

Synthesis and Characterization of Complex Structure of Colloidal InP Quantum Rods and Dots

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Nanocrystals of InP with different diameter and shape were synthesized by colloidal chemistry method. Their complex structure, such as core/shell composite and close-packed arrays, are also prepared in order to find the best configuration for delocalization of charge in nanocrystals. One-dimensional (1D) semiconductors, quantum wires, naturally provide preferred delocalization of carriers directed along the long crystal axis. Because of that, quantum wires are better conductors than quantum dots. We have very recently synthesized InP nanorods and nanowires in the diameter range of 30-100 Å and 1-3 μm length. These prepared nanorods are in a strong confinement regime since the Bohr diameter for bulk InP is about 200 Å. For preparation of nanorods we used an organometallic precursor that decomposes thermally into InP and In metal particles. The latter serves as nucleation catalyst for the growth of the rods. The morphology of the product depended on the reaction time, temperature, the nature of the stabilizer, and the amount of amorphous InP introduced during the rod growth. Quantum rods of zinc blende structure with a high degree of crystallinity are grown along the (111) crystallographic planes. The absorption spectra are in the visible spectral regime, suggesting a substantial blue shift with respect to the bulk (band gap 1.35 eV), due to size confinement effect. Moreover, the Stokes shift of the emission band in the quantum rods is substantially larger than the shift in the corresponding quantum dots. Our studies also show that in complex heterostructures of InP quantum dots that consist of close-packed arrays of a core(InP)/shell(GaInP₂) composite, charge delocalization occurs. We recently incorporated colloidally prepared InP quantum dots arranged in a close-packed array into a larger bandgap GaInP₂ thin film by metal organic vapor phase epitaxy technique and found that in this composite structure the confinement energies are dramatically reduced. This raises the possibility to fabricate composites with specific properties of surrounding matrix to achieve exciton delocalization in illuminated quantum dots.