Strain-Compensated Quantum Dot Cascade Lasers

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Over the past two decades, quantum cascade lasers (QCLs) have been constantly improved in their performance and at this point have matured into the preferred choice of coherent sources in the mid-infrared (mid-IR) spectral region for a wide range of applications. More and more companies have attempted the usages of QCL on air-pollution, water-contamination, industrial-discharge, breath-medicine, and toxicant detection. Due to the essence of the extremely short non-radiative lifetimes commonly associated with the intersubband transitions in the quantum wells, the room temperature wall plug efficiency of QCL is no more than 30%.

At present, how to increase the efficiency of QCL further on is still a challenge. Quantum dot cascade laser (QDCL), in which quantum well active region is replaced by quantum-dot active region, is predicted as high-efficiency. However, the design and growth of QDCLs is extremely difficult. In this talk we demonstrate the development of QDCLs by two-step strain-compensation active region design and material growth technique. The QDCLs based on three-layer QDs active region, two-layer QDs active region, and single-layer QD active region have been exploited, paving a route for developing QDCLs.

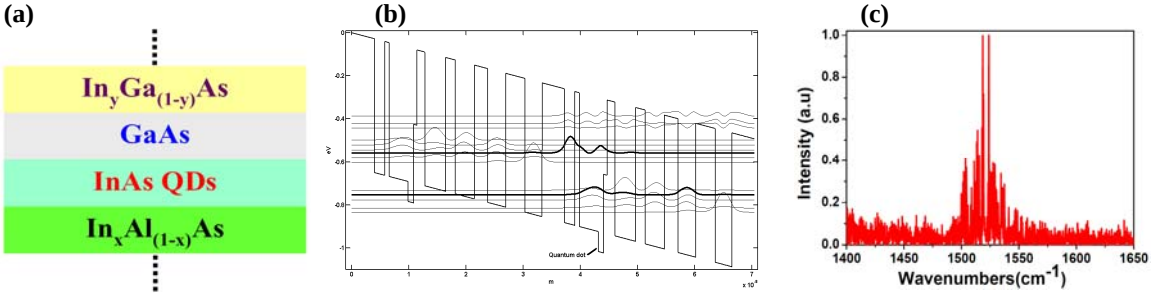

Figure 1. (a) The layer structure of QDCL based on single-layer QDs active region. (b) Calculated conduction band diagram and subband wave functions under electric bias. (c) Lasing spectrum

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