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FUTURE TRENDS FOR GREEN ENVIRONMENTAL APPLICATIONS OF NANOTECHNOLOGY: A REVIEW

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Review Article

Abstract

Providing a clean and safe environment is one of the great challenges facing humanity. As a result of various human activities over thousands of years in the field of agriculture, industry, housing, burning fuel and elimination of forests and agricultural areas, the environment has been greatly destroyed, and water, air and soil are polluted, and this has resulted in a several risks and problems that It began threatening humanity, perhaps the most important of which is the spread of diseases and epidemics caused by pollution, such as climate change and global warming, which caused major climatic problems that led to storms and floods on the one hand, and drought, desertification and water scarcity on the other hand. It may also lead to bigger and deeper problems if we delay facing this challenge. Green environmental applications such as nanotechnology have great for environmental sanitation (land, water, air) and treatment of pollution resulting from agricultural and industrial activities, accommodation and others. It has a set of low-cost solutions to environmental cleaning problems. Environmental protection is one of the most prominent applied fields that nanotechnology pays great attention to because of the interrelationship between human health and environment in which-it lives. Green technology aims to use less harmful technology to human health and the environment and gradually leads to storage, distribution and use systems that are clean and non-

polluting to the environment. Thus, it reduces carbon dioxide emissions significantly, and saves the world from the problem of climate change or global warming. Hence, this article aims to review the future green ecological applications of nanotechnology.

Keywords: Nanotechnology, Green environmental.

التطبيقات الحديثة والافاق المستقبلية لتقنيات النانو: مراجعة مقال

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الخلاصة

نتيجة للنمو السكاني في العالم، يتزايد استهلاك الطاقة والمواد، مما يؤدي إلى عواقب بيئية. وتشمل بعض هذه العواقب زيادة إنتاج النفايات الصلبة، وزيادة تلوث الهواء الناجم عن المركبات والمنشآت الصناعية، وتلوث المياه السطحية والجوفية. تتمتع تقنية النانو بإمكانية تحسين البيئة من خلال التطبيق المباشر للمواد النانوية للكشف عن الملوثات ومنعها وإزالتها والتطبيق غير المباشر لها باستخدام عملية تصميم صناعي أفضل وإنتاج منتجات صديقة للبيئة. تعد تقنية النانو مجالًا ناشئًا يغطي مجموعة واسعة من التقنيات قيد التطوير حاليًا في المقياس النانوي. يلعب دورًا رئيسيًا في تطوير طرق مبتكرة لإنتاج منتجات جديدة، واستبدال معدات الإنتاج الحالية وإعادة صياغة المواد والمواد الكيميائية الجديدة مع تحسين الأداء مما يؤدي إلى تقليل استهلاك الطاقة والمواد وتقليل الضرر الذي يلحق بالبيئة بالإضافة إلى المعالجة البيئية. على الرغم من أن انخفاض استهلاك الطاقة والمواد يفيد البيئة، فإن تقنية النانو ستوفر إمكانيات لمعالجة المشكلات المرتبطة بالعمليات الحالية بطريقة أكثر استدامة. تتناول التطبيقات البيئية لتقنية النانو تطوير حلول للمشاكل البيئية الحالية، والتدابير الوقائية للمشاكل المستقبلية الناتجة عن تفاعلات الطاقة والمواد مع البيئة، وأي مخاطر محتملة قد تشكلها تقنية النانو نفسها. لقد بحثت هذه المراجعة في تطبيقات تقنية النانو لتطوير حلول للمشاكل البيئية الحالية، والتدابير الوقائية للمشاكل المستقبلية الناتجة عن تفاعلات الطاقة والمواد مع البيئة.

كلمات مفتاحية: نانو تكنلوجي، البيئة الخضراء.

Introduction

After the era of steam and huge mechanical machines that began at the end of the eighteenth century, the period of Silicon, which emerged with the invention of the first transistor at the beginning of the fifties, has entered human civilization in a new phase since the beginning of the nineties, which is the era of nanotechnology (9). Nano-science is the study of structures and molecules on the Nano-meter scale, which is about 1-100 nm; while nanotechnology is the branch of technology that applies Nano-science to everyday objects like devices. A single human hair is 60,000 nm thick and the DNA double helix has a radius of 1 nm as a point of comparison (Fig.1).

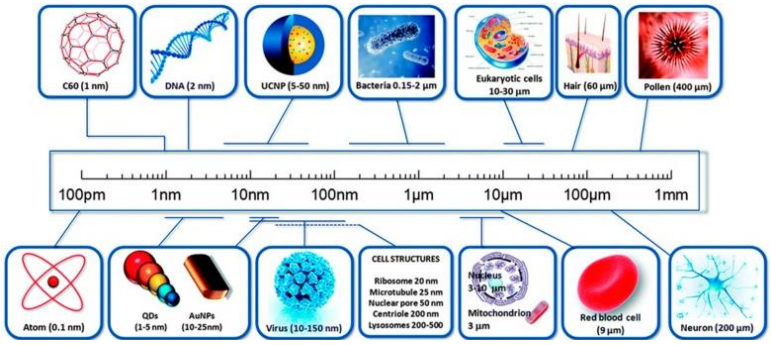

Figure 1 A comparison of sizes of Nano-material. Reproduced with permission from reference (2).

The science of nanotechnology has received great attention globally because of the radical changes it has brought about in the physical, chemical, magnetic and electronic properties of materials (18). The goals of nanotechnology are consistent with the international development goals set by the United Nations in the third millennium. The United States announced the National Nanotechnology Initiative, which made nanotechnology a national strategic technology and opened the field of great government support for this technology in all industrial, scientific and university fields (10). This was followed by Japan's establishment in 2002 of a specialized centers for researchers in nanotechnology by providing all specialized equipment, supporting and encouraging researchers and exchanging information among them (47). Applications of nanotechnology (Fig.2) are driving the development of Nano-particle uses in various fields (energy storage, production and transfer, improvement of agricultural production, drinking water treatment, disease diagnosis and follow-up, drug delivery, food processing and storage, air pollution treatment, construction, health monitoring, pest and insect resistance (3 and 13).

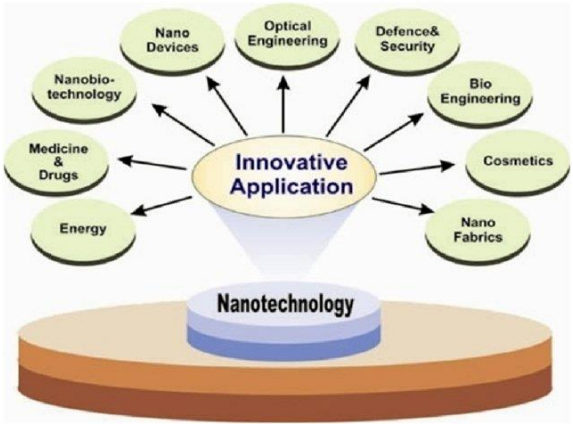

Figure 2 Various applications of nanotechnology.

Let's look at the ten most important challenges facing society in the twenty-first century. We find that energy comes first, followed by the provision of healthy water, safe food, a clean environment, poverty, terrorism, wars, the spread of diseases, education, democracy and the population explosion (34 and 40). Followed by providing healthy water, safe food, a clean environment, poverty, terrorism, wars, the spread of diseases, education, democracy and population explosion (53). The field of nanotechnology is not a separate field from science, but rather works on the basic components of matter, namely atoms and molecules, and the roots of Nano-science and technology are the gems of concepts of science, and what is new is to increase our understanding of the interaction between atoms and molecules and the tools used to process and create new materials and tools on the ultra-small gradient (28, 29 and 46). The literature (19) indicates that nanotechnology is an attempt to understand the behavior and properties of materials and control them at scales ranging from individual atoms or molecules to around 100 Nano-meters to create small-sized installations, devices and systems with new properties and functions. The borders between traditional branches of science such as chemistry, physics, mechanics and biology are disappearing with the emergence of Nanotechnology and Nano-materials. It has given great hope for scientific revolutions soon that will change the direction of technology in many applications (33). The widespread interest in nanotechnology dates back to 1996-1998, when the American International Technology Evaluation Center conducted an evaluation study of nanotechnology and its importance in technical innovation. The study concluded with points, the most important of which is that nanotechnology has a great future in all medical, military, informational, electronic, computer, petrochemical, agricultural, biological and other fields (36). This technology aims to make materials used in all areas of knowledge, whether chemical, physical, biological, or industrial advanced technology. Nanotechnology is an upcoming industrial revolution that will transform cognitive and industrial concepts into something like a fantasy compared to the current reality concepts (33 and 49). Nanotechnology is applied due to its ability to integrate the physical, biological and chemical properties of Nano- materials so that they can be employed in any field, whether in the human body, or in the engine of an aircraft. Conventional, and then standardizing the quality of the product, as well as reducing

the cost of production and reducing the energy consumed, and there are devices at the Nano level capable of directing the atoms and putting them in their right place during the reaction process (5).

Environmental protection is one of the most prominent applied fields that nanotechnology pays great attention to due to the connection between human health and the ecological conditions in which they live. Pollution is typically caused by industrial activity, agricultural chemicals or improper disposal of waste and is associated with the population growth rates the world is witnessing. There is a need to create new materials that protect the environment by cleaning up contaminated natural waters, wastewaters, and the air (36). There is a need not only to create new materials that protect the environment by cleaning up toxins from natural waters, wastewaters and the air but also to develop novel nanomaterials and modernize the techniques currently used in the removal of pollutants. Nanotechnology can be used to remove toxic chemicals, bacteria, and heavy metals from sewage, and may be able to extract some radioactive isotopes from the discharge of nuclear reactors (27). Researchers at the Pacific Northwest National Laboratory in Richland, Washington (part of the US Department of Energy) used a permeable silica cast with a special active layer to remove lead and mercury from the water supply (45). A study confirmed that one of the most important challenges facing the field of nanotechnology is the environmental field, which focuses on the main concepts from several sub-fields. All traditional sciences and technologies have failed to provide successful and sustainable solutions to many issues and challenges facing human societies today. The hope was for a scientific breakthrough that uses new sciences and technologies that can confront these issues and challenges. These breakthroughs are expected to face these issues and challenges and provide successful and sustainable solutions. Nanotechnology has important roles to play in international efforts in the field of sustainability due to its ability to understand and address issues early as well as solve them at the atomic and molecular level, i.e. the building blocks of matter (living or nonliving). Green nanotechnology significantly enhances environmental sustainability by producing Nano-materials and Nano-products, without harming the environment and human health (31). To address these issues, the current nanotechnology research attempts to answer the main question: What are the green environmental applications of nanotechnology in the future? This review highlights the applications and future impact of nanotechnology in various fields.

The concept and history of nanotechnology: The word Nano is a Greek word meaning dwarf. Getting acquainted with the manufacture of materials, devices and systems at the nanoscale requires familiarity with the nature of nanotechnology, since a nanometer is one billionth of a meter, or a nanometer (nm). In addition, Nano-meter is a thousand times smaller than a micrometer; and one micrometer (μm) is a thousand nanometers. A Nano-meter is tens of thousands of times smaller than the diameter of a single strand of human hair; also, thousands of times smaller than a human cell, and a hundred times smaller than a cold virus, for example. The beginning of nanotechnology goes back to the American mathematician Richard

Feynman, who won the Nobel Prize in 1959, the inventor of the idea of Nano (9 and 38). Where the term nanotechnology first appeared in 1974 by the Japanese scientist Norio Taniguchi while he was trying to express the means, methods and processes of manufacturing and operating micro-mechanical and electrical elements (15 and 51), and in 1981 the Swiss scientists "Gerdbing" and "Henrikruhr" were able to invent the " the microscope" Scanning Tunneling", for which they were awarded the Nobel Prize in 1986 (48). This microscope made it possible for the first time in history to obtain images of particles and atoms and the possibility of affecting them and moving them to form “Nano” formations, opening the door wide to “nanotechnology.” (21 and 50), and in 1986 the American mathematician Eric Drexler wrote a book called Engines of Genesis. He simplified the basic ideas of nanotechnology, including imaginary concepts and proposals that express the possibility of imitating biological systems in biology and manufacturing molecular-sized devices (16 and 27). But the actual launch of nanotechnology was in 1991, when a Japanese researcher discovered “carbon Nano-tubes” (55). While he was studying the ash resulting from the process of an electric discharge between two carbon electrodes, using a highly efficient electron microscope, he noticed that the carbon molecules take a tube-like arrangement inside each other and the diameter of these tubes is in a range not exceeding a few Nano-meters. In 1993, the American scientist Donald Beth was able to monitor Nano-tubes. “Nano-tubes" consisting of only one layer, the diameter of one tube is 12 Nano-meters. A team of Chinese scientists recently gained access to the smallest Nano-tube in the world, with a diameter of only 0.5 Nano-meters, and in 2004 the industrial application phase of this technology began, and Nano-metric materials were used in the Malaysian rubber industry, which led to an amazing improvement in its specifications, its mechanical properties jumped from 12 to 20 times to add simple parts of the Nano-materials, as was possible by the current Nano-formulations. As for the overlapping Nano-tubes, they show a unique property as they move inside each other without any resistance, which makes them eligible for Nano--industries with superior capabilities in various fields, especially the medical fields military, computing and communications. Scientists have predicted a promising future for this technology, and industrialized countries are pumping millions of dollars to develop it. Japan’s funding to support nanotechnology research for this year has reached one billion dollars, while in the United States, the budget provided for this science is estimated at one trillion dollars until 2014, and there are 40,000 qualified scientists working in this field (4). Today, the world stands on the threshold of a tremendous scientific revolution that is no less than the industrial revolution that moved it to the age of machines and the age of industries or the technological revolution that moved it to the space age, which is based on the use of particles in the manufacture of everything with new unique and distinct specifications and at a cost often up to one tenth of the current cost.

The future effects of nanotechnology: Scientists consider nanotechnology to be the language of the future; it is one of the innovations of the post-industrial stage, where the industrial stage setting relied on the philosophy of mass production based on ability. It is one of the innovations of the post-industrial scene, where the industrial

stage relied on the philosophy of mass production based on knowledge. In contrast, the new industrial wave depends on scientific innovation and the production of knowledge itself, and the use of the smallest organisms, whether in the "femtosecond" time or in Biology, where the secret code for the formation of living cells was known, which facilitated the cloning of animals, or the development of medicine. It became possible, thanks to nanotechnology, to implant a micro-submarine no larger than a pin head, consisting of two thousand or three thousand atoms, to resist cancer cells and stop their growth.

In contrast, the production of invisible nanotech-enabled weapons remains the most dangerous aspect of nanotechnology. The American " Stealth Fighter" plane, which was tested for the first time in the 1991 bombing of Iraq, which radar does not see, relies on the idea of placing Nano-particles as close to the transparent color as possible, absorbing the electromagnetic waves emitted by the radars and disappearing from the screen while they pass directly over the target. Nanotechnologies herald a new industrial revolution; whose applications are expected to enter fields other than medicine and military aspects, such as agriculture, food, water purification, the environment, electronics and computers. It will also meet needs in military, security and exploration applications in near far space. Scientists point out that with nanotechnology, it will be possible for a person to carry a supercomputer on his wrist, the supercomputers that exist today in research centers or large universities will be just a wristwatch carried by humans, meaning that this technology will make everything from the needle to the missile. Still, the supercomputers that exist today in research centers or large universities will be just a wristwatch carried by humans, meaning that this technology will make everything from the needle to the missile. Still, with a quality that surpasses everything that was made before and at a very low cost, and using this wondrous technology, our clothes will alert us about our health, environmental factors, and perhaps the weather. You may choose for us the appropriate clothes for the weather. Rather, it will clean itself without any assistance, heat or cool the body according to the outside temperature, and buildings and machinery will be able to transmit wirelessly when they need maintenance, or they may be able to repair themselves (42).

Green environmental applications of nanotechnology in the future: Nanotechnology has brought about tremendous progress in cleaner production technology represented in reducing industrial waste, thus eliminating industrial pollution, improving the efficiency of the use of available economic resources, and working on the production of heat-resistant neoplastic and oil products (30 and 56). Environmentally friendly Nano-materials are used that interact with ultraviolet rays, allowing the process of self-cleaning of materials such as: windows, car glass, as well as the use of Nano-particles that work to get rid of pollutants and unpleasant odors, such as: using silver particles and Nano-titanium dioxide (20 and 44). There are numerous applications for this wonderful technology in agriculture, bio-biology, and engineering, not forgetting the military occupation and many other fields (39).

Various human activities in agriculture, industry, and housing, fuel burning, and deforestation negatively affect the environment by polluting the water, air, and soil. Thus, the natural balance has been altered, and its consequences affected many different aspects of our lives, causing problems that began to threaten humanity, such as the spread of diseases and epidemics as well as climate change and global warming. Climate change impacts human health via direct and indirect pathways, including increased mortality in the population and the appearance and spread of infectious diseases (1). There is also a great need to solve these problems more effectively; science and nanotechnologies have great potential for environmental sanitation (water, air, and land) and treatment of pollution from agricultural, industrial, housing and other activities. Nano-particles represent a new generation of nanotechnologies that treat and clean the environment from pollution, and have a range of low-cost solutions to environmental clean-up or remediation of pollutants (32). Among these nanoparticles, iron nanoparticles possess a good efficiency in treating environmental pollution. It can absorb a large number of pollutants due to its large surface area and high surface energy. Many Nano-products have been experimentally proven to be able to remove pollution and clean the environment, including Nano-porous membranes and filters that remove pollutants from water and gaseous media (39). Nanofibers have exhibited great potential manufacturing various types of protective clothing and environmental applications (43). Recent development in nanotechnology offers many solutions to improve the environment and to produce more efficient and cost-effective energy concerning reducing - carbon dioxide emissions significantly and saving the world from the problem of climate change and global warming (2).

Uses of nanotechnology in the fields of food and agriculture: Food companies seek to apply nanotechnology to produce the best crops free of preservatives and harmful chemicals. In the food industry, nanotechnology can improve food quality, shelf life, bioavailability, cost, and nutritional value. Nanotechnology is one of many disciplines that integrate chemistry, physics, biology, and engineering researchers into one template. Nanotechnology has many food applications, among which we mention food additives (Nano-scale) to develop the manufacturing quality of foodstuffs as well as food safety in addition to enhancing food packaging materials, for example; the use of Nano-materials can inform the consumer about the safety and suitability of the food item, as Nano-perceptions are added to the food manufacturing substance to identify the spoilage of food products as well as harmful microbes (22, 41 and 52). The most exciting application is for the Kraft Company, which specializes in the food industry. Some time ago, it invented programmed drinks, which are tasteless and colorless drinks that include Nano-particles for color and taste. When placed in the microwave at a certain frequency, they turn into lemon juice; at another frequency they turn into apple juice and so on (37).

Nanotechnology applications in water purification: Water is the most important component of life on Earth and a precious resource for human civilization. Providing clean and affordable water to meet human needs is a major challenge in the twenty-

first century worldwide, and 780 million people still lack access to improved drinking water sources. 80% of diseases in developing countries are caused by polluted water. The need for water increases with the increase in population growth and per capita consumption, and two-thirds of the world is threatened by thirst by 2050.The water cycle in nature has preserved the provision of fresh water and its purity during the exchange of water between the ocean, the land, and the atmosphere with the permanent recharge of groundwater, rivers, and lakes, and this has generated a guarantee of water availability and purity, but the various human activities resulting from the enormous economic developments and over a long period (Industrial and agricultural activities, the development of cities, and the burning of fossil fuels) contributed significantly to water pollution and increased demand (water withdrawal increased during the period from 1900 to 2010 to more than eight times), and also led to a significant change in the climate, which increased temperatures, Sea level rise, snow melt, and irregular rainfall. Thus, water resources have been affected in many parts of the world and have begun to deplete and become more polluted, and it is no longer possible to meet the increasing need for them, and they have become the main factor limiting economic development and population growth. During the past few years, there have been applied research outputs that led to the presentation of several promising innovative solutions related to the field of nanotechnology and its current and future applications in treating environmental pollutants in water, soil and air and avoiding their occurrence again (17, 23 and 26). One of the most important of these sciences and technologies that are qualified to provide new and innovative solutions to provide the required quantities of water by desalinating sea water, treating invalid water and removing various pollutants from it and keeping it pure, where Nano-filtration membranes are used to remove salts, dissolved (desalination) from saline (hard) water, removal of micro-contaminants (arsenic and calcium), water softening (removal of calcium and magnesium ions) and waste treatment, and in some uses the removal of biological pollutants such as microbes and viruses, as well as Nano-catalysts of various forms and types that can be used to analyze organic pollutants, salts and heavy metals from liquids, while magnetic Nano-particles are used to remove heavy metals such as arsenic, salts and organic compounds from water. We need for sampling for analysis in laboratories, and working to monitor water and keep it pure, and some many scientific institutions and companies have started working on using nanotechnology to desalinate or treat water, remove pollutants from it, recycle, monitor and keep it pure (5).

Nanotechnology applications in the field of air purification: Through nanotechnology, ground measurements made using portable measuring devices with precise Nano-sensors have made it possible to monitor and monitor air pollution levels (14 and 30), and this is done by linking these devices wirelessly to geographic information systems. The light-weight and small-sized sensors are distinguished by their superior sensitivity in distinguishing between explosive materials and filtering them with high accuracy. Nano-sensors were employed in monitoring and tracking the forest fires that broke out in California in 2007, as well as using thermal imaging technology, and

NASA took this step after the planes failed when they took off to fly over the burning areas (54).

Preparation Methods of Nano material: The objective of various industrial applications and technology is to produce highly efficient and safe products, and therefore the technological complexity does not stand in the way of reaching chemicals with high-quality applications and specifications. The physical and chemical specifications accompanying the raw materials often determine the type and nature of the method used to prepare nanoparticles. Although there are differences between the production methods, they depend on the economic cost and production capacity of each technique. Synthesis methods also depend on the diversity of use and application of the prepared nanomaterials (8). The increasing demand for these materials; since their inception, has led steadily to a diversification of their production methods with high potentials at the qualitative and quantitative levels, especially in the industrial fields (electronics and communications) and medical fields (various treatments and the manufacture of biological alternatives for humans), which was not only impossible to reach but also required economic cost. One of the most important common features of all methods is building a material at the scale of the atom (atom vs. another) to design new materials with desired properties to get the desired results (5). The difference in the mass size scale of an individual substance leads to the difference in the chemical activity; the smaller the scale, the greater the chemical activity resulting from, the greater chemical effect of this substance. Accordingly, nanotechnology and nanoscience are steadily accelerating based on the interim requirements and the global technical explosion in various sectors (11). Consequently, the great global competition in nanotechnology will create great pressure on the governments of developed countries to continue and reach the best result for the unexpected economic effects of doing so. The government of the United Kingdom of Great Britain constitutes one example of this, as it formed global research teams according to a two-year plan, and the experiment was subsequently repeated with another five-year schedule. Evaluating the results and the level reached, and thus taking into consideration all the recommendations lead to quick access towards the best production of these materials, which are mostly environmentally friendly materials that do not deplete natural resources and are more economical in various sectors. The manufacture of Nano-motors is an example of rapid development (11).

Technologies of preparation: The size of the expected particles is a reason for the quality of the technology used to build Nano-particles, in addition to the nature of the use constitutes a decisive work in the heart of the technology used, especially in the optical styles and the medical field. There is a wide variety of techniques that can produce Nano-structures with varying degrees of quality, speed, and the cost. All these techniques can be included within two main classifications, namely, the ascending path and the descending path, and the electrochemical method was used.

Bottom-up Technology: This method is based on the process of assembling and building Nano-particles from smaller particles (atoms and molecules). To obtain this

method depends on the chemical reaction variables and the type of control systems used for each aggregation reaction to obtain particles of required size and shape. It starts with the atomic level and builds molecules with extreme precision. Through the self-assembly of particles, the atoms are arranged in a specific structure subject to their minute nature. The modern semiconductor industry depends on the growth of crystals, which gives a good example of the method of self-assembly (self-growth). This method relies on removing the last weakly bonded atom and sticking it to the modern molecule. Bottom-Up Technology this method can be called the shredding method (the process of converting large-sized materials into smaller sizes and the same material mass) the shredding method (the process of converting large-sized materials into smaller sizes and the same material mass) metaphorically, and it depends on the principle of removing atoms or molecules from the original materials of large dimensions. The use of thin films for materials is one of the common methods in this field to produce Nano-materials according to the required measurements, but several other techniques are used in this method, especially mechanical cutting technology and superior engineering control technology. Using these techniques to obtain Nano-materials directly or manufacture them depends on using micro-composition materials (12).

Convergence of top-down and bottom-up techniques: The convergence relationship between the preparation techniques for Nano-materials top-down and bottom-up can be explained and during seventy years of production, which is represented in the amount of development that has taken place in the accuracy of the dimensions and measurements used in this field and from 1974 until 2010, where the evolution and diversity of methods are noted within the range of the two techniques and the convergence achieved Between them is a proportion of the measurements he has reached compared to the time required for the growth and development of this field. The production of designs for large particles can be controlled through advanced chemical processes in this field. Currently, the dimensions of control are represented by the development of existing preparatory methods, which leads to excitement and the generation of forms. A hybrid for manufacturing, or by using certain intermediate cases to improve the quality of the Nano-product and the economic costs associated with it, taking into account the resulting environmental impact and according to the permissible international standards (6 and 35).

Eco-Friendly synthesis of Nano-particles: Environmentally friendly synthesis depends on biological systems and plants, as this method is low cost, safe, harmless, less polluting and toxic to the environment, and the scope of synthesis can be expanded. Therefore, environmentally friendly synthesis is preferred over various chemical methods. Plant receptors mediate its salty substances, and the valence states of mono and binary metals change to a zero-valence state and the metal atoms are linked and the growth phase occurs to form a group of diverse shapes and then create Nano-particles and form a morphology mediated by activity and plant receptors. Nano-particles can be synthesized from organisms and Microorganisms, including fungi, algae, seaweed, and rainwater (24 and 51).

Conclusions: The modern technology called nanotechnology, which some people may know and others may not be aware of, is a set of tools, techniques and applications related to manufacturing and installing of a specific thing using extremely small scales. Nanotechnology is based on the use of molecules in producing everything that can be produced with new and unique specifications. The importance of using nanotechnology lies in a very large reduction in costs and in a manner commensurate with the new specifications that products enjoy when compared to other methods, whether traditional or modern. Nanotechnology has multiple uses services in all fields of science.

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