SYNTHESIS AND CHARACTERISATION OF PURE AND MN^{2+} DOPED CADMIUM SULPHIDE NANOPARTICLES

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INTRODUCTION

- Nanotechnology refers to the branch of science and engineering devoted to designing, producing, and using structures, devices, and systems by manipulating atoms and molecules at nanoscale, i.e. having one or more dimensions of the order of 100 nanometer (100 millionth of a millimeter) or less.
- The applications of nanotechnology can be very beneficial and to make a significant impact on society. It has already been embraced by industrial sectors, such as the information and communications sectors, food technology, energy technology, as well as in some medical products and medicines.

Cadmium Sulphide

CADMIUM SULPHIDE

- CdS is an II-VI group semiconductor having a bandgap 2.42 eV.
- Cadmium sulphide (CdS) is a promising material in the field of photoelectric conversion in solar cells, thin-film transistor (TFT) nonlinear optics semiconductor laser and flat panel display.
- Thin films of CdS can be piezoelectric and have been used as transducers which can operate at frequencies in the GHz region.

Mn^{2+} Doped CdS Nanoparticles

- Mn^{2+}-doped semiconductor nanocrystals (NCs) exhibit strong dopant-related emissions at energies substantially lower than the host bandgap, overcoming the vexing problem of self-absorption in contrast to the excitonic emission of their undoped counterpart.
- Mn^{2+} doping has created a great impact on the physical properties of CdS NPs and makes them be a potential candidate in non-linear optics, electronic and optoelectronic devices due to the trapping of excited electrons by the Mn^{2+} impurity ions.

Synthesis Of Pure And Mn^{2+} doped cds nanoparticles

PREPARATION OF CDS NANOPARTICLE

CdS nanostructures have been prepared using numerous physical and chemical techniques such as

- Sol-gel
- Hydrothermal
- Solvothermal
- Co-precipitation
- Microwave-assisted methods

SOLVOTHERMAL METHOD:

- Synthesis is a method of producing chemical compounds.
- It is very similar to hydrothermal route.
- Thus solvothermal synthesis allows for the precise control the physio-chemical properties of this solvent.
- This process of making cds nanoparticles.
- The materials irradiated with microwaves they absorb energy from the microwave field.

MATERIALS USED:

- Analytical reagent cadmium acetate, thiourea, manganese acetate along with distilled water used for the preparation of pure and Manganese doped Cds nano particles.
- Double distilled water and acetone were used for washing purpose.

FORMULA

The formula used to estimate the required amount of substance was

$$\textbf{Required substance} = \frac{M.X.V}{1000}$$

M – Molecular weight of the substance.

X – Concentration in molar units.

V – Required volume of solution.

SAMPLE PREPARATION

- Manganese doped CdS nanoparticles were synthesized in distilled water by using microwave irradiation.
- The salts cadmium acetate, thiourea and manganese acetate were of the analytical grade and were used with no further purification.
- The solutions of these salts in the concentration of 1:3 ratio of cadmium acetate and thiourea respectively.
- The combined solutes are dissolved in 50ml of distilled water as a solvent and kept in microwave oven. Microwave irradiation was carried out until the solvent gets evaporated.

SAMPLE PREPARATION

- The colloidal precipitate obtained was cooled and washed several times with double distilled water and the sample was allowed to dry in atmospheric air.
- Further wash with acetone and get dry in atmospheric air, now sample was collected as a yield. To prepare Mn^{2+} (2.5 and 5wt %) doped with CdS nanoparticles, we have to add manganese acetate with cadmium acetate and the preparation method is simultaneous like the pure sample.
- All the three samples (pure, 2.5wt% and 5 wt % Mn^{2+} doped) were prepared and annealed at 200^{0}c for 1 hour to improve the ordering.

REACTION TIME, YIELD PERCENTAGE AND COLOUR

Name of the Samples	Reaction time (min)	Yield percentage (%)	Colour
Pure CdS Nanoparticles	30	13.513	Yellow
2.5wt% Mn^{2+} doped CdS Nanoparticles	10	7.067	Light Orange
5wt% Mn^{2+} doped CdS Nanoparticles	11	5.652	Light Orange

COLOUR AND YIELD PERCENTAGE

Pure, 2.5wt% & 5wt% Mn^{2+} doped CdS nanoparticle.

CHARACTERIZATION TECHNIQUES

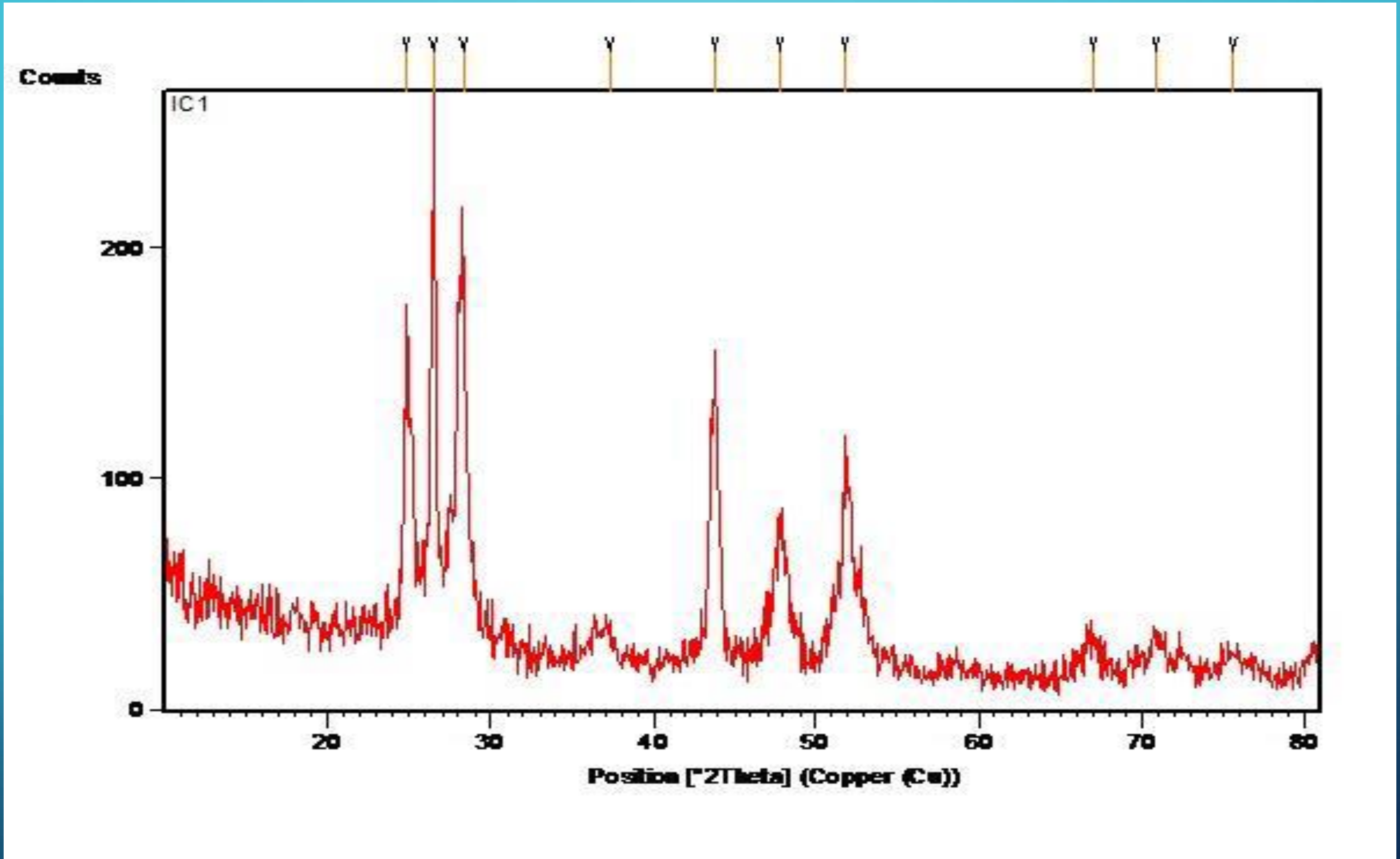
The nanoparticles can be characterized by various techniques which provide important information for the understanding of different features.

Here we analyse the sample using characterization methods such as

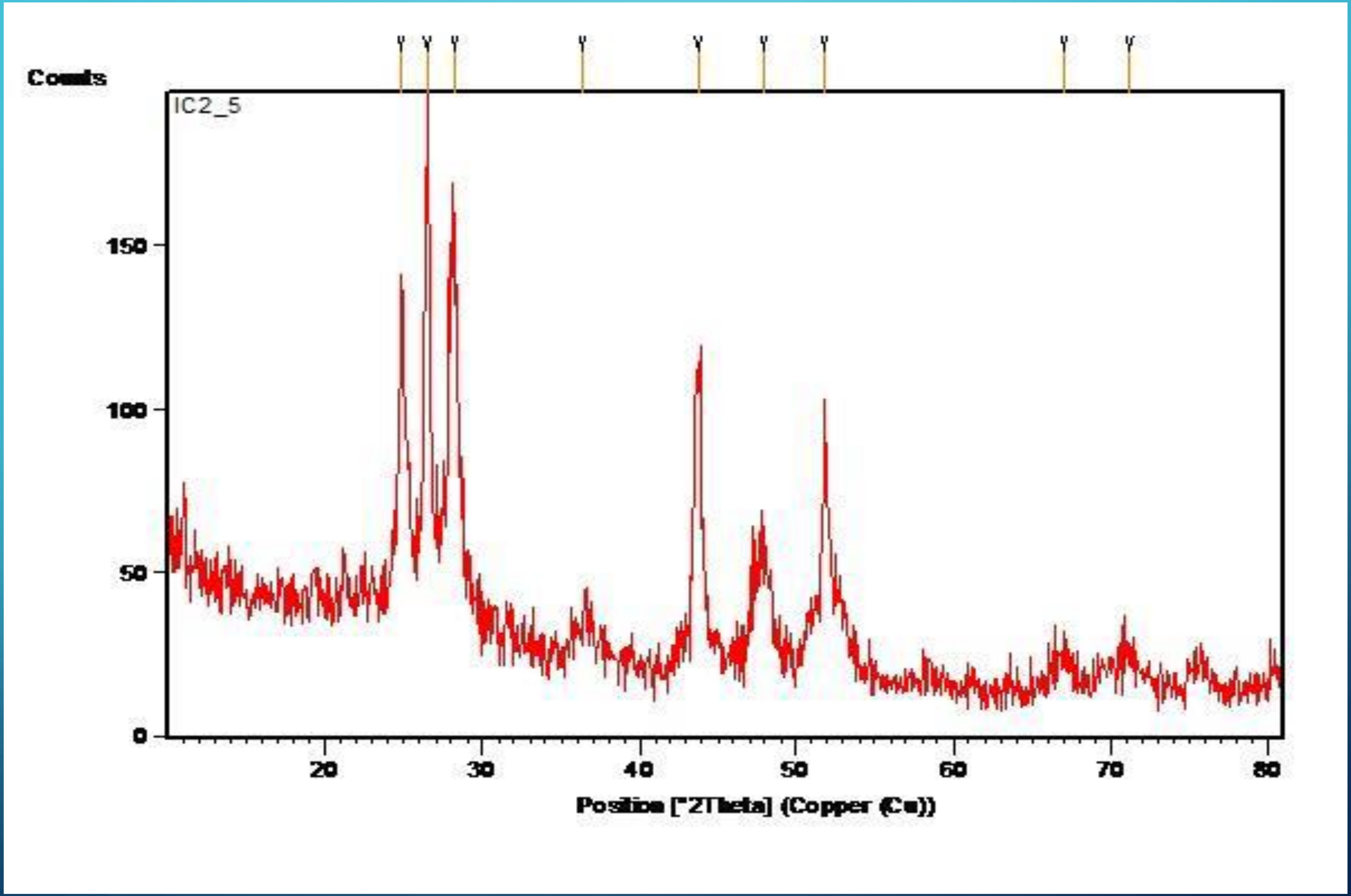
- PXRD and
- UV- Vis analysis.

POWDER X-RAY DIFFRACTION STUDIES

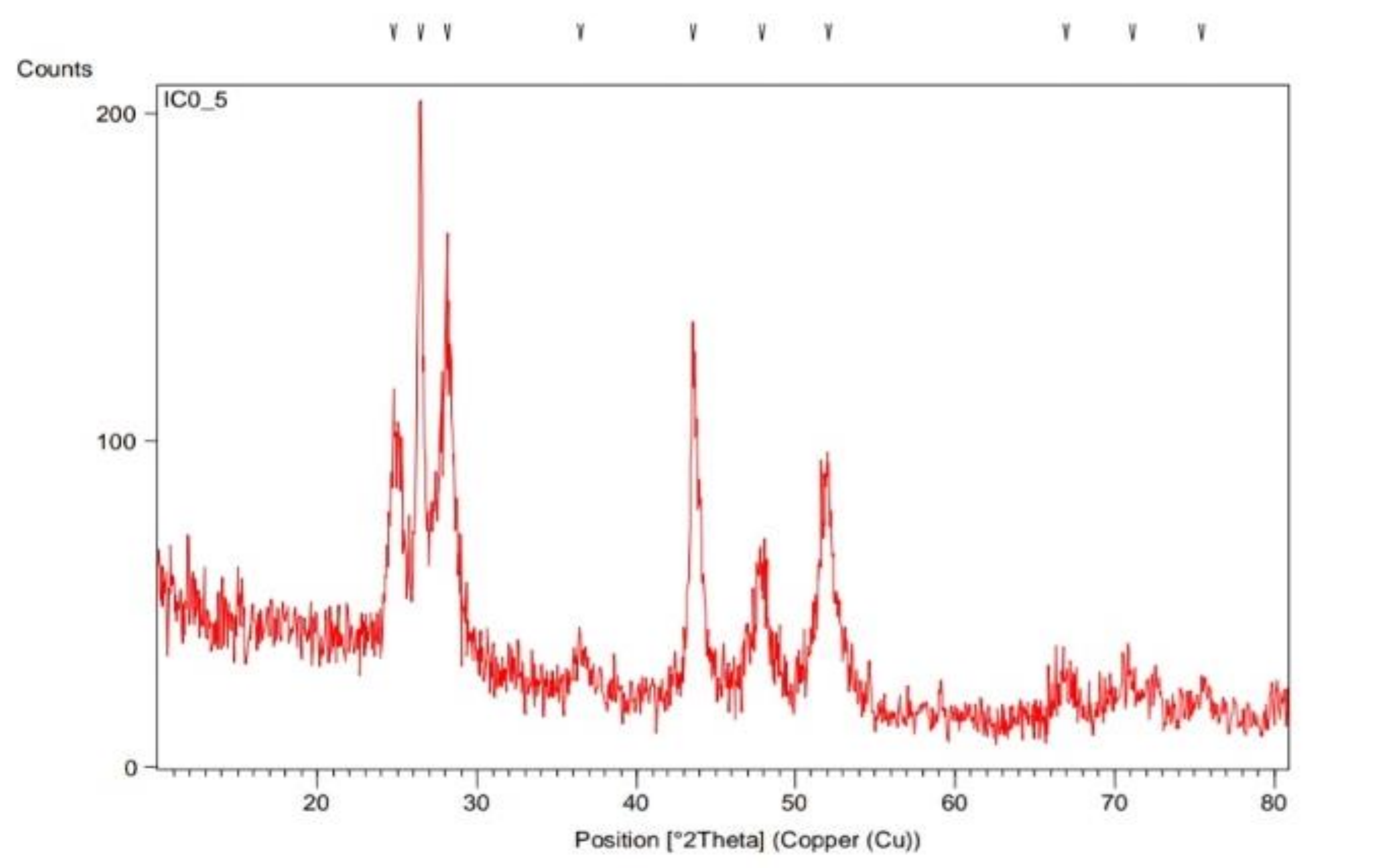
The powder X-ray diffraction pattern of CdS nanoparticles is shown in the figures below. PXRD spectra obtained in the present study are well matched with reported one. The preparation materials confirmed the prepared nanoparticle of CdS. Then the prepared sample is hexagonal in structure matched with the hexagonal form of CdS (JCPDS Card No: 41-1049) having constant. a = 4.140Å c = 6.719Å.



Pure CdS sample



2.5wt% Mn^{2+} doped CdS nanoparticle



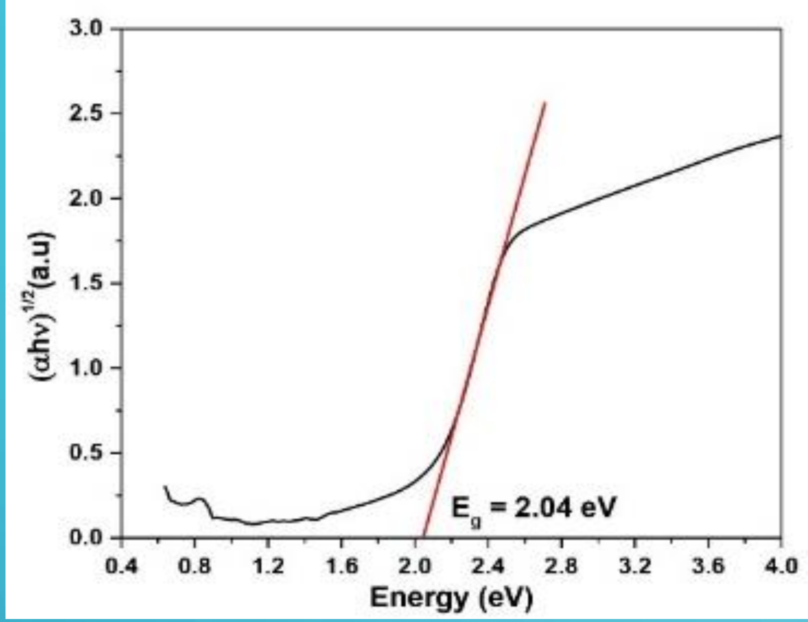
5wt% Mn^{2+} doped CdS nanoparticle

LATTICE PARAMETERS AND GRAIN SIZE

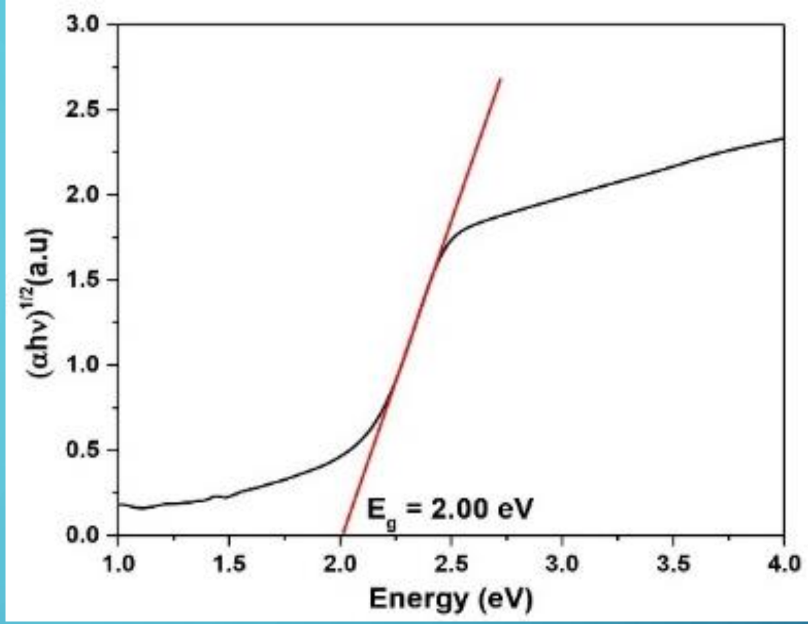
Name of the samples	a Å	c Å	Volume of the Unit cell	Average Particle Size (nm)
Pure CdS Nanoparticle	4.1179	6.51742	110.516	21.73
2.5wt% Mn^{2+} doped CdS NanoParticle	4.14113	6.72032	115.246	22.80
5wt% Mn^{2+} doped CdS Nanoparticle	4.141746	6.72032	115.280	19.33

UV-VIS SPECTRUM STUDIES

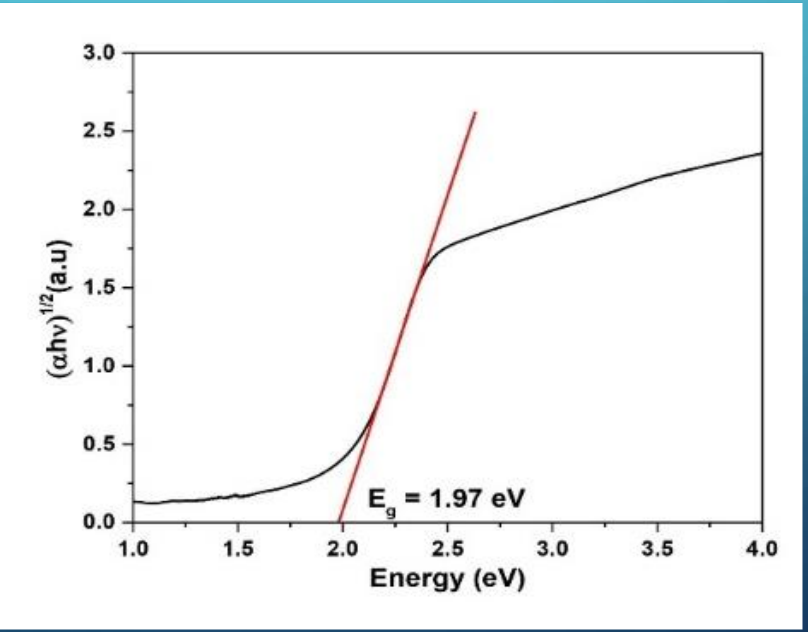
- The most dramatic properties of semiconductor nanoparticles is the size evolution of optical absorption spectra.
- Hence UV-Visible absorption spectrum and Energy band gap plot for pure and Mn^{2+}(2.5wt% and 5wt%) doped CdS nanoparticles.
- The optical characteristics of the nanoparticles were investigated the absorption measurements in the range of 248-1952nm.
- The absorption data were analysed and the band gap was estimated using the Tuac's relationship between the absorption coefficient (α) and the photon energy (hѵ) [Mn2+ doped CdS nanoparticles and their applications.



Pure CdS sample



2.5wt% Mn^{2+} doped CdS nanoparticle



5wt% Mn^{2+} doped CdS nanoparticle

CONCLUSION

- The PXRD patterns indicates the confirmed of hexagonal structure and the average particle size was calculated in the range of 19.33 – 21.73nm.
- The UV-Vis absorption band at about was observed as absorption band in the range of 248-1952nm.
- The value of direct bandgap of pure and Mn^{2+} doped CdS nanoparticles are found to Eg = 2.04eV, 2.00eV, 1.97eV respectively.
- Because of its electronic and wide application properties, they are useful for photonic materials such as solar cells, light emitting diodes, and lasers.

THANK YOU !