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Review

Nanotechnology and Medicine: A Review

Khayala Mammadova*, Shayman Hasanova, Hagigat Hajizada, Zeynab Mirhashimli and Hafiz Hasanov

Azerbaijan Medical University

***Corresponding Author's E-mail: xayale81@yahoo.com**

Abstract

Nanotechnology is developing part of science particularly in medical field which by this method doctors already could eliminate cancer cells from body without any negative side for body differently from radiotherapy, as well as contagious diseases are treatable by supporting nano robots. Nanorobots are small structure which measured by nm. Gradually developing of nanotechnoloy industry will make easier to overcome uncureable disease in next decade for this time.

Keywords: Nanomaterials, Nanotechnology, Nanomedicine, Drug delivery, Chemotherapy, Radiotherapy

INRODUCTION

What does nano mean? It means small, very small. The size of red blood cell is 10000 nm. But it is too big to be considered nano. However, it is made up of all kinds of nano materials. If we would look at this close enough, we would see that the outer walls of the cells are stabilized by the flexible, mesh like protein skeleton. The bars and connectors making up this mesh are considered part of a nano material. Without these reinforcing nano structures, the cell would be much more fragile and nearly as flexible. It wouldn't stand a chance in our body. Everything is made up of nano materials. Nano materials are arrangement of molecules and atoms that when combined create stable building blocks that can be made into larger more complex materials and structures.

DISCUSSION

The structure of a nanoparticle is generally determined by the chemical composition of the material, the number of atoms in the particle, and the character of the chemical interaction between atoms. Nanoparticles can be regular crystalline structure, can be amorphous and can be noncrystallographic pseudoclose packing. For each of these structural states of a nanoparticle, there is a certain set of numbers of the atoms involved in the particle that corresponds to optimum stable configurations. These numbers are called the magic numbers (V. Ya. Shevchenko et al., 2002). Filipovich and Kalinina proved (Dieter et al., 2018) that, beginning with a critical size, the contribution of the surface energy to the free energy of a system increases considerably and as a consequence, nanoparticles can have an amorphous structure. The study of nanoscale zirconia particles revealed specific structure in homogeneous nanoparticles consisting of different structural units with coherent interfaces between them (centaur nanoparticles) (Agnieszka Opalinska et al., 2015). Referring to the private communication by Fuller, Mackay (Angelié C, Soudan JM et al., 2017) has shown that a cuboctahedron whose vertices are occupied by 12 spheres connected by rigid edges (a structural element of the face-centered cubic lattice) can be transformed by rotations into a regular icosahedron. A similar transformation can occur with a multilayer icosahedron; i.e., structural elements of regular crystal lattices that consist of comparatively few atoms can readily be converted into noncrystallographic pseudoclose packings. A particular structure (an amorphous structure, a regular crystalline structure, or a noncrystallographic pseudoclose packing) of nanoparticles of a material

under given external conditions is determined by the chemical composition of the material, the character of the chemical interaction between atoms, and the size factor. In an ideal case, a regular (translationally symmetrical) distribution is characterized by a minimum of the free energy. However, the energy decrement is usually insufficient to overcome the potential barrier to rearrangement. Therefore, the structure of nanoparticles is also determined by their prehistory. Let us analyze specific features of the formation of nanoparticles in terms of generalized crystallography and crystallization in a broad sense (Jaison Jeevanandam et al., 2018; Bernal J. D., et al., 1933).

Bernal (Bernal J. D., et al., 1933) was apparently one of the first to note that very small crystals do not need to be completely regular. In particular, this is true for colloidal systems, disperse particles in enamels, and crystals obtained in a stressed state or by devitrification. In their geometrical, physical, and energy characteristics, atoms near the surface are nonequivalent to those in the bulk of a medium. If the constraints imposed by the three-dimensional periodicity are removed, a symmetry corresponding to less regular pseudoclose packings (in particular, icosahedral packings) becomes possible. The main cause of a regular structure is the pseudoidentity of repeating units, which can be not only atoms or ions but also larger-sized structural units. Effects due to the identity (or approximate identity) between particles (atoms) constituting a structural unit, be it a crystal, a fiber, a film (membrane), or a glass, should be distinguished from the effects caused by the aggregation of different regular structural units. If the atomic rearrangement within the already formed nanoscale objects is hindered by some kinetic factors, the already existing, approximately identical nanoscale objects aggregate by adding the entire structural units.

The entire structural units participating in the formation of a nanoparticle can be one-dimensional (linear chains), two-dimensional (planar atomic networks), and three-dimensional. Such a manner of aggregation of any species, be they atoms, molecules, polymer chains, atomic networks, or larger-sized aggregates, is a consequence of the identity or approximate identity between structural units. Structural features of complex nanoscale objects are essentially dependent on their metric properties (the dimensionality and the average sizes of structural units, the preferred distance between them, etc.). Consideration of the aggregation by adding entire structural units enables one to distinguish between the purely geometrical multiplicity factors and the nature of chemical bonding which is responsible for only the primary properties of aggregates. A classical example of macroscopic structures formed by linear structural units is amphibole asbestos, and examples of structures composed of two-dimensional structural units are phyllosilicates and one-dimensionally disordered (turbostratified) structures (Cymes Kirsten Nicholson et al., 2016). Among the nanoscale objects, we should mention supraclusters (clusters of clusters) (Andrew Pinkard et al, 2018, V. Ya. Shevchenko et al., 2002) and structurally inhomogeneous centaur nanoparticles (V. Ya. Shevchenkoetall., 2002). The general principle of construction, which is known as self-consistency or self-organization, is based on the ability of objects that have strongly different and sometimes unexpected external forms to combine spontaneously into complex structures through the interaction at small specific association sites. Thus, self-organization of approximately identical objects with the aim of attaining a more favorable mutual coordination is the main process responsible for the final structure of a nanosystem. The aggregation-inducing forces can have very different natures. Consequently, nanoparticles can differ in structure. The covalent bonding forces tend to establish rigid angles between bonds. The metallic bonding forces generally lead to the maximum possible mutual coordination between atoms. The structure of nanoparticles can also be governed by ionic, heteropolar covalent, or weaker hydrogen bonding forces, orientation dipole–dipole interaction forces or induced dipole– dipole interaction forces (the van der Waals forces). The effective range of these (short- or long-range) forces specifies the characteristic scale of structurization. The short-range forces have a range of the order of the shortest interatomic distance and result in ordering on a scale from several fractions of a nanometer to several nanometers. Thus, the metric range of the nanospace is readily found to be from ~0.5 nm to ~100 nm.

Theoretically, an optimum mutual coordination can be achieved only if a cluster or a small particle contains a strictly specified magic number of atoms. For each of three possible cases (amorphous structure, regular crystalline structure, and noncrystallographic pseudoclose packing), there exists its own set of magic numbers. However, the forms of a considerable fraction of experimentally observed clusters and nanoparticles differ from the perfect form to some degree or another (EmilRoduner et al., 2006, B. Ravisankar et al., 2013). Nanoparticles and clusters are small-sized systems (G. Reza Vakili-Nezhaad) in which fluctuations of the averages of the thermodynamic quantities are significant. The thermodynamic distribution of small particles substantially differs from the microcanonical distribution. In addition to configurations characterized by the minimum free energy, various defect structures are formed with a high probability. Molecular dynamics calculations demonstrated (David Tomanek et al., 1986,Giulia Rossi et al., 2004) that clusters, each containing a magic number of atoms, are more stable and can arise with a higher probability (Arbind Kumar Mallik et al., 2011). This can be efficiently used in producing nanoclusters characterized by a narrow size distribution (Ali Khorsand Zak et al., 2011). Efremov et al. (Mikhail Yu. Efremov et al., 2000) investigated the

thermodynamic properties of indium clusters by using such a highly sensitive method as nanocalorimetry and revealed abnormal (as they called them) discontinuities in the temperature dependence of the integral heat capacity. These discontinuities are explained by nonsimultaneous melting of clusters of different sizes, which is also associated with the existence of magic numbers. As a rule, amorphous clusters and nanoparticles are formed in accordance with electron magic numbers. They are determined by the number of bonding orbitals (GiorgiChiradze et al., 2016; V. G. Yarzhemsky et al., 2012). Depending on the number of valence electrons, the electron magic number corresponds to a number of atoms such that the cluster they form contains completely filled electron shells (S. Neukermans et al., 2007). For example, clusters and nanoparticles of alkali metals are aggregates characterized by an amorphous structure and a predominantly metallic interatomic bonding. Knight et al. (Zhenyang L. etall., 1990) proposed a jellium model for describing the electronic structure of the aforementioned particles. Within this model, the Hamiltonian of the electron subsystem is described in an ordinary manner and the effect of the ionic cores is modeled by a uniform positively charged background (a jellium). This model is adequate when there are no pronounced directed covalent bonds between atoms in a cluster and if the wave functions of valence electrons are strongly delocalized. The electron subsystem of a spherically symmetrical amorphous cluster, like an isolated atom, is stable provided it contains exactly the magic number of collective electrons necessary for the formation of the completely filled electron shells. If one more atom is added to such a stable cluster, the valence electrons of the atom after collectivization should occupy high-energy states, which decrease the stability of the system as a whole. Since alkali metal atoms have only one valence electron each, the number of atoms required for the formation of a stable structure (the magic number Gm) should be consistent with the degree of degeneracy of energy levels of an electron in a three-dimensional potential well (Freitas RA, 2005).

The use of nanotechnology in medicine offers some exciting possibilities. Some techniques are only imagined, while others are at various stages of testing, or actually being used today. Nanotechnology in medicine involves applications of nanoparticles currently under development, as well as longer range research that involves the use of manufactured nano-robots to make repairs at the cellular level (sometimes referred to as nanomedicine).Whatever you call it, the use of nanotechnology in the field of medicine could revolutionize the way we detect and treat damage to the human body and disease in the future, and many techniques only imagined a few years ago are making remarkable progress towards becoming realities.

The role of nano in diagnosis

Some nanotechnology is designed to seek out cancer cells and attach to them using specialized receptors which bind to the tumor selectively. Once founded the tumor the nanoparticles send out the signals that tell doctors where it's located. This can help accurately visualize tumors tumors.

Nanotechnology in Medicine Application: Drug Delivery

The difference between nano- and radiotreatment

In radiotherapy X-rays react with the water to produce free radicals which in turn destroy DNA and other molecular structures killing cells. Unfortunately these free radicals destroy healthy cells just as well as cancer cells and radiotherapy is therefore limited by the healthy tissues damage. But in nano x- ray therapy standard x-ray s activate the nano x-ray particles in the patient tumor. The nano crystals are optimized to absorb more x-rays and produce many more free radicals than water. Damaging the tumor cells DNA and cellular structure more severely than the surrounding healthy tissue because of the nanoparticles. The x-rays effect is amplified and localized within the tumor.

One application of nanotechnology in medicine currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer cells). Particles are engineered so that they are attracted to diseased cells, which allow direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease (Ranganathan R. et al., 2012).

Chemotherapy: Nano Medical Cures Coming Closer?

Generally Chemotherapy infects on the healthy cells more than than the cancer cells. Because a cancer cells are growing inside a water balloon or a tumor fortress as we like to say and that the pressure inside that balloon is greater that the outside. That is one of the reasons why chemotherapy's are less effective than we would anticipate in patients. Because the pressure is basically forcing chemotherapy's away from the cancer cells, that they are targeted to kill.

It is used gold nanoparticles attached to a molecule of a tumor-killing agent called tumor necrosis factor alpha (TNF) as well as a molecule of Thiol-derivatized polyethylene glycol (PEG-THIOL), which hides the TNF bearing nanoparticle from the immune system. The PEG-THIOL allows the nanoparticle to flow through the blood

stream without being attacked. The combination of a gold nanoparticle, TNF and PEG-THIOL is named Aurmine.

The nanoparticle carrying the TNF accumulates in cancer tumors but does not accumulate in other regions of the body. CytImmune uses a combination of two techniques to target the TNF-carrying nanoparticle to cancer tumors. First, the nanoparticle is designed to be too big to exit most healthy blood vessels. The second technique involves the TNF molecules binding to the tumor (Olga M. Kutova et al., 2019).

TNF has been shown to be most effective when intake with other chemotherapy drugs. It is also performed pre-clinical testing of another combination in which TNF, PEG-THIOL and a chemotherapy drug called paclitaxel is bound to the surface of the nanoparticle (Navedulhaque et al., 2010).

Aurimune selectively binds TNF receptors on blood vessel cells at the site of disease. After binding destroys the tumor's nutritional support structures and protective barriers.

CONCLUSION

Nanotechnology manufacturing are developed frantically since last decade. Scientists by this time got more arrivals due to founding out to cure cancer disease clearly by supporting of nanoparticles which cancertherapy by nanotechnology equipments are upgrading on this time. Getting healing of patients with cancer disease by nanotechs are more efficiacy than radiotherapy which nanorobots are affecting solely to exact place where localized the cancer cells.

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