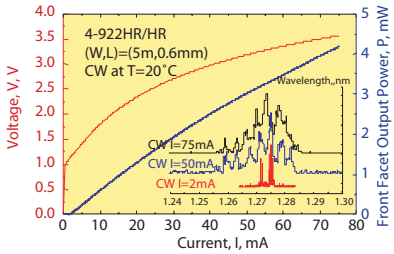
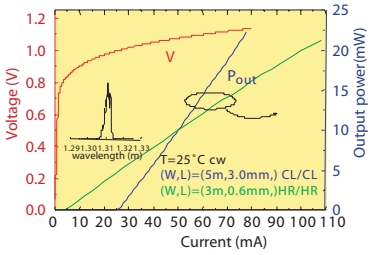
Long wavelength Quantum Dot Lasers
長波長奈米量子點雷射

Quantum dot (QD) lasers, with their potential for higher output power, higher efficiencies, lower threshold current densities, temperature insensitivity and variable wavelengths, are viewed as an emerging cornerstone photonic technology with wide applications. ITRI uses epitaxial methods to grow high quality InAs/InGaAs quantum dots on GaAs substrates and has demonstrated a room temperature, 1.31 micron wavelength QD laser with record-low threshold currents at 1.43 mA. A high power output of 150 mW was also achieved. Its lasing characteristics with 45-degree divergent angle are among the best ever recorded.

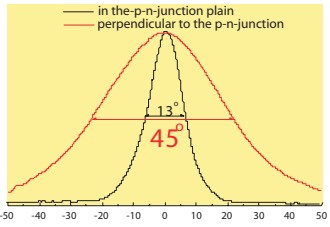
理想的奈米量子點雷射具有低起始電流及熱穩定性高的特性，未來將於雷射製作技術中佔有非常重要的地位，而GaAs基板上的長波長雷射則是未來寬頻光通訊光源發展的趨勢。本研究於GaAs基板上磊晶成長高品質發光波長1.31微米的 InAs/InGaAs 奈米量子點材料，並成功地利用多層堆疊技術大幅提高基態光增益，目前有脊狀波導邊射型雷射的1.43 mA超低起始電流、波長1.31微米光垂直發散角45度與輸出功率達150 mW等特性領先世界。



Low threshold current ridge waveguide QD lasers. Threshold current: 1.43 mA



Low divergent angle, 1.31 μm QD laser characteristics
λ =1.31 μm, V_o=1.0 V, R_S=1.0 Ω, I_{th}= 5 mA



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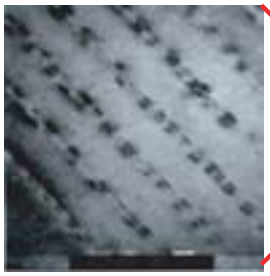
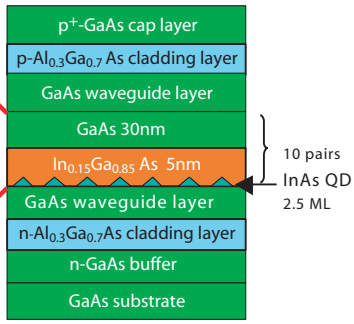
Vertical divergent angle 45°



TEM micrograph 2002/10



Stacked 10 layers InAs/InGaAs quantum dot laser structure on GaAs substrate

Stained cross-section of a stacked two-layer QD laser viewed with FESEM

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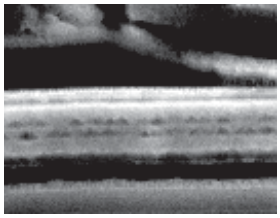

2-stack QDs laser with ridge waveguide width of 5 μm and the stained QDs with base width around 40 nm are clearly seen from SEM 2002/10

The present work uses molecular beam epitaxy to prepare multi-layers of low defect quantum-dot structure on GaAs substrates. The high quality of the layers increases the gain of QDs to allow successful fabrication of high performance edge emitting lasers with emission wavelength 1.31 μm. Record low threshold current of 1.43 mA has been achieved with the ridge waveguide laser structure using a low divergent angle design. Such high performances mark an important achievement in laser epitaxy and a big step toward the photonics application of quantum dots.

Applications

- 1.0 ~1.31 μm optical communication lasers.
- Long wavelength quantum dot LEDs
- Optical memory and far IR detectors.