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RAPID SYNTHESIS OF 3-MERCAPTOPROPIONIC ACID CAPPED CdTe QUANTUM DOTS USING L-ASCORBIC ACID IN ATMOSPHERIC CONDITIONS

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The aqueous synthesis of cadmium telluride (CdTe) quantum dots (QDs) capped with thiolate ligands is a widely accepted approach for producing biocompatible, semiconducting nanomaterials for fluorescence imaging and detection. Conventional routes typically require over 6 h of reaction time and an inert atmosphere to prevent the growth of oxygen induced surface impurities and to ensure the formation of stable QDs by completing crystal growth. This work introduces an optimised, rapid, nitrogen-free method to produce brightly luminescent CdTe QDs under natural atmospheric conditions using L-ascorbic acid (AA) as a co-capping ligand. This employs a one-pot aqueous reflux system at 100 °C, with only the NaHTe precursor prepared under inert conditions. The main synthesis proceeds completely in ambient atmospheric conditions, with optimised Cd:Te:3-mercaptopropionic acid (3-MPA):AA molar ratios of 1.0:0.1:0.7:1.0 and a specific pH of 11.9±0.1 to accelerate nucleation and QD growth. Under these conditions, complete red shift of the QD emission from green to deep orange was observed within 120 min, reducing synthesis time by 67% compared to standard methods. The strong alkalinity promotes full deprotonation of 3-MPA-SH groups, which enhances thiolate binding to Cd^{2+} and monomer stability. AA effectively passivates the QD surface, preventing oxidation of Te^{2-} to Te^{0} and surface defects. Absorption peak area (APA) was increased by 67.7% at higher pH, though excessively high pH (>12.9) compromised colloidal stability. APA was increased by 189.8% by doubling the Cd:AA ratio. Replacing toxic reductants such as N_2H_2 with AA and omitting nitrogen purging enhanced safety and reduced reagent cost by about 40%. The combination of these ligands renders the QDs biocompatible compared to hydrophobic ones. The COOH rich shell helps to reduce Cd^{2+} leaching, thereby lowering the toxicity. With their colloidal and chemical stability lasting up to several months, these functionalised QDs are currently being applied in on-going studies of microplastic detection in environmental samples.

Keywords: Ambient conditions, CdTe Quantum dots, L-ascorbic acid, Nitrogen free, Water soluble