Effect of swift heavy ion on CdS quantum dots embedded in PVA matrix and their applications.

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Abstract: We report synthesis of CdS quantum dots by chemical route at room temperature. In this technique CdS specimen are produced by simple chemical reactions where polyvinyl alcohol (PVA), acting as matrix, plays the key role in controlling particle growth during synthesis. These samples have been irradiated by 100MeV C^{+6} swift heavy ion (SHI). After that, the samples have been characterized by High Resolution Transmission Electron Microscopy (HRTEM), Atomic Force Microscope (AFM), UV/VIS absorption spectroscopy and impedance analyzer.

Topic area : *Nanotechnology*

Key words: *Quantum dot, Blue shift, Impedance analysis, Nano tuned device, SHI*

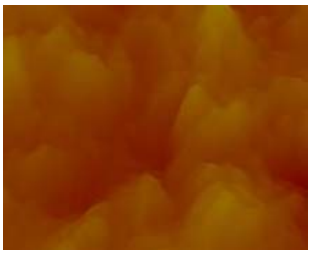
Introduction: Recently [1-15], preparation of semiconductor quantum dots and their applications in optoelectronics and electronics are the frontier area of research. Sophisticated methods are available to synthesize quantum dots but due to manifold advantages Chemical route is a very popular method at present [1]. Here in this paper it is an attempt to report synthesis of CdS quantum dots by chemical route and its impedence study.

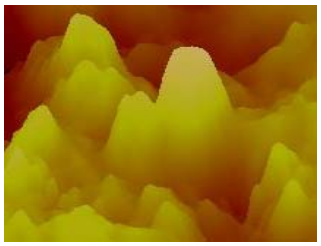
Experimental: To synthesize CdS quantum dot [13-15], over coated with SiO_2 , 5 grams Polyvinyl Alcohol (PVA) are dissolved into 100 ml double distilled (D/D) water. The mixture is taken in a three necked flask fitted with thermometer pocket and N_2 inlet. The solution is stirred in a magnetic stirrer (stirring rate of 200 rpm at constant temperature of 70^0 C) for 3 hours. Thus, a transparent water solution of PVA has been prepared. The solution is degassed by boiling N_2 for 3 to 4 hours. Similarly, $CdCl_2$ solution is made by dissolving 5 gms of $CdCl_2$ in 100 ml D/D water. Next PVA solution and few drops of HNO_3 is added to the mixture and stirred at the rate of 250 rpm at a constant temperature of 55^0C while 2Wt % aqueous solution of Na_2S is put into it drop wise unless the whole solution turns into yellow color. The solution is kept in dark chamber at room temperature for 12 hours for its stabilization followed by its casting over glass substrate and drying in oven at 50^0 C. This film contains CdS quantum dots[6] embedded in PVA matrix. The prepared sample has been characterized by Transmission Electron Microscopy, (using JEM 1000 C XII), Optical absorption spectroscopy (using Perkin Elmer Lamda 35 1.24),Atomic Force Microscopy(NanoScope. IIIa) and impedance analyzer (Solartron SI 1260).

For irradiation, sample is cut in 1cm X 1cm size and put in irradiation chamber under high vacuum condition (4.6×6-10 Torr) for irradiation with 100-MeV C^{+6} ion beam (^{64}C, 1PnA) using four ion doses of 1×10^{11}, 5×10^{11}, 5×10^{12} and 10^{13} ions/cm^2, available from the 15UD tandem pelletron accelerator at IUAC, New Delhi, India

(a) **(b)**

Fig 1: HRTEM images of CdS quantum dots (a)before and (b) after irradiation.





(a) **(b)**

Fig 2 : AFM images of CdS quantum dots (a)before and (b) after irradiation

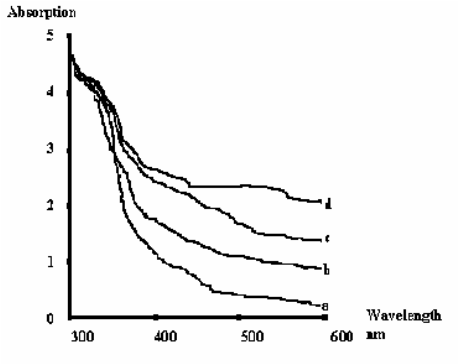


Fig 3: UV/VIS absorption spectra of CdS specimens. a, b, c, and d stand for virgin sample and samples irradiated by 1st, 2nd and 3rd dose respectively

Sample	Absorption edge (nm)	Size (nm)
Virgin	375	7.6
1st dose	380	7.7
2nd dose	379	7.7
3rd dose	380	7.7

Table 1: Absorption spectroscopic data of CdS specimens

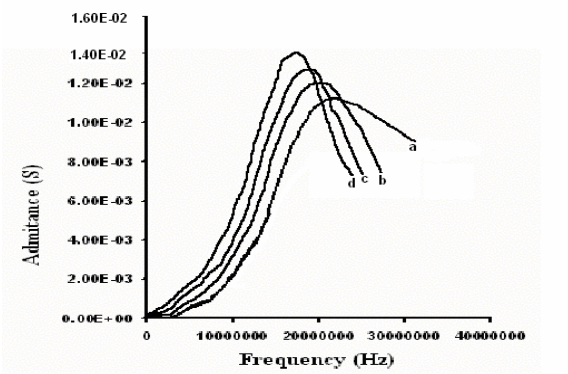


Fig 4: **Impedance curve of CdS QD pristine(a)and irradiation (b),(c) and (d) samples**

Sample	Size	Shape
Virgin	8.8	Spherical
1st dose	8.6	Spherical
2nd dose	8.5	Elliptical
3rd dose	9	Elliptical

Table 2: TEM data of CdS samples

Discussion:

It is already reported[12] that quantum dot impedance is basically due to capacitance which varies directly with particle size. After ion irradiation, particle agglomerates resulting in formation of bigger particle[15] of larger capacitance (fig 4). Due to this phenomena, quantum dot impedance changes resulting in modification in admittance Vs frequency curves of irradiated samples.

Conclusion:

CdS quantum dots prepared by chemical route lies approximately within 9 nm. Impedance analysis infers that CdS quantum dot behaves as nano tuned device. The critical frequencies (equivalent resonant frequency) vary depending on the size, shape and material of the prepared sample. After ion irradiation, particle agglomeration takes place resulting in formation of bigger particle of larger capacitance. Due to this phenomena, quantum dot impedance changes.

Acknowledgement:

Authors thank Prof. A Choudhury (Vice Chancellor, Gauhati University, Guwahati, Assam, India) and Dr. D K Avasthi (Scientist G, IUAC, Delhi, India) for their valuable suggestions and assistances during this work.

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