Quantum Dots and its Study in the application of Solar Cell and in Medicine

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Abstract - *Quantum dots are Semiconductors Crystals in Nano range whose excitons (electron-hole pair) are confined in all 3-Dimensional space. They have properties that differ from large samples, including a bandgap that becomes larger for smaller particles. These properties create several applications for quantum dots, including efficient solar cells . QD also called the artificial atoms but generally bigger then atoms (100nm for QD and 0.1nm for Atoms). Quantum Dots are highly tunable they have variable bandgap. Quantum Dot Solar Cell have efficiency of 60% and earlier solar cell has 33% efficiency. Quantum Dots can be used as carrier for drugs because they find and bind to cancer cell and illuminate.*

Key Words: **Quantum Dot, Solar Cell, NanoTechnology, Excitons, NanoCarriers**

1. INTRODUCTION

In Quantum Dots the attractive forces are exerted by background charges but in atoms by nuclei. Quantum dots have properties between bulk semi-conductor and Atoms. Semiconductors crystals smaller than about 10 nm, known as quantum dots, There properties are different from large Semicondutor crystals, It includes a bandgap that becomes larger for smaller semiconductor. Due to These properties QD have several applications for quantum dots, like efficient solar cells and qubits for quantum computing. Various synthesis procedures have been proposed like chemical synthesis and lithographic synthesis similarly which is used in the semiconductor industry. The easily tunable bandgap of quantum dots makes them especially suited for optical applications,

1.1 Quantum Dots

In Bulk Semiconductor electrons are free to move in 3-Dimensional space. In thin firm Semiconductors electrons are free to move in two dimensions and confined in one dimension by a potential well it is created due to larger bandgap of the semiconductor on either side of film, In Quantum Wire the electrons is confine in two directions and can only move in one dimension. Electrons and holes are confined in all three dimension. Due to the quantum confinement Quantum dots are act like a artificial atoms by showing controllable discrete energy levels, Quantum Dots can be optically excited after absorbing photons the electrons in QDs gain energy leading to the creation of exactions. An exaction is a bound state of an electron and a hole. After relaxation from the excited state to its lower energy state electron and hole recombine (exaction recombination) and emitting a photon.

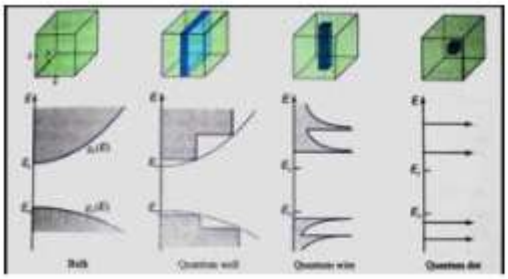

Fig -1: Diagram of Bulk SC, QWell, QWire, QD.

2. Compare Insulator, Conductor, Semiconductor Energy Band

Insulator: Insulator are those material who do not conduct electricity The valence band fill with electrons and conduction band of those material remains empty. The forbidden energy gap between the conduction band and the valence band is very large. The difference is more than 10ev. Crossing the forbidden energy gap from valence band to conduction band large amount of energy is needed.

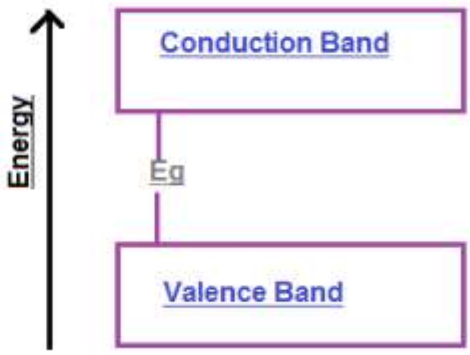

Fig-2:- Energy band diagram of Insulator

Conductors: In Conductor the valence band and the conduction band overlap each other. There is no forbidden energy gap here so Eg=0. At absolute zero temperature large number of electrons remain in the conduction band. The resistance of conductor is very low So, the electricity can pass easily through the conductors.

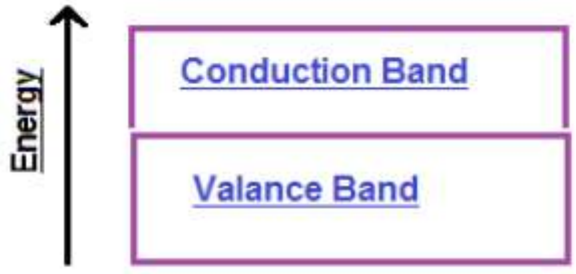

Fig-3:- Energy band diagram of Conductor

Semiconductors: Semiconductors are those materials whose electrical conductivity is between conductors and insulators. The forbidden energy gap of a semiconductor is nearly same as insulator. The energy gap is narrower. It can easily overcome due to thermal agitation or light or by vibration. A semiconductor remains partially full valence band and partially full conduction band at the room temperature. The conduction band remains full empty of a semiconductor where the valence band remains full of electrons at absolute zero temperature. So, semiconductor are insulators at absolute zero temperature. On the other hand with the. increasing of temperature the electrical conductivity of semiconductors increase.

Fig -4:- Energy band diagram of SC

In Bulk Semiconductor the energy level in conduction and valence band are very close to each other they seem's to be continuous but at energy level of semiconductor at nano scale no longer be continuous they became discrete.

Quantum Confinement:- When the particle dimension of a semiconductor near to and below the bulk semiconductor Bohr exciton radius which makes materials properties size dependent electrons feel the presence of the particle boundaries and respond to changes in particle size by adjusting their energy. This phenomenon is known as the quantum-size effect.

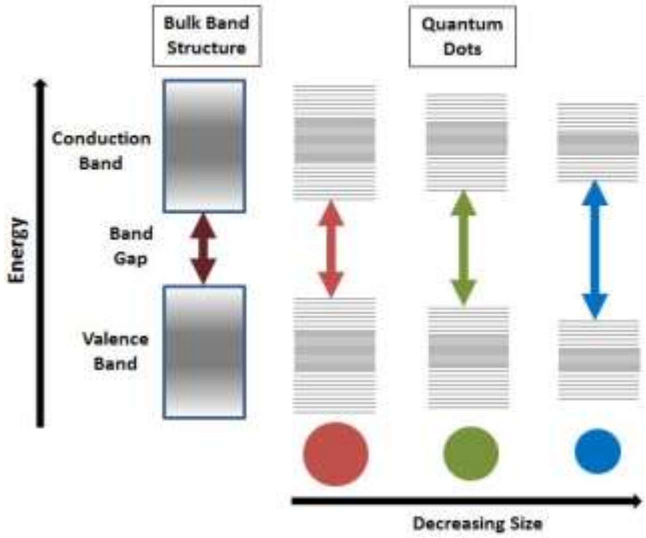

Fig-5:- Energy band diagram of Quantom Dot.

3. APPLICATIONS

i. SOLAR CELLS:- Present solar cell consists of a large silicon p-n junction. In Which a photon with energy greater than or equal to the bandgap of silicon hits the solar cell, it transfer its energy to excite the single electron with energy exactly equal to the silicon bandgap. Photons with less energy are transmitted by the silicon and do not contribute to the power output. Quantum dots of varying size can form layers on top of each other in which QD with largest bandgaps on top. Incoming photons will be transmitted by quantum dots with too large bandgaps until they reach a layer with a bandgap smaller than their energy. Then photon will excite an electron with an energy very close to its own energy, and very little energy is wasted. The efficiency approaches the 66%.

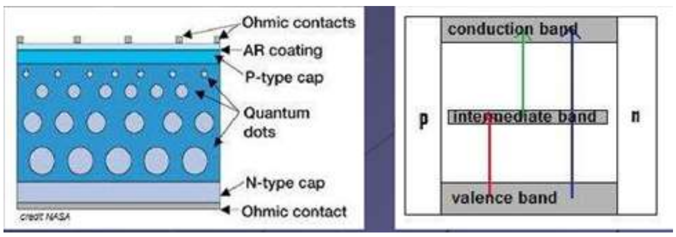

Fig -5:- Quantum Dot Solar Cell

ii. Targeted Drug Delivery:- These quantum dots can be put into single cells, or lots of cells, in the tissue of living organisms. In future it is planned to attach specific antibodies to the quantum dots will find and bind to cancer cells and illuminate them when they fluoresce. In this we attach drug molecule to quantum dots, then be able to deliver the drug just to the cancer cells where it is needed. Current drugs affect the whole body not just the cancer.

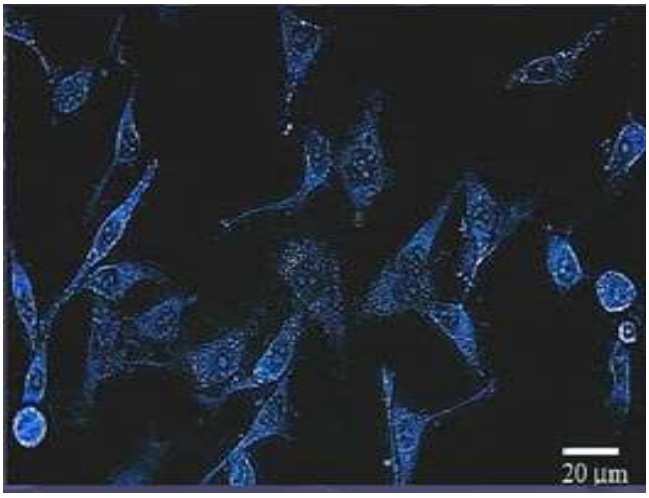

Fig -6:- Quantum Dot illuminate inside Cancer Cell

3. CONCLUSIONS

Applications of this effect to photovoltaic cells are very promising in increasing efficiency, provided that scalable manufacturing techniques can be developed. Finally, the utility of quantum dots as qubits in quantum computing has been investigated. The precise electronic control afforded over electron spins is promising for developing scalable quantum computing.

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