TAILORING OF BLUE, GREEN, GREEN-RED EMISSION FROM INORGANIC CRYSTALINE (Cd, Zn)Se QUANTUM DOTS – ZnSe AMORPHOUS PHASE COMPOSITE FOR WHITE LIGHT APPLICATION

IITM Technology Available for Licensing

Problem Statement

- QD-LEDs (Quantum Dot based Light Emitting Diode) has drawn intense research and commercialization due **to narrow emission peak exhibited by QDs , better thermal stability and operation under high brightness and high current**.
- The existing technologies has disadvantages where QD-LEDs are susceptible **to efficiency loss due to self-absorption, and broad deep level emissions where there are hurdles in controlling the ultra-small and stable QDs with uniform size distribution**

Technology Category/ Market

Category – Advanced Materials, Electronics and Circuits
Applications –Light Emitting Diodes, Quantum dots, Semiconductors, nanomaterials
Industry – Semiconductors
Market -The Quantum Dots Market size is expected to grow from USD 4.71 billion in 2023 to USD 10.51 billion by 2028, at a CAGR of 17.41% during the forecast period (2023-2028).

Key Features / Value Proposition

Technical Perspective:

- Light Emitting Device based on novel composite made of crystalline and **amorphous inorganic semiconductor quantum dots**, said composite comprising **Zn alloyed CdSe quantum dot and ZnSe-amorphous (ZnSe-a) phase used for white light applications**
- Emission of wide range of colour achieved by fine tuning/controlling the size and composition of Quantum dots

User Perspective:

- Semiconductor Quantum Dots composite coated directly on UV light wide band gap metal oxide nanorods/ films or metal oxides
- **Low cost** electroluminescence device

Technology

- The present invention discloses a **(Cd,Zn)Se composite system for white light emission** comprises a mixture of inorganic crystalline **Zn alloyed CdSe quantum dot and ZnSe-amorphous (ZnSe-a) phase**
- The (Cd,Zn)Se composite system exhibits:

(i) A weakly confined sharp blue emission from ZnSe-a phase (ZS-NBE)

(ii) A strongly confined size-tunable sharp near **band-edge emission from (Cd,Zn)Se** in the green to red region (CS-NBE)

(iii)A broad defect deep level (DL) green-red emission;

- The **white light emission** is achieved by tailoring the combination of weakly confined sharp blue emission from **ZnSe-a phase** and a **broad green-red emission** from deep defect level along with the near-band-edge emission from an alloyed QDs in **(Cd,Zn)Se system.**
- The composite sizes of **CdSe, $Cd_{0.5}$ $Zn_{0.5}$Se and $Cd_{0.25}$ $Zn_{0.75}$Se** quantum dots are in the range of 2 to 5 nm
- The intensity of broad DL emission drastically decreases with increasing particle size of quantum dot
- The Zn-near-band-edge emission (Zn-NBE) is seen at 460 nm in all the spectra,the deep levels (DL) are seen at 640 nm in (a) and (b), and at 680 nm in (c)

Images

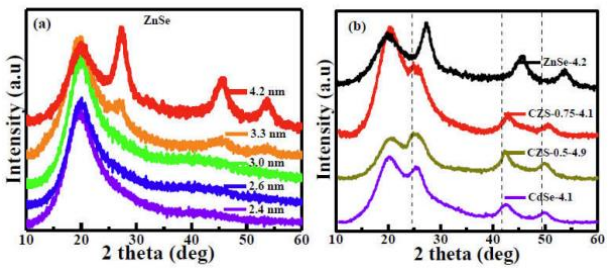

Fig. 1 Shows XRD patterns of (a) pure ZnSe and (b) are the comparative spectra of CdSe, alloyed of CZS-0.5, CZS-0.75 and ZnSe QDs respectively

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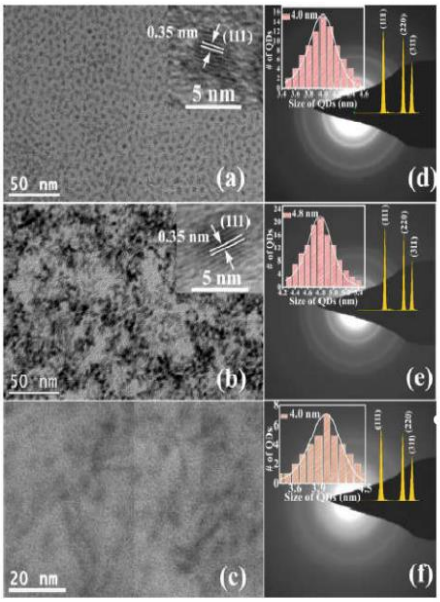

Fig. 2 Shows TEM image of one sample from each set and its corresponding SAD pattern of (a, c) CdSe-4.1 nm (top panel) (b, e) CZS-0.5-4.9 nm (middle panel) and (c, f) CZS-0.75-4.1 nm (bottom panel) QDs respectively. HRTEM images and size distribution histogram plots are inserted in their corresponding panel

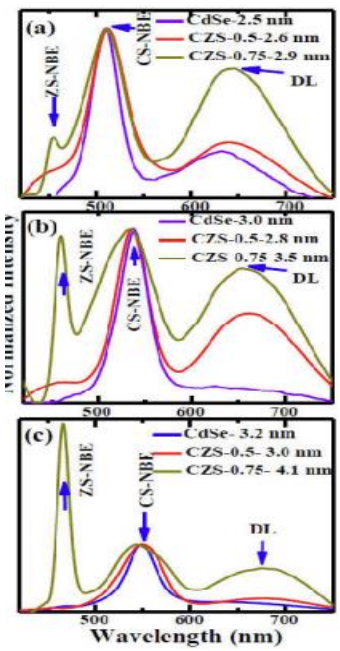

Fig. 3 Shows photoluminescence spectra of CdSe QD, CZS-0.5 and CZS-0.75. The Zn-near-band-edge emission (Zn-NBE) is seen at 460 nm in all the spectra. The deep levels (DL) are seen at 640 nm in (a) and (b), and at 680 nm in (c)

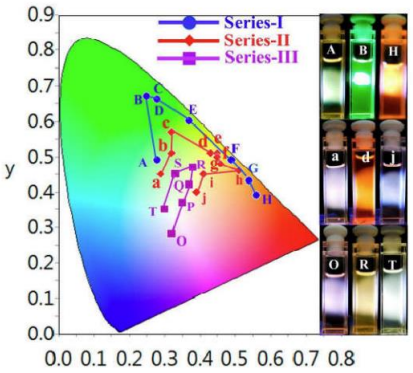

Fig.4 Shows combined chromaticity diagram of (Cd,Zn)Se QD series. Series-I, series-II and series-III correspond to pure CdSe, CZS-0.5 and CZS-0.75 QDs, photoimPhotoimages of luminescent color emitted from the cuvette containing QDs dispersed in the solution from representative samples

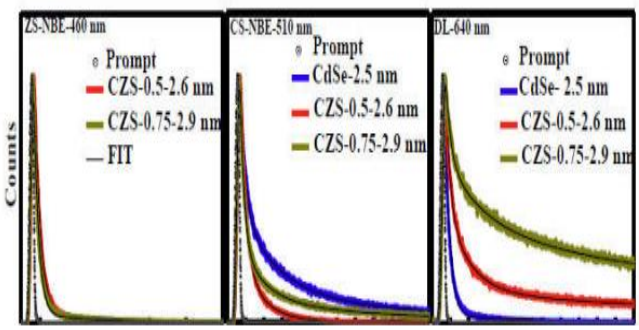

Fig.5 Shows PL lifetime decay of CdSe, CZS-0.5 and CZS-0.75 under excitation wavelength 390 nm. The life time measurements were carried out at wavelengths corresponding to the emission as indicated in the caption in each figure

Intellectual Property

- **IITM IDF Ref. 1459**
- **IN441213-Granted**

TRL (Technology Readiness Level)

TRL-3, Experimental Proof of Concept

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