DIGESTIVELY-RIPENED SEED/NUCLEUS-DRIVEN RAPID AND HIGH YIELD SYNTHESIS OF MONODISPERSED CERAMIC/COMP

IITM Technology Available for Licensing

Problem Statement

- **Uniform size distribution** is of key significance to realize the functions of nanoparticles, the. **Monodispersed nanoparticles** having relative standard deviation less than 5% show unique properties and higher performances when compared with their poly-disperse counterparts.
- However, synthesis of monodispersed nanoparticles is **difficult and expensive** requires direct alternation of the synthesis method. Moreover, **repeatability of such process is not satisfactory.**
- Alternatively mono-disperse nanoparticles can be produced using **post-treatment methods such as digestive ripening** where a polydispersed colloidal solution ends up with monodispersed particles, through an in-situ solution-reprecipitation process. However, the **refluxing step in digestive ripening is tedious and results in low yield**.
- There is a need for a simple process to synthesize **ceramic/compound semiconductor monodispersed nanoparticles** using **digestively ripened quantum dots as nuclei** seeds in a green and scalable manner by **avoiding the refluxing step**.

Intellectual Property

- IITM IDF Ref 1567
- **IN : 350425- Patent Granted**

TRL (Technology Readiness Level)

TRL 4 Basic Technology Validated in Laboratory

Technology Category/ Market

Category-Micro & Nano Technologies

Industry Classification:

NIC (2008)- 20- Manufacture of chemicals and chemical products; **2610**- Manufacture of electronic components; **24201**- Manufacture of Copper from ore, and other copper products and alloys

Applications:

Semiconductor nanoparticle based technologies such as electronics, magnetics, optical materials, sensing, catalytic device applications, nano-lubricants etc

Market report:

The global nano copper oxide market was valued at USD 185.6 Million in 2023 and is projected to grow to USD 905.6 Million by 2032 with a CAGR of 18.7%

Research Lab

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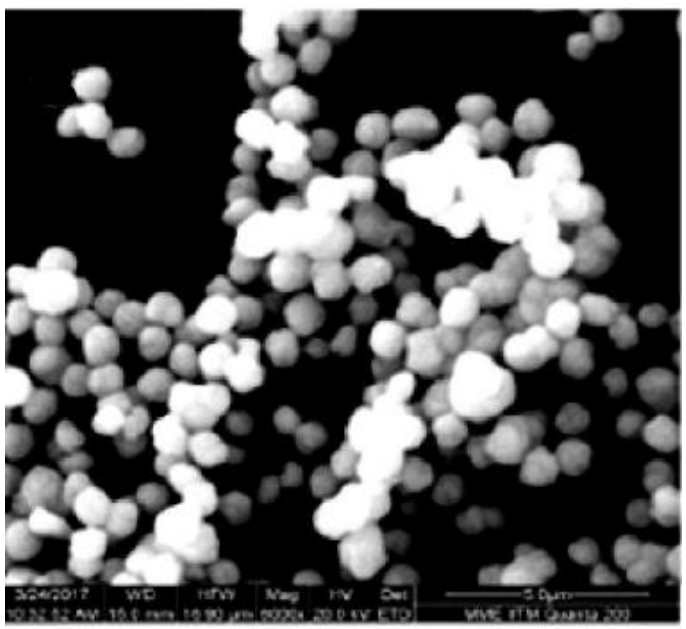

Figure: Represents a SEM image of the monodispersed CuO Nano-particles.

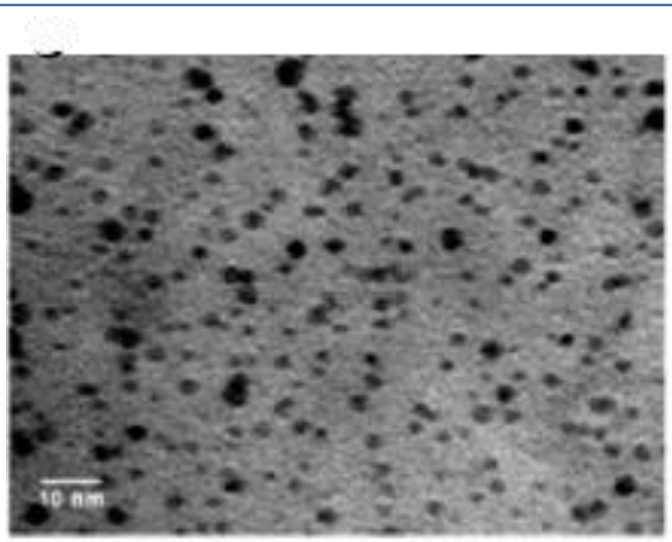

Figure: TEM image of the digestively ripened CuO quantum dots. The TEM image clearly shows that the digestively ripened copper oxide quantum dots that are used for the seed solution are monodispersechn the range of 1.9 to 2.9 nano-metres size.

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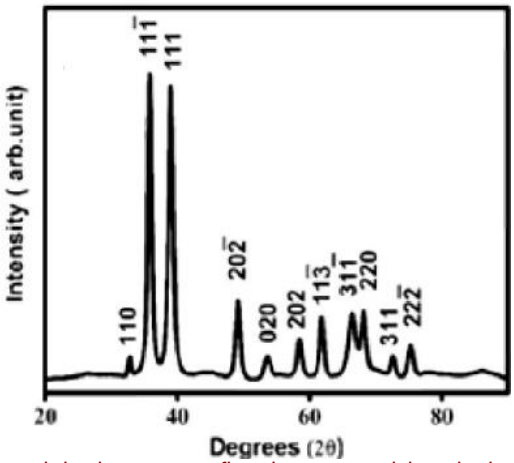


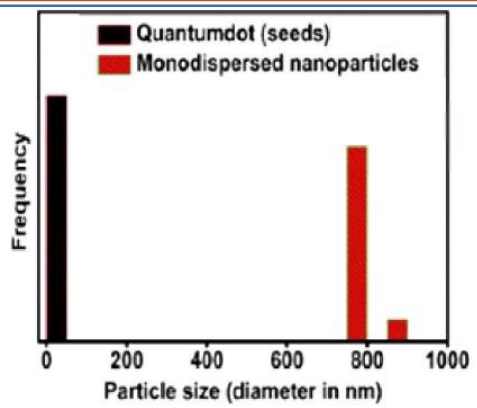
Figure: The X-ray Powder Diffraction (XRD) graph is shown to confirm the nanoparticles obtained from digestively ripened CuO quantum dots are monodispersed CuO.

Technology

- Cu(OAc)2·H20 and NaOH are the starting precursors for quantum dots synthesis. The reaction is carried out in ethanol which acts as a medium. Ethanolic solution with concentration 3 mM of Cu(OAc)2 · H20 is prepared.
- Copper oxide synthesis is aided by the addition of NaOH (solid) to the reaction mixture at room temperature. A constant molar ratio of Cu(OAc)2·H20 to NaOH is maintained about 1:6 to ensure the formation of quasi-spherical particles and eliminates the possibility of habit development in quantum dots
- The mixture is stirred using a magnetic stirrer at 1100-1200 rpm. Once complete dissolution of NaOH, TEA is added to the ethanolic mixture; this must be done in a drop wise manner. TEA: Cu(OAc)2·H20 molar ratio is varied systematically (1:1, 3:1, 5:1, 10:1and15:1), so as to study the effect of capping agent on copper oxide QDs.
- It is observed that the most stable and smallest particles are formed when ratio is 10: 1. The formed stable ultra-small QDs are used as seeds for the synthesis of monodispersed nanoparticles.
- The ultra-small digestively ripened monodispersed copper oxide quantum dots is stabilized ethanol or in any other suitable solvent to form a seed solution.
- The growth solution with varied concentrations from 50 to 10 millimolar (mM) of Cu(OAc)2.H20 are prepared in distilled water. The final solution is prepared by mixing an optimal amount of seed solution with growth solution.
- The final solution is transferred to an autoclave or any other heat source. However, the growth is isothermal. Afterwards, the reactor is cooled to room temperature naturally. Reaction temperature and time are variables that can be used to obtain a specific final nanoparticle size..

Key Features / Value Proposition

- Compared to conventional post-treatment methods the invented method uses a low cost equipment and soft-chemicals that avoid the need for a refluxing step while making the process green.
- The nanoparticles obtained are in the range of 730 to 770 nanometres (nm) size. However, this size is readily varied by employing longer growth times.
- Compared to conventional high-temperature processes, the invented process is carried out at low temperature less (than 100°C) and has traits that make the process readily scalable.
- The process is not limited to CuO and can be readily extensible to other oxide materials or ceramic or semiconductor materials. Also, a large number of oxides are digestively ripened by merely changing the solvent and the surfactant.



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