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Strong quantum confinement effect in Cu_4SnS_4 quantum dots synthesized via an improved hydrothermal approach

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ABSTRACT

We developed an improved hydrothermal method with water-oil two-phase reaction system to synthesize size-controllable and oil-soluble Cu_4SnS_4 (CTS) quantum dots (QDs). The water-oil interface played an important role in controlling nuclei process, growth speed, crystal size and size-distribution of CTS QDs. X-ray diffraction, Raman scattering and transmission electron microscopy studies suggested that the formation and growth mechanism of CTS QDs was revealed to involve three steps. The crystallographic orientation of the CTS nanoprism was analyzed in detail. The blue-shift of absorption edge and broadening of Raman bands were observed due to the quantum confinement effect. The exciton Bohr radius of CTS QDs was calculated to be 3.3-5.8 nm by using the first principle calculation. The size dependence of band-gaps of CTS QDs follows the particle-in-a-box effective-mass model. The ability to fabricate high-quality CTS QDs certainly facilitates the solar cell applications.

Keywords: Cu_4SnS_4, Quantum confinement effect, Bohr radius, Solar cell

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