MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE

(UGC - AUTONOMOUS)

Report on

Guest Lecture on Quantum Dots and Applications

Organized by Dept. of Chemistry - MITS

27 - 28 May 2015

Dr. V. Brahmaji Rao

Senior Professor, School of Biotechnology, Dr. Swaminathan Research Foundation

Submitted by: Dr. N. S. Kameswara Rao - Professor and Head, Dept. of Chemistry

Dr. V. Brahmaji Rao, a Senior Professor of Nano Science and Technology in School of Biotechnology of Dr. Swaminathan Research Foundation, recognized by JNTU-H visited our campus on 27th and 28th of May to interact with our faculty and management.

Day 1: Prof. Brahmaji Rao interacted with the faculty of Physics department, Dr. Victor, Dr. Verma and Dr. Sumit and discussed current research in Nano Science. Later in met Prof. A. R. Reddy and Prof. Jilani of ECE department followed by a short meeting with maths faculty members. In the afternoon, he had a meeting with our **Secretary & Correspondent and Prof. V. Kutumba Rao** and discussed various possibilities of collaborations with our institutions.

Day 2: The Resource Person delivered a lecture on **"Quantum dots and applications"** in the board room. Faculty from ECE, ME, Chemistry and other departments including our Dean R&D, Dean RRC attended the lecture. Research scholars from chemistry department also attended the lecture.

A brief summary of the lecture:

A quantum dot is a semiconductor atom whose excitons are confined in all three spatial dimensions. As a result, they have properties that are between those of bulk semiconductors and those of discrete molecules. Quantum Dots are more closely related to individual atoms rather than bulk materials because of their discrete quantized energy levels instead of energy bands. Therefore they are also known as artificial atoms. The Behavior of the Quantum dots can be understood with the help of the concept of Excitons. An Exciton is an electrically neutral quasi particle. Quantum dots are made by creating an island of conductive material consisting of Excitons surrounded by insulating material. Electrons that enter the quantum dot will be confined. An exciton may be formed when a photon enters a semiconductor, exciting an electron from the valence band into the conduction band, leaving a localized vacancy of opposite electric charge behind to which the electron is attracted by the Coulomb force. This attraction provides a stabilizing energy balance, and as a result, the exciton has slightly less energy than the unbound electron and hole. Excitons exist in insulators, semiconductors and some liquids. The exciton is regarded as an elementary excitation of condensed matter that can transport energy without transporting net electric charge. Excitons have an average physical separation between the electron and hole, referred to as the Exciton Bohr Radius and this physical distance is conspicuous for each material. Exciton Bohr Radius magnitude determines the formation of the Band structure In a Quantum dot the Energy Band splits and exists as independent energy levels of The Excitons. In order to implement a system that encodes information in the form of electron position it becomes necessary for a model in which to construct a vessel in which an electron can be trapped and allowed there. This vessel is called **"Potential well"** .There are several ways to implement quantum dots but apparently the most common, and the ones used in are metal products .Quantum dots, also known as nano crystals, & are a special class of materials known, as semiconductors in which crystals are composed of periodic groups of II-VI, III-V, or IV-VI materials. Quantum dots are unique class of semiconductors because they are so small, ranging from 2-10 nano meters (10-50 atoms) in diameter. At these small sizes materials behave differently, giving quantum dots unprecedented tunability and enabling never before seen applications to science and technology. The usefulness of quantum dots comes from their peak emission frequency's extreme sensitivity to both the dot's size and composition, which can be controlled .This remarkable sensitivity is quantum mechanical in nature, if the size of a semiconductor crystal becomes small enough that it approaches the size of the material's Exciton Bohr Radius, then the electron energy levels can no longer be treated as continuous

They must be treated as discrete, meaning that there is a small and finite separation between energy levels. This situation of discrete energy levels is called quantum confinement. Under these conditions, the semiconductor material ceases to resemble bulk, and instead can be called a quantum dot. This has large repercussions on the absorptive and emissive behaviour of the semiconductor material. Because quantum dots' electron energy levels are discrete rather than continuous, the addition or subtraction of just a few atoms to the quantum dot has the effect of altering the boundaries of the bandgap. Changing the geometry of the surface of the quantum dot also changes the band gap energy, owing again to the small size of the dot, and the effects of quantum confinement. The band gap in a quantum dot will always be energetically larger; therefore, we refer to the radiation from quantum dots to be "blue shifted".