NANO THINGS INTO MACROSCOPIC WORLD

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Scientists believe that the Earth was formed around 2 billion years ago. It has gradually grown into this stage passing so many eras. In the mean time finding of fire, finding of wheel have directed the world to a new era which has been revolutionized by new findings. Another important finding was alchemy which was developed to modern chemistry today. Today, the world is headed towards nanotechnology which is the science in the 1 nm level. "**There's Plenty of Room at the Bottom**" was a lecture given by physicist Richard Feynman at an American Physical Society meeting at Caltech on December 29, 1959. Feynman considered the possibility of direct manipulation of individual atoms as a more powerful form of synthetic chemistry than those used at the time. The talk went unnoticed and it did not inspire the conceptual beginnings of the field. In the 1990s it was rediscovered and publicized as a seminal event in the field, probably to boost the history of nanotechnology with Feynman's reputation. However, this concept was used by the ancient people without knowing the science in it. For example, Roman people painted their church with different colours using different particle sizes of gold as the painting agent. This is only an example for the reduced particle size used by people in ancient times. Other examples are lotus effect, butterfly wing effect, geko's legs, etc.

The science behind the above mentioned nanotechnology scenarios were discovered by physicists and they verified that the characteristic features of the reduced particle size are different than the macroscopic size of the same material. This reduced size of particles has higher surface area (1000 time more) of the material into volume ratio. Also, when the particle size is reduced, it changes its chemical and physical properties due to the changes of the band gap of the material. When decreasing the particle size, it tends to increase the band gap of the material thus leading to different optical properties.

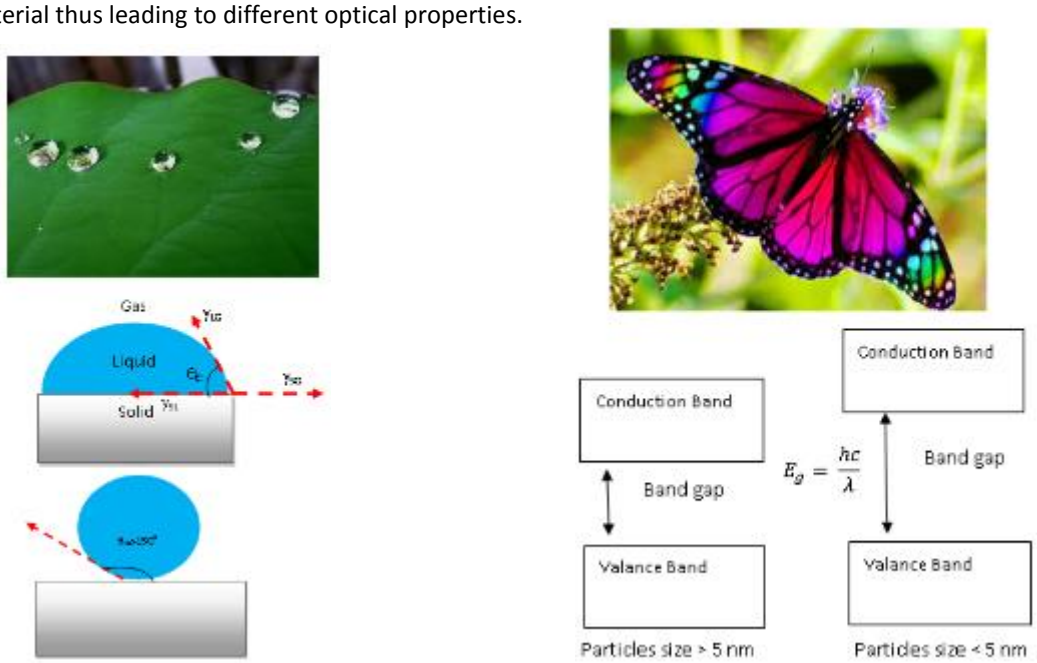

Figure 1: Lotus leaf and the theory behind ultrahydrophobosity and butterfly wings and theory behind colour variation

With time, scientists have been studying the preparation methods of nano particles via top-bottom or bottom-up approaches. Especially, chemists are interested in bottom-up approaches while physicists are involved in top-bottom approaches. However, both approaches have led to preparation of nano particles which are used for variety of applications such as, energy utilization using solar cells fields of dye-sensitized solar cells, thin film solar cells, organic polymer hybrid solar cells and energy storage batteries and fuel cells, water purification using various filtration techniques employed with nano particles, textile industry like self-cleaning, hydrophobic textiles, intelligent textiles, antibiotic and anti-fungal textiles, engineering applications such as molecular machine and robotics, nano electronic devices, ceramic manufactures with multiple properties like strength, porosity and hardness and medical applications such as bio-sensors, targeted drug delivery, cancer treatment, bone transplant and gene therapy.

Many organic and inorganic high band gaps insulating materials are involved in this field such as calcium carbonate, hydroxyapatite, carbon, calcium phosphates, aluminum oxide, silica and magnesium oxide [1] and high band gap semiconductor materials such as titanium dioxide, zinc oxide, cadmium sulfide and tin dioxide. Among them many of the semiconductor material nano particles are used for numerous applications such as gas sensors, heat mirrors, optoelectronic devices, electrode materials, Li-ion battery anodes, in catalysis and transparent electrodes for solar cell devices. Also there are variety of technique such as, sol-gel, precipitation, in-situ polymerization, freeze-drying, sputtering, microwave irradiation, anodic oxidation, thermal evaporation, thermal oxidation, physical vapour evaporation, solvo-thermal, carbothermal reduction, polymeric precursor, acid route and thin film by chemical vapor deposition involved in preparation of nano particles [2, 3].

Among them acid route and hydro-thermal processes are the simplest techniques in order to prepare nano particles. These are relatively inexpensive and require low energy. We have been studying the preparation of SnO_2 semiconductor nano particles in our Semiconductor Research Laboratory, Department of Physics, University of Peredeniya, and have employed both methods. We obtained 20 nm to 60 nm size particles which can be used for so called applications and we have already successfully employed them in dye-sensitized solar cell application [4]. We used relatively low temperature (around 100 ^{o}C to 250 ^{o}C) for hydro-thermal method in compared to acid route (around 500 ^{o}C to 800 ^{o}C). When the temperature was decreased, the particles size also decreased in both methods. Also, hollow nanosphere particles can also be obtained by varying the treatment period (time duration of the temperature supplying) in hydro-thermal methods. These findings can be used in the many different ways as SnO_2 is a high band gap semiconductor material.

References

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