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Expanding the one-dimensional CdS-CdSe composition landscape: Axially anisotropic CdS1-xSex nanorods

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Abstract
We report the synthesis and characterization of $CdS_{1-x}Se_x$ nanorods with axial anisotropy. These nanorods were synthesized via single injection of a mixture of trioctylphosphine sulfur and selenium precursors to a cadmium-phosphonate complex at high temperature. Transmission electron microscopy shows nanoparticle morphology changes with relative sulfur and selenium loading. When the synthetic selenium loading is between 5% and 10% of total chalcogenides, the nanorods exhibit pronounced axial anisotropy characterized by a thick "head" and a thin "tail". The nanorods' band gap red shifts with increasing selenium loading. X-ray diffraction reveals that $CdS_{1-x}Se_x$ nanorods have a wurtzite crystal structure with a certain degree of alloying. High-resolution and energy-filtered transmission electron microscopy and energy-dispersive X-ray spectroscopy confirm the head of the anisotropic nanorods is rich in selenium, whereas the tail is rich in sulfur. Time evolution and mechanistic studies confirm the nanorods form by quick growth of the CdSe-rich head, followed by slow growth of the CdS-rich tail. Metal photodeposition reactions with 575 nm irradiation, which is mostly absorbed by the CdSe-rich segment, show effective electronic communication between the nanorod head and tail segments.

Keywords
axial anisotropy, cadmium chalcogenide, graded alloy, heterostructure, nanorod

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