Synthesis of copper quantum dots by chemical reduction method and tailoring of its band gap

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Metallic copper nano particles are synthesized with citric acid and CTAB (cetyltrimethylammonium bromide) as surfactant and chlorides as precursors. The particle size and surface morphology are analyzed by High Resolution Transmission Electron Microscopy. The average size of the nano particle is found to be 3 - 10 nm. The optical absorption characteristics are done by UV-Visible spectrophotometer. From the Tauc plots, the energy band gaps are calculated and because of their smaller size the particles have much higher band gap than the bulk material. The energy band gap is changed from 3.67 eV to 4.27 eV in citric acid coated copper quantum dots and 4.17 eV to 4.52 eV in CTAB coated copper quantum dots. [http://dx.doi.org/10.1063/1.4948747]

I. INTRODUCTION

Transition metal nano structures have been the focus of considerable interest due to their unique optical and electrical properties and potential applications due to their excellent luminescent properties in semiconductor electroluminescence devices, fluorescence devices, non-linear optical devices, solar energy conversion devices and light-emitting diodes for flat panel displays.[1–6]

Nanoparticle represents the state of matter, somewhere between the molecular and the extended solid state. It is well known that the optical properties like absorption of the nanosized metals differ drastically from the properties of the bulk material due to the change in energy band gap. The band gap depends upon the particle size because of quantum confinement effect, which implies that a single material can exhibit several different colours both by absorption and emission. Quantum confinement of both electron and hole in all three dimensions leads to an increase in effective band gap energy of the material with decreasing the size of the particle. By controlling the crystal size, band gap of the nano particle is tuned and leading to the band edge emission.[7–10]

Quantum dots are nano particles of tens of atoms but in very lower size regime, in which the electrons and holes are completely confined. These are zero dimensional materials. It is also called artificial atom because of its quantum properties. At such reduced sizes (smaller than the Bohr-exciton radius within the corresponding bulk material), those nano particles are completely different from the bulk of the same kind due to quantum confinement effect. Quantum confinement can be defined as, in nano particles whose diameter is smaller than the size of its Bohr-exciton radius the degree of freedom of particle is reduced from N to zero.[11–16] So energy levels can be modelled using particle in a box model in which the energy of different states depend on the length of the box. If there radii are on the Bohr-exciton radius, then the quantum dots are said to be in weak confinement regime and the radii less than the Bohr-exciton radius, then the quantum dots are said to be in strong confinement regime. Due to this quantum confinement, quantum dots exhibits different opto-electronic properties, including their high emission quantum yield, size tunable emission profile and narrow spectral bands. Strong size dependent properties results in a

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