

LAW OF ACTION OF NANOPARTICLES

Abstract

The current period is the era of Nanoscience (Nanomaterial and Nanotechnology), where revolutions in practically all subjects of Science and Technologies relax life that reflects an extensive investigation area which encompasses Nanodevices, their unique structures, and systems with innovative possessions and novel roles linked to the prearrangement of their atoms or molecules on the 1–100 nm scale. To understand the function and activity of NPs, it is essential to expose how NPs work in almost all fields of Science and Technology, like Engineering, Materials and Pharmaceutical Sciences, Physics, Chemistry, Biology, and Computer Science. The activity and action of NPs at the microsize level, including atoms, molecules, tubes or fiber based to inhabit the electronic system, move around in orbit; this orbit may be considered a surface for the electron where the electron interacts as energy to the surrounding molecules and determine the effectiveness of the Nanoparticle. The activity of NPs may be linked with the dual nature of the particle, where size (matter) and energy are effective. The high activity of the small size of the NPs is based on energy which in turn is related to the surface electron as NP showed an increased surface-to-volume ratio that must be intact with outer orbit. This report demonstrates the action of NPs in the advancement and key ethics of Nanoscience and Technology in the contemporary timeline period of findings and indicators related to every field of Science.

Keywords: Nanoparticle, Activity, Surface Area, Dual Nature.

Author

Rafia Azmat

Department of Chemistry

University of Karachi

Pakistan.

rafiasaeed200@yahoo.com

I. INTRODUCTION

The term 'Nano' represents minor and illustrates one thousand millionth of a meter (10^{-9} m) of material size. Today the "Nano" term reflects particle, material or tube structures as Nanoparticle, Nanomaterial or Nanotube functional in Science and Technology. They can be differentiated among i) Nanoscience and ii) Nanotechnology. The search on the structure of molecules ranging between 1 and 100 nm is referred to as Nanoscience, while the term Nanotechnology is practical applications of these Nanomaterials, including nanodevices (1). The expansion of Nanoscience started in the 5th century BC, when scientists considered the matter and stated that matter is composed of small, indivisible and indestructible particles, now termed atoms. Today, the smallest particle size was scanned by SEM technology, reported as 1 -100nm, and referred to as nanoparticles. In 1959 American physicist and Nobel Prize laureate Richard Feynman specified the concept and use of Nanoparticles referred to as Nanotechnology. Feynman delivered a lecture at the annual meeting of the American Physical Society " at the California Institute of Technology (Caltech) entitled "There's Plenty of Room at the Bottom," where he gave a theory, "Why can't we write the entire 24 volumes of the Encyclopedia Britannica on the head of a pin?", and designated a visualization of via machinery to paradigm minor machines and down to the molecular level (2). Later, He was considered the father of modern Nanotechnology when his novel idea was proven correct. Norio Taniguchi, a Japanese scientist after fifteen years in 1974, first used and defined the term Nanotechnology: "Nanotechnology primarily comprises several processes like separation, merging, and distortion of constituents by one atom or one molecule. The Histories of Nanotechnology generated questions regarding Richard Feynman's 1959 talk, ***"There's Plenty of Room at the Bottom,"***? that this talk was the beginning of the Nanotechnology deliberated by well-informed individuals. It led to trials such as the discovery of the scanning tunnelling microscope, followed by progress in nanotechnology when the physicists Gerd Binnig and Heinrich Rohrer developed a novel sort of microscope at IBM Zurich research laboratory, the Scanning Tunneling Microscope (STM) (3). The STM practices a strident tip that transfers nearer to a conductive surface so that the electron wave functions of the atoms in the tip overlap with the surface atom wave functions. Under Voltage, electrons "tunnel" through the vacuum gap from the atom of the tip into the surface (or vice versa). In 1983, the group published the first STM image of the Si(111)- 7×7 reconstructed surface, which nowadays can be routinely imaged (4). Le et al. (5) reported nanoshells to possess ideal properties as a substrate for combining enhanced Raman scattering and surface-enhanced infrared absorption followed by bulk area at the same longitudinal locations on the structure (Fig.1).

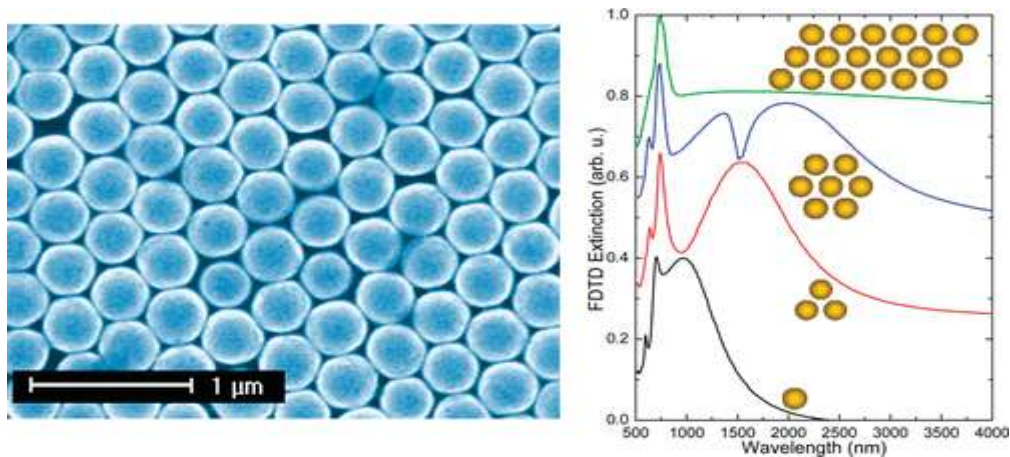


Figure 1: SEM Image and Extinction Spectra of a Typical HCP Au Nanoshell Array Sample (Le et al. [5])

Material work at the Nanoscale and the ability to modify Science at the practical application level is the most needed technology of the current era that requires attention, observation, measurement, manipulation, and assembling manufacturing for industrial purposes. It has two major parts i) structuring of the material at the Nanoscale or shape and size development at the Nanoscale (1-100nm) and ii) must have a novel use at the technological level. The scientific community of the world considers these two factors, but a major part needs attention related to the action of these NPs and how it works. A detailed survey revealed that less attention was paid to this factor.

This communication deals with the working capability or action of Nanomaterial in every field, which is based on the action of matter states. Nanomaterials are tiny particles observed under an electron microscope, they may be considered a separate particle-like gaseous state, and all theories can be applied to it specifically. They behave according to Maxwell's distribution of velocities and energies related to their movement, while energetic states can be explained by taking the example of the photoelectric effect (Fig.2), where the radiation of light ejects surface electrons. Movement or Velocity of the NPs and energy distributed according to the Maxwell–Boltzmann distribution of energies while the activity of the NP is associated with the surface electrons like that of the photoelectric effect, and electrons interact with other molecules as NPs reproduced proven active three or more times and their activation and electrons remain intact with the outermost orbit of the atoms or molecules of NPs

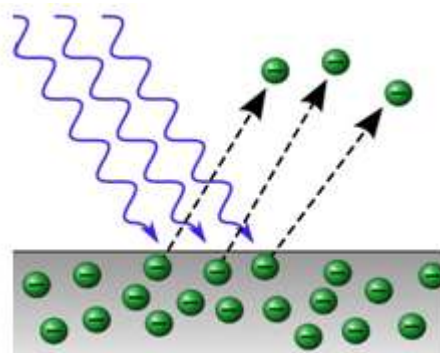


Figure 2: Photoelectric Effect (Ejection of Electrons by the Interaction of Radiation on a Metallic Surface)

The activity of NPs is related to movement as they are separated into tiny particles with high surface electron energy; therefore, it is supposed that NPs activity may follow Maxwell's distribution of energies and Velocities according to equation (1) modified to NPs.

$$(V_{NPs})^2 = (V_{NPx})^2 + (V_{NPy})^2 + (V_{NPz})^2 \text{_____} \quad (1)$$

The movement of NPs is linked with the Velocity, which in turn is related to the energy at the Cartesian coordinate system and can be written like equation (2).

$$f(V_{NPs}) = 4\pi V^2 / (m2\pi kBT)^{3/2} \exp(-mv^2/2kBT) \text{_____} \quad (2)$$

Therefore, It is proposed that Nanoparticle works according to the Maxwell-Boltzmann Distribution of Molecular Energies for atom and molecule and recommends that each Nanoparticle moves like an atom or molecule, and its function or activity is directly proportional to the energy of surface electrons according to the following equation

$$a \propto S_{ev} \text{_____} \quad (3)$$

where a is the activity of NPs and S_{ev} is the surface electron volume ratio

$$a = k S_{ev} \text{_____} \quad (4)$$

or

$$k = a/S_{ev} \text{_____} \quad (5)$$

putting the value of k into equation (2), we have

$$f(V_{NPs}) = 4\pi V^2 / (m2\pi a/S_{ev} BT)^{3/2} \exp(-mv^2/2 a/S_{ev} BT) \text{_____} \quad (6)$$

The above equation narrates that activity depends on the size and surface electrons following Maxwell's distribution Law of energies. The smaller the size higher the activity. It was concluded that the size of NPs is significant where a large surface volume ratio is involved in the activities of NPs.

Similarly, the Nanotubes are the varied structure of NPs, and they have more electrons on the surface which is more active. Activity or action of NPs in any reaction system based on its surface area as the material surface increases allow more atoms to interact with the particle or material. The large surface area is accountable for nanomaterials' conductivity, strength and durability.

Furthermore, the progress of Nanoscience is apparent in engineering, bioengineering and computer technology, where the usual size of computers decreases to hand size and extremely effective portable laptops. The designing of the complex electrical circuits was reduced to Nanoscale by electrical engineers. Also, many advances are noticed in smartphones and other modern electronic devices for daily use. All these are related to the highly active surface of the Nanomaterial. Recently, several studies highlighted nanotechnologies' huge potential in biomedicine for diagnosing and treating many human diseases (6). In this regard, bio-nanotechnology is considered by many experts as one of the

most intriguing fields of application of Nanoscience. In recent decades, nanotechnology's applications in many biological-related areas, such as diagnosis, drug delivery, and molecular imaging, have been intensively researched and offered excellent outcomes(7).

II. CONCLUSION

It was concluded that the surface volume ratio of NPs plays a key role in building new devices at Nanoscience and Nanotechnology levels; generated energy determines law of action of Nanoparticles. Furthermore, the applications of nanotechnology are infinite. It started from basic to advanced levels, from computers, agronomy, medical devices and drugs to resources that decrease petroleum prices for cars and aircraft.

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