Nanotechnology for clean, beautiful and healthy life

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1. Abstract

나노기술은 단순히 작은 물질의 세계에 대한 과학적 발전만을 의미하는 것은 아니고, 21세기의 신산업 혁명이라 불리 울 만큼 사회, 경제 전반에 지대한 변화를 가져오는 시대의 커다란 흐름으로 이해하고자 한다. 본 논문은 나노기술을 보는 세계인의 시각 속에서 우리 나름대로의 나노기술에 대한 정의를 내려보고 아름답고 건강한 삶을 추구하는 인류에게 특히 생활용품, 화장품, 의약품 분야에서 나노기술로 인해 얼마나 많은 변화가 올 것인가를 예측해 보는 것에 초점을 맞추었다.

2. What is nanotechnology?

Nanotechnology can best be considered as a 'catch-all' description of activities at the level of atoms and molecules that have applications in the real world. A nanometer is a billionth of a meter, that is, about 1/80,000 of the diameter of a human hair, or 10 times the diameter of a hydrogen atom. Based on the definition of the national nano initiatives, we define that nanotechnology is the creation and utilization of functional materials, devices and systems with novel properties that are achieved through the control of matter at the molecular

level in the range of 0.1 nm to 100 nm. The two fundamentally different approaches to nanotechnology are graphically termed 'top down' and 'bottom up'. 'Top-down' refers to making nano scale structures by machining and etching techniques, whereas 'bottom-up', or molecular nanotechnology, applies to building organic and inorganic structures atom-by-atom, or molecule-by-molecule.[1]

Over thirty years ago 20th Century Fox took the movie going public on a "Fantastic Voyage". In the cinema, scientists with the ship shrank to the size of a pin's head. Audiences shuddered and gasped as the miniature ship sailed through the bloodstream, encountering white blood cells that seemed as large as the giants confronted by Gulliver on his travels. The ship's crew narrowly avoided destruction and its heroes were restored to normal size. It was a fantastic first step toward human dreams of shrinking medicine to microscopic size. Today at the cinema we are entertained by even more dramatic stories of kids shrunk to the size of ants (Honey, I Shrunk the Kids (Disney,1989) and Honey, I Blew Up the Kid (Disney, 1992)). But is it just fiction? In 2000, the barrier between man and machine is as thin as a strand from the double helix. As computer equipment, surgical tools and communications pipelines shrink ever smaller, the next step in engineering is to merge biological and mechanical molecules and compounds into really, really small machines. This will happen in many different ways, and it raises many new issues. So, many people living today become to believe that nanotechnology will make our dreams come true.[2]

3. Application of nanotechnology at household and healthcare industry

3-1. Treatment of cancer and age related disease[3]

From the simplest of organisms to the most complex, cells form the building blocks of life. Cells can be separated into two groups; those that can divide and that will never divide. Cells that do not divide for the entire life of the organism are known as post mitotic, these are cells such as nerves or muscles. Cells that have potential to divide are known as mitotic. These cells constitute the majority of epithelial organs such as liver, gut, skin and it is these cells that have the potential to cause cancerous tumors.[3]

Dermal fibroblasts, the mitotic cells that make up the underlying dermal layer of the skin, experience a significant change of function due to cellular sequence. Fibroblasts from young dermis produce collagen and elastin, both essential to the health and elasticity of skin. Senescent fibroblasts on the other hand not only stop making high levels of collagen and elastin, but they also produce collagenase the enzyme that degrades collagen. Dr. Minica Peacock at Columbia University suggested that old skin, with senescent fibroblasts stops producing collagen and elastin that is essential to health and elasticity of the skin. He also suggests that more tumors occur when tumor cells are introduced into senescent fibroblasts compared to pre-senescent fibroblasts.[3]

Then, how do we prevent from aging of our cells? And how does nanotechnology solve the practical question? Some scientists are stepping the fantastic voyage to

the blood by nanoparticles and nanocapsules to cure the tumor cells and deliver the effective materials to stimulate and revitalize the fibroblast. The purpose of the nanoparticles is to introduce a new type of therapy and to actually go inside individual cells and to repair them, or if there' s a lot of damage, to get rid of those cells. A simple injection with a hypodermic needle can release thousands or millions of these capsules into a person's bloodstream. Once there, nano particles will take advantage of the body's natural cellular signaling system to find damaged cells. The trillions of cells in a human body identify themselves and communicate with each other via complex molecules embedded in their outer membranes. These molecules act as chemical "flags" for communicating to other cells or as chemical "gates" that control entrance to the cell for molecules in the bloodstream (such as hormones).[3]

A variety of concepts have been introduced for controlled drug delivery with the use of polymeric materials as drug carriers to treat the cancer and age related disease. By the application of nanotechnology, fundamental changes in drug production. And delivery is expected to affect about half of the $380 billion worldwide drug production in the next decade. An example of current commercialization is liposome-encapsulated drugs produced by Nexstar (doxarubicin for cancer treatment and amphotericin B for fungal infection) with sales over $20 million in1999.[1,3]

3-2. For clean and beautiful life

When matter is made in the form of small particles that have diameters of a few nanometers new properties are obtained. This will have far-reaching effects in

the technological developments in the next decade, and it will lead to the design of new ranges of functional or " smart" materials. Examples of the new properties include a) enhanced permeability, which results from the encapsulation of an effective ingredients into nano sized particles (30 to 50 nm), b) new magnetic properties leading to materials that exhibit very high permeability but no magnetic hysteresis loss, c) materials with very high surface area, hence show enhanced reactivity and catalytic properties, d) nanocomposite materials having enhanced mechanical properties and e) nano sized particles with biocompatibility to be used as biosensors and/or biomaterials. The development of this field will depend on a synergy between the science of nanoparticles and the methods of making them and incorporating them into composite materials. Here we would like to outline some of the new scientific issues and possibility offered by nanoparticles and nanocomposites, identify some applications and problems areas.[4]

3-2-1. Nanoparticles for biomaterials and additives

Hydroxyapatite (HAP) is a main component of human bone and teeth, has a good biocompatibility and is used extensively as hard tissue biomaterials. In order to develop natural bone from implanted apatite materials in bone defect regions, it is very important to regulate the digestion of the materials. Recently, low crystalline HAP shows a greater resorption in vivo and had a greater solubility compared to other calcium phosphates in the low pH region, so the issue is how HAP can be produced as a digestible material. Another issue regarding the hydroxyapatite is the synthesis of nano crystalline by nano structure processing as a means to achieve materials with ultrafine microstructures for structural, catalytic, electronic and optical application since nano structure processing

improves the sinterability of ceramics and enhances the mechanical reliability by reducing flaw sizes.[5,6]

Nano sized titanium oxide has received much attention in recent years. It has been used as a photo catalyst in many applications, including degradation of pollutants and solar energy conversion, as well as in the transformation of organic compounds. The mechanism for TiO_2 mediated degradation involves its oxidative/reductive capabilities. Excitation of TiO_2 with light of energy greater than the band gap results in electron ejection from the semiconductor valence band generating a positive hole at the valence band and an electron at the conduction band. Recently, Synthesis of nano-sized TiO_2 with the properties of activation at visible light source and the incorporation of TiO_2 into molecular sieves seem to be important since it offers a new design of photo catalytic system.[7]

3-2-2. Molecular sieves for nanoreactor and catalysis

One of the most well known inorganic molecular sieves is zeolites. Zeolites are a well-defined class of crystalline naturally occurring aluminosilicate minerals. The pore and channel openings of zeolites vary from about 0.3 to 0.8 nm depending on the structure. Zeolite catalysts now are used to process over 7 billion barrels of petroleum and chemicals annually. However, the limited pore and channel system restrict the application of zeolites into specific fields and many efforts have been done to fine more sizable molecular sieves.[1]

In 1992, researchers at Mobil Oil company discovered a new molecular sieves with larger pore diameter (>2 nm) than zeolites by the application of surfactant as a template.[8] These new molecular sieves such as MCM-41 and MCM-48 (mesoporous

molecular sieves) have been extensively studied for the last decade to increase the hydrothermal stability and to increase the acidity by applying the alumina sites since those are potentially important catalytic materials. In 1997, another new molecular sieves such as SBA series have been developed as a result of applying nonionic surfactant system to template.[9] Recently, self-assembling of silica on surfactant micelle and nanocasting using mesoporous silica as a template has opened up a synthesis route to ordered mesoporous carbons with various pore shapes, diameters and connectivities.[10]

3-2-3. Encapsulation technologies for delivery system

A way to treat the age related symptoms from the skin would be " trans-epidermal and or trans-follicular delivery system" . The skin, because of its protective function exhibits a quality, which allows it in principle to appear impermeable. Permeation and resorption are processes of a complete penetration of the skin barrier, which the adsorbed materials reach the blood circulation (resorption). In general, sparingly water soluble (lipid soluble) materials can be better resorbed than water-soluble materials, which can be more easily resorbed from fatty media. Recently, some publication regarding on the trans-epidermal delivery system suggest that the size of the materials to be delivered seems very critical. Recently, some company succeeded the encapsulation of oil-soluble ingredients sized by 30 to 50 nm and published their results. These encapsulated particles seem to be quite stable at surfactant system and well delivered to the deep skin layer. Enhancers are also very important for the trans-epidermal delivery. Many actions such as hydration, association with lipid head groups, keratin swelling, lipid bilayor disintegration, protein interaction, lipid

interaction are considered to be a suitable mechanism of enhancement system at trans-epidermal delivery.[11] In conclusion, three important factors such as lipophilicity, size and enhancer govern the effectiveness of material through trans-epidermal.

3-2-4. Nanocomposites for biosensor

Synthetic materials capable of selectively recognizing proteins are important in separations, biosensors and the development of biomedical materials. Recently, the technique of molecular imprinting of specific protein recognition sites has been reported. The molecular recognition is attributed to binding sites that complement molecules in size, shape and chemical functionality.[12]

Another recent successful study regarding biosensor is bionic eyes. Millions of " rods and cones" are in the back of every healthy human eye (retina) They are biological solar cells in the retina that convert light to electric impulses. The impulses travel along the optic nerve to brain where images are formed. Without rods and cones, people are blind. Thin-film ceramic sensors with photosensitive nanocomposites could serve as substitutes for bad rods and cones.[13]

4. Conclusion

We have reviewed the recent studies regarding on the application of nanotechnology for the treatment of cancer and age related disease and household and healthcare industry. It is not possible to give full justice to all of the aspects of nanotechnology in a short review. But one thing we can conclude is that we will often see the products applied nanotechnology sooner or later.

5. References

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