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# MICROWAVE IRRADIATION ROUTE TO SYNTHESIZE GSH CAPPED CDTE QDS

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## ABSTRACT

*Highly luminescent GSH capped CdTe quantum dots (QDs) were prepared using organic solvent through a facile microwave (MW) aided wet chemical route. The QDs were water soluble and bio-compatible. The morphology of GSH-CdTe QDs is also characterized by SEM study. Sharp visible photoluminescence emission peaks is observed in the visible region at 500 nm for CdTe QDs, attributed to the quantum confinement and effective capping of unsaturated bonds by GSH. The average particle size of QDs was found to be ~ 2 nm , obtained from XRD studies .*

***Keywords:* *Capping, Microwave, Photoluminescence, Quantum Dots, Wet chemical route.***

## I. INTRODUCTION

QDs are being intensively used for producing solar panels [1, 2] optoelectronic devices [3] and as fluorescent probes in bio-imaging and bio-sensing [4-6] among other applications. QDs have many advantages such as sharp emission spectra, higher chemical stability, tunable optical properties, photochemical stability and high quantum yields as compared to organic fluorescent material. Synthesis of QDs through high temperature thermal decomposition of organo-metallic compounds in high boiling point (B.P.) toxic organic solvents needs long reaction time and involves complex synthesis procedures producing QDs with poor biocompatibility [7–13]. So there is a quest for new, simpler and efficient synthetic routes with organic solvents. Present study focuses on synthesis of size controlled CdTe QDs through a fast and facile MW aided wet chemical route. Glutathione (GSH)-capped CdTe QDs (GSH-CdTe) were synthesized under mild conditions found in biological systems that allow micro-organisms growth under moderate pH, temperature, buffer and oxidising conditions. Further, a biological thiol and a tri-peptide GSH works both as a reducing and capping agent for the aqueous synthesis of CdTe QDs[14], found in abundance in cells and are suitable for the stabilization of CdSe and CdTe QDs[15,16].MW irradiation is used as an efficient heating source which creates numerous nucleation sites in the solution, leading to the formation of homogeneous and size controlled nanoparticles. Synthesis of ZnS QDs using different polar solvents with high MW absorption is already reported[17]. Moreover, the quantum confinement effects in QDs are size dependent and are instrumental in determining their optical properties, so the solvents were chosen carefully to get a better control over the particle size distribution of CdTe QDs. A mechanism to describe the role of solvents in controlling the size dispersion is presented in detail for a better understanding of the process.

## II. EXPERIMENTAL

The synthesis of CdTe QDs and their subsequent coating were as follows-
$CdCl_2.2.5H_2O$ was diluted with 40 ml of Toluene. During the constant stirring GSH, Sodium citrate, $K_2TeO_3$ sol and $NaBH_4$ were added into Cadmium sol. 1M NaOH was then used to adjust the pH 10 under vigorous stirring. The mixture was kept in MW for 1 min at 300W. The mixture was cooled down to ~ $50^oC$. The as prepared CdTe solution concentrated to ¼ of the original volume was precipitated using 2-propanol and collected via centrifugation. CdTe QDs dispersion was prepared by redissolving this colloid precipitate in 3ml DD water.

## III. RESULT AND DISCUSSION

### 3.1 Role of Organic Solvent

In present study we are using organic solvent to prepare GSH-CdTe QDs. Selection of precursors and solvent play a very important role in MW assisted reaction kinetics. GSH dissolved in various polar/ non-polar solvents was used for capping and surface passivation. It was observed that the nanocrystal size variations are reduced in case of non-polar organic solvents where ligands controlled the growth rate of particles. Present study adopting MW aided synthetic strategies using high B.P. nontoxic solvents, to achieve a lower particle size distribution along with a sharp PL emission free of peaks related to defects. It will be interesting to relate the functional groups present in the solvents with the surface passivation mechanism prevailing in them. One can attribute the effective passivation of QDs by Toluene to the methyl group attached to the benzene ring present in them, which has a greater affinity to bind CdTe. Optical studies show a stronger passivation by Toluene as compared to other organic solvent like EG and resulting in a better size control, smaller QDs and higher surface to volume ratio.

### 3.2 SEM Studies

The SEM micrograph ( instrument used: JEOL EO JSM 5600) of the as obtained QDs are shown in “Fig.”1 representing GSH–CdTe QDs synthesized using Toluene as a solvent. This micrograph shows densely populated colony of CdTe QDs with almost spherical morphology. The inset attached with “Fig.”1 shows that these QDs are well dispersed.

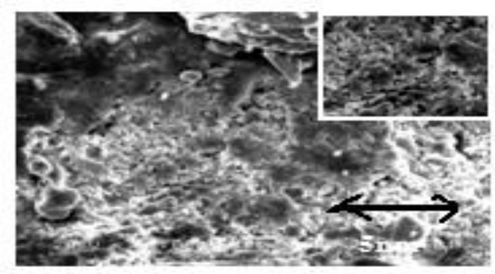

**Fig.1. SEM micrograph of GSH-CdTe QDs**

### 3.3 PL of GSH-CdTe QDs

“Fig.”2 shows the PL emission spectra of GSH-CdTe QDs. The PL emission peak for GSH-CdTe QDs obtained at 500 nm.The size of CdTe QDs synthesized in toluene is 2nm and so they are well within a strong quantum confinement regime, so the PL peaks obtained for GSH-CdTe in our case are blue shifted. Further, In case of GSH - CdTe, it has been reported that the hydrolysis of GSH leads to release of sulfur [18], which forms a CdS shell around CdTe. CdS has a higher band gap, so it leads to a further blue shift observed in GSH-CdTe. [11, 19, 20-22]

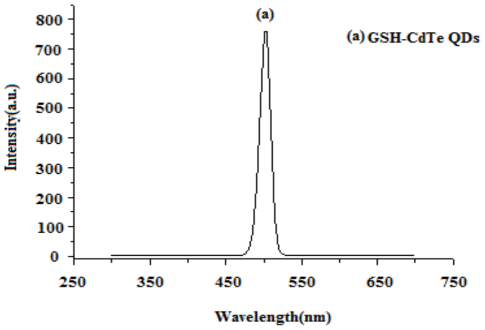

**Fig.2. PL of GSH-CdTe QDs**

### 3.4 XRD Studies

"Fig."3 shows the XRD pattern of CdTe QDs prepared at pH 10 observed .The peaks located at $2\theta = 26{\cdot}3^0$, $42.5^0$ and $52.2^0$ can be attributed to (111), (220) and (311) planes of the zinc blend phase of CdTe. The particle sizes were calculated by Scherer's formula and they are found to be 2.07 nm, for pH 10 for the prominent peaks. All the peaks of CdTe observed in present case were shifted towards a lower scattering angle as compared to those observed in bulk CdTe. This can also be attributed to the formation of CdS shell around CdTe core due to GSH [18, 23].

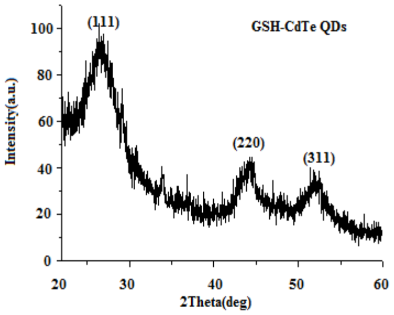

**Fig.3. XRD pattern of GSH-CdTe QDs**

## IV. CONCLUSIONS

In present work, a green chemistry approach was used successfully to prepare size controlled CdTe QDs capped with a non-toxic capping agent GSH. The capping of GSH not only stabilized the nanoparticles, but also allowed controlled further growth of QDs, improving homogeneity in QDs size, shape and stability. It was observed that the organic solvent toluene was effective in controlling the particle size distribution. SEM micrograph shows densely populated colony of GSH-CdTe QDs with almost spherical morphology. Formation of a CdS layer in GSH- CdTe was verified through XRD studies. PL spectra give blue shift due to quantum confinement.

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