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One-pot synthesis and characterization of InP/ZnSe semiconductor nanocrystals

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Abstract

We report on the one-pot synthesis of InP/ZnSe quantum dots (QDs) using a precursor-based colloidal synthesis in a noncoordinating solvent environment. The structural and optical studies were carried out on the as-prepared InPQDs. The quantum yield of the nanocrystals was recorded as 6% and a 1.4 times reduction in the ratio of trap-related emission to band edge emission was observed on ZnSe passivation of the InPQDs.

1. Introduction

The colloidal group III–V semiconductor nanocrystals (NCs) have attracted enormous interest in the past two decades [1]. The principal attraction to this class of nanocrystals lies in the robustness of their covalent bond compared to the ionic bond in group II–VI semiconductor systems [2,3]. This property carries along an enhanced optical stability and reduced toxicity as a result of non-erosion of constituent ions when they are used in biological milieu [4]. Within the group III–V semiconductor materials, the InP system appears popular due to its relatively narrow band gap (1.35 eV) and large excitonic Bohr radius (11.3 nm) [5]. These parameters allow for the tuning of the photoluminescence emission wavelengths from the blue to the near infrared regions [6]. Research in InP-based nanocrystals is also premised on the need to find less toxic non-cadmium based quantum dots for applications in biomedicine [7].

However, despite the fact that the covalent nature of the group III–V is acknowledged, it is unfavorable for their synthesis. The precursors of group III–V nanocrystals possess strong covalent bonding, and therefore demand high synthetic temperatures and long reaction times. In 2010, Kim et al. [8] reported the fabrication of trioctylphosphine oxide (TOPO)-capped InP/ZnSe using chloroindium oxalate as an indium precursor in a reaction carried out over several days with a quantum yield of 6.8. In this paper, we report a shorter route to the synthesis of palmitic acid-capped InP/ZnSe nanocrystals using a one-pot hot-injection [9] method. Further, weakly coordinating solvent, 1-octadecene (ODE), was used in our work because

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