicle paints can be applied to the outer surface of the vehicle.

f. For the world's increasing energy needs, nanotechnologies have great potential for cleaner, efficient and environmentally friendly energy production. Among the important energy technologies in which nanotechnology can play a role, we can count heating, lighting, energy storage, hydrogen production and storage, and fuel cells.

g. Nanotechnological developments, combat uniforms that can encounter the necessities anticipated from uniforms and war clothes, camouflage covers for defense technologies have been established. Today, Unmanned Aerial Vehicles are extensively utilized for both surveillance and attack and destruction purposes. Different mini vehicles are being developed for military units and special units, flying, walking and at sea at micron level for smaller and instant short-range observation.

h. Nanosensors, which have become widespread recently, have an indispensable role in monitoring the ecological quality of air, water and the environment with full and sensitive data. Different nanostructured materials have been developed for the detection of different components. Faster and more cost-effective cleaning and purification is possible with nanomaterial applications. The most appropriate approach in nanotechnological methods is selectivity and cleaning and removal of pollutants.

i. There are the following technological predictions in the developments in medicine, health and life sciences that will affect the lives of individuals in the future world: the average life expectancy is over 100 years; Healing all kinds of diseases by DNA repair and manipulation; organ regeneration; designed babies, bodies, organs; instant pain relief, artificial muscles for maximum strengthening. In our future, a rapidly changing “Nano World” may be shaped by developments, innovations and new discoveries in nanoscience and nanotechnology. It is calculated that nanotechnologies will rapidly combine with information-communication, biology and cognitive (brain and perception) sciences with their key roles and create enormous innovation opportunities in all other science and technology fields.

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