IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

AN ULTRA-FAST, MECHANOCHEMICAL, SOLVENT-FREE PROCESS FOR SYNTHESIZING PHOTO-LUMINESCENT CARBON QUANTUM DOTS UNDER AMBIENT CONDITIONS

IITM Technology Available for Licensing

Problem Statement

- Current methods for synthesizing **photoluminescent carbon quantum dots are complex, time-consuming,** and often require high temperatures, hindering their practical applications.
- There is a **need for a simple, rapid, and efficient solid-state process** at room temperature to synthesize photoluminescent carbon quantum dots, allowing for their widespread use in **diverse fields such as biomedicine, sensing, and pharmaceuticals.**

Technology Category/ Market

Category – Nanotechnology.
Applications – Biomedical Engineering, Chemical, Environmental Engineering.
Industry - Advanced Materials & Manufacturing, Catalysts, Pharmaceuticals, Water Treatment.
Market -Data Bridge Market Research analyses that the nanotechnology market, which was USD 7.33 billion in 2022, would rise to USD 114.54 billion by 2030 and is expected to undergo a **CAGR of 41%** during the forecast period 2023 to 2030.

Key Features / Value Proposition

Technical Perspective:

- The invention offers a **solvent-free, mechanochemical process** for efficiently synthesizing **photoluminescent carbon quantum dots** at room temperature, **enabling rapid and cost-effective production.**

Industrial Perspective:

- Industries in nanotechnology, materials science, and chemistry can benefit from this **simple and economical process,** with potential applications in **biomedicine, sensing, and pharmaceuticals.**

TRL (Technology Readiness Level)

TRL- 4, Technology validated in lab.

Intellectual Property

- **IITM IDF Ref. 1757**
- **IN 386786 (PATENT GRANTED)**

Technology

The technology for this invention involves a solvent-free, **mechanochemical** process for **synthesizing photoluminescent carbon quantum dots (CQDs) at room temperature**.

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The process utilizes an **anhydride monomer** (**e.g., maleic anhydride**) and an **amine initiator (e.g., imidazole**) mixed and ground in a mortar to form a **low-melting solid solution.**

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This solid solution undergoes an **exothermic reaction,** leading to the **formation of carbonaceous char**.

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The char is then purified by rinsing with **acetone** and drying, resulting in **black, powdery carbon quantum dots.**

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Optional doping with **metal or non-metallic compounds** can also be done to produce **carbon quantum dot hybrids.**

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These **CQDs** find applications in **biomedicine, sensing, and pharmaceuticals**, and their small size contributes to their **photoluminescence** and **enhanced solubility/dispersion abilities**.

Research Lab

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Image

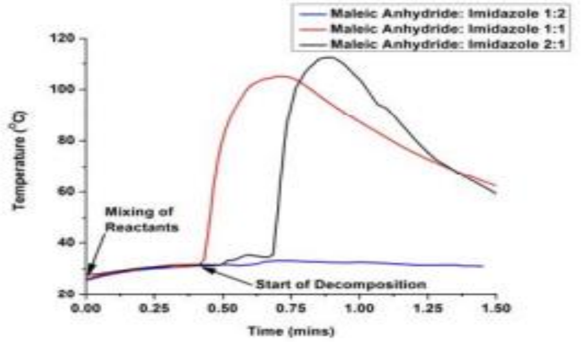

FIG.1 shows the evolution of the temperature, during the solid-state reaction.

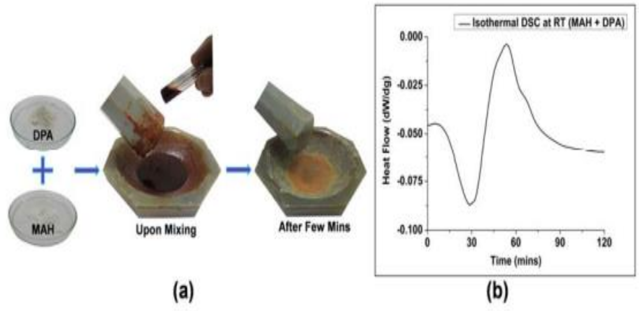

Fig. 2 (a) shows the photographs of the reaction intermediate and the final product of maleic anhydride-diphenylamine 1:1 amic acid and FIG. 2(b) shows the DSC curve for In situ isothermal DSC for the maleic anhydride-diphenylamine 1:1 amic acid.

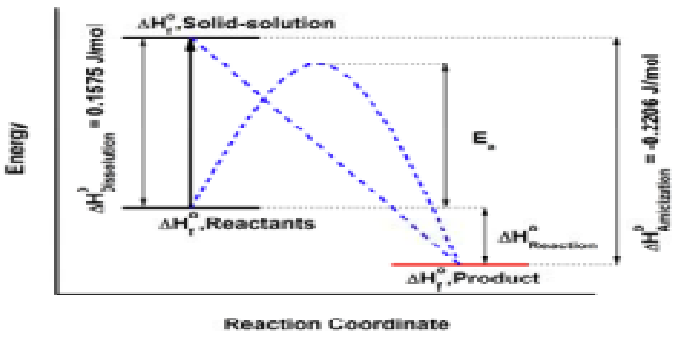

Fig. 3 shows the energy vs. reaction coordinate plots for maleic anhydride-diphenylamine system

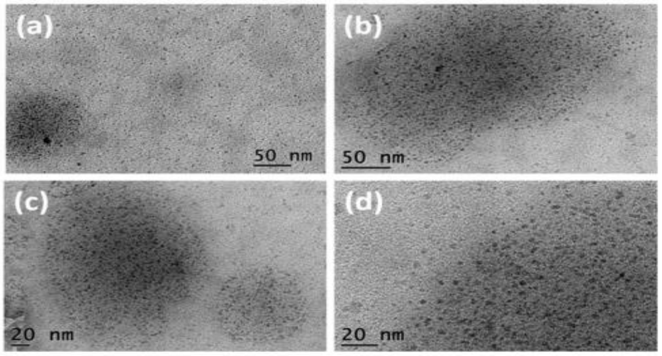

Fig. 4 (a-d) represents TEM micrographs of the CQD's

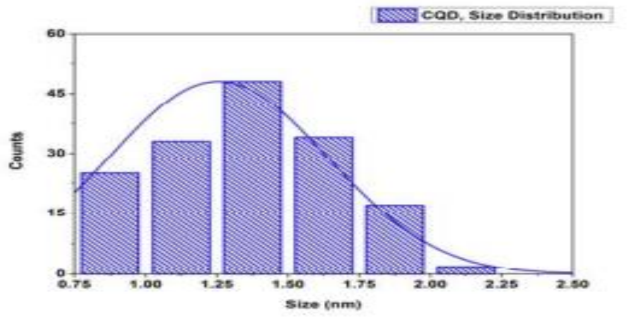

Fig. 5 shows the size distribution of the CQDs obtained by image analysis.

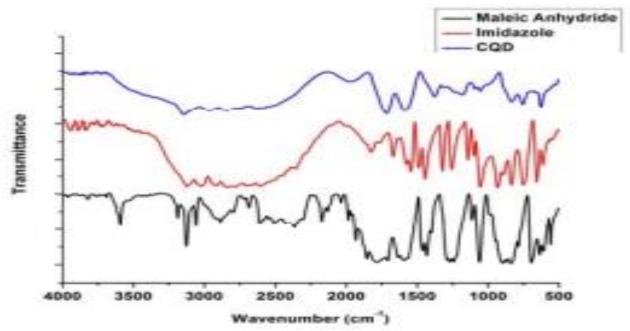

Fig. 6 shows the FTIR spectra of the CQDs and other precursors.

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