Mid-Infrared Active Quantum Dots

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In spite of extensive research, mid-infrared emission from self-assembled semiconductor quantum dots produced by the usual heteroepitaxial Stranski-Krastnow growth has remained elusive due to the unfavorable type II band alignments of most narrow band gap material systems. In this talk, I will present an alternative synthesis approach, based on epitaxial PbTe quantum dots (QDs) embedded in a wide band gap CdTe matrix. These materials are practically strain free due to the almost perfect lattice matching but exhibit a huge quantum confinement due to the very large 1.2 eV difference in the band gaps. Our synthesis approach is based on phase separation rather than on lattice-mismatch strain and is driven by the large miscibility gap between IV-VI and II-VI materials due to the difference in lattice structure. As a result, in epitaxial structures phase separation occurs at elevated temperatures, resulting in the formation of well isolated, nearly spherically and wetting-layer free PbTe quantum dots with atomically abrupt interfaces. The quantum dots exhibit intense mid-infrared emission even at room temperature and the dot size can be varied over a wide range by changing the deposited layer thickness or composition or by variation of the growth temperature. Due to the large quantum confinement, mid-infrared emission can be tuned over the whole 1.5 – 4 µm wavelength region. Application of these quantum dots in the form of MID LEDs and microdisk lasers is demonstrated, where the latter represent the first quantum dot lasers emitting at wavelengths longer than 1.6 µm. Potential applications of such devices are in molecular gas analysis, environmental monitoring and medical diagnostics.