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Quantum Nanoparticles as a Source of LASER and its Various Applications

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Abstract- Nanotechnology is the foremost vital and advanced field of science with millions of sensible use . The list of applications and benefits of engineering has mature chop-chop and it's the potential to revolutionalize many technology. It's a large type of applications in several sectors like food safety, cars, agriculture, energy, health, and environmental safety. These nano particles exhibit fully totally different characteristics than that of the first structure. Nanoparticles adjust all the properties related to quantum physics. These characteristics might lead nano technology to at least one step ahead in scientific development. This text discusses some quantum characteristic of nanoparticles and applications of engineering in numerous fields.

Keywords: Nanotechnology, Nanoparticles, Quantum mechanics, Applications

I. INTRODUCTION

Nanotechnology is that the understanding and application of matter at the nanoscale, at dimensions between approximately 1 and 100 nanometers having special and novel properties. Encompassing nanoscale science, engineering, and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale. The unexpected rise within the interest and development of nanotechnology is essentially thanks to the new and weird properties of small or nanoparticles. The properties of the fabric are different at nano scale as compared to the first scale. Matter like gases, liquids, and solids can exhibit unusual physical, chemical, and biological properties at the nanoscale, differing in important ways from the properties of bulk materials and single atoms or molecules the essential reason is that the nanoparticles have a relative larger surface and smaller volume as compared to the first particle. This property of nanoparticles plays a crucial role to exhibit different physical properties and chemical properties. It's also responsible enough to form materials more chemically reactive albeit they're inert in larger size. Thanks to this property, nanotechnology may be a famous branch altogether the sensible applications basically in engineering applications. Nonmaterial applications also are playing a big economic role as pollutant adsorbents [1], biosensors for monitoring and detection of various compounds [2], and in increasing the efficiency of sunshine sources, motors, electrodes, and efficient wear-resistant material. Due to this interesting properties of nanoparticles, nanotechnology is becoming the foremost important part in many scientific and engineering applications ranging from agriculture to spacecraft although it's some negative impacts within the point of legal and ethical value. This technology is additionally very competent enough to satisfy all the wants of the overgrowing population within the economical point of view. In medical sector, nanoparticles have reached a milestone in curing many diseases in several manner whether directly or indirectly. The assembly of foods during a huge amount is additionally due the new scientific methods and applications of nanotechnology. Many research project and development goes on so as to urge more benefits from the nanoparticles by some modification within the properties of the nanoparticles.

II. PROPERTIES OF NANOPARTICLES

MAGNETIC PROPERTIES

Magnetic NPs are of great curiosity for investigators from an eclectic range of disciplines, which include heterogenous and homogenous catalysis, biomedicine, magnetic fluids, data storage resonance imaging (MRI), and environmental remediation such as water decontamination. The literature revealed that NPs perform best when the dimensions is utilized in different applications [3-7] The uneven electronic distribution in NPs leads to magnetic property. These properties also are dependent on the synthetic protocol and various synthetic methods like solvothermal microemulsion [8], thermal decomposition, and flame spray synthesis are often used for his or her preparation [9]

MECHANICAL PROPERTIES

The distinct mechanical properties of nps allow researchers to appear for novel applications in several vital fields like surface engineering, nanofabrication and nano manufacturing. Totally different mechanical parameters like elastic modulus, hardness, stress and strain,adhesion and friction will be surveyed to grasp the exact mechanical nature of nps. Beside these parameters surface coating, curdling,and lubrication conjointly aid to mechanical properties of nps [10]. Nps show dissimilar mechanical properties as compared to microparticles and their bulk materials. Moreover, in a very

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lubricated or lubricated contact, the distinction within the stiffness between nps and the contacting external surface controls whether or not the nps area unit indented into the arrange surface or deformed once the pressure at contact is significantly massive. This vital info could reveal however the nps perform within the contact state of affairs. The process is given in Fig.1.Tight controls over mechanical options of nps and their interactions with any reasonably surface area unit very important for enlightening the surface quality and elevating material removal. Fruitful outcomes in these fields usually would like a deep insight into the fundamentals of the mechanical properties of nps, like modulus of elasticity and hardness, movement law, friction and surface adhesion and their size dependent characteristics [10].

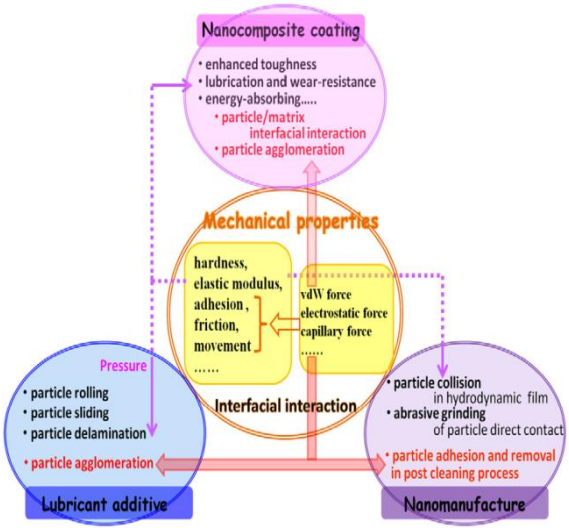

Fig.1 Schematic view of the mechanical properties and their applications [10].

THERMAL PROPERTIES

It is well-known incontrovertible fact that metals nps have thermal conductivities above those of fluids in solid form. For instance, the thermal conductivity of copper at room temperature is about 700 times greater than that of water and about 3000 times greater than that of engine oil. Even oxides like alumina (Al_2O_3) have thermal conductivity above that of water. Therefore, the fluids containing suspended solid particles are expected to display significantly enhanced thermal conductivities relative to those of conventional heat transfer fluids. Nanofluids are produced by dispersing the nanometric scales solid particles into liquid like water or oils. Nanofluids are expected to exhibit superior properties relative to those of conventional heat transfer fluids and fluids containing microscopic sized particles. Because the warmth transfer takes place at the surface of the particles, it's desirable to use the particles with large total area. The massive total area also going to increases the steadiness suspension [13]. Recently it's been demonstrated that the nanofluids consisting of cuo or Al_2O_3 nps in water or ethylene exhibit advance thermal conductivity [14].

III. QUANTUM MECHANICS, NANOPARTICLES AND LASER

Quantum nanoscience is that the basic research area at the intersection of nanoscale science and quantum science that makes the understanding that permits development of nanotechnologies. It uses quantum physics to explore and utilize coherent quantum effects in engineered nanostructures. this might eventually cause the planning of latest sorts of nanodevices and nanoscopic scale materials, where functionality and structure of quantum nanodevices are described through quantum phenomena like superposition and entanglement. With the growing work toward realization of quantum computing, quantum has taken on new meaning that describes the consequences at this scale. Current quantum refers to the quantum mechanical phenomena of superposition, entanglement and quantum coherence that are engineered rather than naturally-occurring phenomena. Quantum nanoscience explores and utilizes coherent quantum effects in engineered nanostructures. Coherence is that the property of a quantum system that permits to predict its evolution in time, once it's been prepared during a superposition of various quantum states. This property is vital when one intends to use the system for specific tasks, like performing a sequence of logic operations during a quantum computer. Quantum coherence is fragile and may easily be lost if the system becomes overlarge or is subjected to uncontrolled interactions with the environment.

Since the size of the nanoparticles are very small, their surface area is more in comparison to volume. As a result, they behave differently. They no longer follow the properties of classical mechanics. They experience quantum effect. They follow all the characteristics and properties of quantum mechanics instead of classical mechanics. As a result their thermal property, optical property, electric property and sound property are affected a lot.

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On the basis of physics, nanoparticles are the microscopic particles. According to de-Broglie hypothesis, when the microscopic material particles are in motion, they exhibit both particle characteristics as well as wave characteristics. They behave as wave as well as particles. So the wavelength associated with these particles are given by [13]

$$\lambda = h/(mv),$$

Where h is Planck's constant, m is the mass of the nanoparticle and v is the velocity of nanoparicle. In this equation the wavelength represents the wave characteristics and the momentum represents the particle characteristics of the material. So the smaller size of the nanoparticle or smaller momentum of nanoparticle results in the larger wavelength which results in the different applications of nano particle in the near future. From the above expression, it is clear that we can change the wavelength of nanoparticles if the mass is changed. We can get the required amount of wavelength by the suitable choice of mass. If the mass of the nanoparticle is less, then the wavelength will be more. As a result the penetration power is also more. So this property can be used for the LASER beam production. By giving some energy to these nanoparticles, they go to the excited state. But in the excited states they are unstable. But some energy states are called metastable states i.e the rate of spontaneous emission is very low. If this process goes on repeating, population inversion takes place. The detailed mechanism is given in Fig.2. As a result the number of particle in the excited state is greater than the number of particles in the ground state. The energy emitted by the excited state particle having longer wavelength is used as the source for LASER beam production.

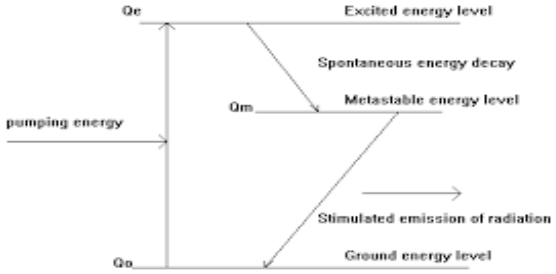

Fig.2 Different steps of LASER beam production.

IV. APPLICATIONS AND POTENTIAL BENEFITS OF NANOTECHNOLOGY

In recent years, nanotechnology plays a crucial role so as to satisfy all the need. It's an enormous sort of many more applications in several fields thanks to its flexibility and potential. The varied applications of nanoparticles are discussed.

Medicine and Tissue Engineering

Nanotechnology plays a crucial role in medicine sector. Thanks to its minute size, it are often employed as a drug within the particular infected cell of our body rather than damaging other cells. It's also wont to deliver vaccine to trigger a robust system. It's also wont to defeat virus indirectly by producing enzymes.

Natural bone surface is sort of usually contains options that ar regarding one hundred nm across. If the surface of a synthetic bone implant were left sleek, the body would try and reject it. Thanks to that sleek surface is probably going to cause production of a animal tissue covering the surface of the implant. This layer reduces the bone-implant contact, which can always end in loosening of the implant and more inflammation. Absolutely it was incontestable that by making nano-sized options on the surface of the hip or knee corrective one might scale back the probabilities rejection likewise on stimulate the assembly of osteoblasts. The osteoblasts ar the cells to blame for the expansion of the bone matrix and ar found on the advancing surface of the developing bone.

Food

It has an important application in food sector starting from its growth to packing. It is used for food safety, food quality and food tasty development. It can be used as a sensor to detect the soiled food. Zinc nanoparticles can be used to block UV rays in plastic packaging and to provide anti-bacterial protection [4]. Research is also being conducted to detect vitamin deficiency in our body using nano sensor. It is also used in the farm sector in order to know the water or nutrients deficiency in the seeds or plants.

Cleaner water

Nanotechnology is also used to solve the problems in water quality and pollution in water. The first thing is to remove the waste material from the industrial waste pollution. Nanoparticles can be used to convert the contaminated water to harmless water so that it can be used properly. The second thing is to remove the excess amount of salt and metals from water. The third concern is to use the nanoparticles to detect the virus in water as the standard filters are not able to do such things. Palladium and graphene oxides nano particles are used in this process [14].

Space

Nanotechnology may hold the key to make space flight more practical. Advancement in nano materials make light space craft and capable for the space elevator possible.

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Solar cell

Very low cost solar cells can be made by using he method of nanotechnology which is long lasting.

Batteries

Nanotechnology is used in the manufacturing of battery. It is assumed that, the battery made up of nanoparticles have longer life time.

Electronics

Nanotechnology is also used for the manufacturer of electronic instruments. The instruments made up of nanoparticles have less power consumption and less energy consumption with maximum efficiency.

Fuel cells

Nanotechnology is being used for the production of the production of the fuel containing less pollution and more efficiency. Nano gold particles can be very effective in generating hydrogen from water which is generally used for the production of fuel.

Cosmetics

The first of those is that the use of nanoparticles as UV filters. Titanium oxide and flowers of zinc area unit the most compounds utilized in these applications. Organic alternatives to those have additionally been developed.The second use is technology for delivery. Liposomes and niosomes area unit utilized in the cosmetic trade as delivery vehicles. Newer structures like solid lipoid nanoparticles and nanostructured lipoid carriers are found to be higher performers than liposomes.In specific, nanostructured lipoid carriers are known as a possible next generation cosmetic delivery agent that may give increased skin association, bioavailability, stability of the agent and controlled occlusion. Encapsulation techniques are projected for carrying cosmetic actives. Nanocrystals and nanoemulsions are being investigated for cosmetic applications. Patents are filed for the applying of dendrimers within the cosmetics trade.

Agriculture

Agriculture provides food for humans, directly and indirectly. As world population is increasing, it's necessary to use the fashionable technologies like bio and nanotechnologies in agricultural sciences is very important. Engineering has been outlined as with reference to materials, systems and processes that operate at a scale of a hundred nm or less. Engineering has several applications all told stages of production, processing, storing, packaging and transport of agricultural product. Engineering can revolutionize agriculture and food trade by innovation new techniques such as: preciseness farming techniques, enhancing the power of plants to soak up nutrients, additional economical and targeted use of inputs, malady detection and diseases, stand up to environmental pressures and effective systems for process, storage and packaging. Nanotechnology offers new approaches for enhancing and written material gift crop management techniques. Normally plant vitamins and plant shielding chemical substances area unit conventionally carried to several elements of plants each essentially through spraying or broadcasting. Because of troubles beside leach of chemical substances, degradation through photolysis, reaction and microbe degradation, leading best all low attention of chemical substances that is tons below desired minimum powerful attention, attain the goal website of plants. A need for police work plant disorder at Associate in Nursing early level so as that uncountable meals could also be enclosed from the viable eruption, has tempted nanotechnologists to look for a nano declare shielding the meals and agriculture from small organism, plant life and infectious agent marketers will use the transferrable device.

There are many more fields in which the phenomenon of nanotechnology is used. But these are all about the major applications of nanoparticles in different fields.

V. CONCLUSION

Nanotechnology could be a revolutionary science which can positively modification our future to an oversized extent. It helps in giving most quantity of energy from the renewable sources. Engineering has lined plenty of domain these days and can cowl plenty within the returning future. The worth of nanomaterials in several technology areas is extremely high attributable to their versatile properties. Industrial investment during this space is additionally growing steady. These days some nanomaterials square measure already getting used commercially Nanomaterials can even be found in sporting instrumentation, clothing, and telecommunication infrastructure. The longer term of engineering is infinite and infinite. A number of the things that exist these days were a subject of fantasy a decade gone and have the potential to remodel our society terribly quickly and endlessly. Thus so as to push a property development of nanotechnologies and safeguard the human health, eco-systems it's necessary to assess the risks side-by-side with the engineering analysis and development.

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