Non-injection one-pot preparation strategy for multiple families of magic-sized CdTe quantum dots with bright bandgap photoemission

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HIGHLIGHTS

- CdTe magic-sized quantum dots with absorption peaks at 427 and 500 nm were synthesized.
- CdTe magic-sized quantum dots were synthesized without prefabricating a TOP–Te precursor.
- The quantized growth mechanism of CdTe magic-sized quantum dots was explained.

GRAPHICAL ABSTRACT

The two families of CdTe MSQDs were sequential growth with evolution of the temperatures.

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ABSTRACT

CdTe Magic-Sized Quantum Dots (MSQDs) with absorption peaks at 427 and 500 nm were synthesized by a non-injection one-pot approach which features high synthetic reproducibility with potential for industrial scale production. Relatively pure forms of two families of CdTe MSQDs with bright band gap photoemission were synthesized without prefabricating a trioctylphosphine–tellurium (TOP–Te) precursor which was previously thought to be necessary when TOP was employed as the reaction media for synthesizing CdTe MSQDs. A transformation between the two families of CdTe MSQDs was observed by tuning the synthetic parameters, such as the concentration of TOP, the reaction temperature and reaction time. New thermodynamic equations were proposed to explain the formation and dissolution mechanism of the CdTe MSQDs.

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1. Introduction

Magic-Sized Quantum Dots (MSQDs) have attracted extensive interest for their bright applications in many scientific and technological fields [1–3]. MSQDs with well-defined size, structure and precise atomic composition are of particular importance because of their reproducible physical, chemical, and optical properties as well as their corresponding applications [4,5]. Due to the differences in their structure, MSQDs remain at several distinct sizes while regular quantum dots exhibit persistent absorbance with a continuous red-shift [6]. MSQDs can minimize ambiguities arising from size dispersion or from poorly defined surfaces and may be very useful as building blocks for functional materials in many scientific and technological fields [7]. On the basis of data from mass spectrometry experiments, powder X-ray diffraction measurements and theoretical modeling, Kasuya et al. [4] have proposed that CdSe MSQDs have a cluster-cage structure that is composed