Barrier Width Effects in InAsP/AlGaInP Quantum Dot Lasers

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Self-assembled InAsP quantum dot (QD) lasers grown on GaAs substrates have potential in applications such as biophotonic sensing and telecommunications, across wavelengths from the near-to-mid infrared. Such devices also offer the possibility to investigate quantum dot laser physics in a less well studied material system than conventional InAs or InP QD lasers.

Previous studies[1] of InP QD lasers have shown that narrow barrier structures result in higher threshold current densities (J_{th}), due to the first layer of QDs influencing the growth of subsequent layers. However, due to the reduction in size of InAsP dots compared to those of InP and less strain in the initial material, the optimum barrier width for InAsP devices requires further investigation.

In this work we have studied a series of InAsP QD structures, which have been grown in a low-pressure horizontal flow MOVPE reactor at 730 °C. Structures studied consist of 5 dot layers, which are formed of 2 monolayers of InAsP self-assembled QDs and covered by 8nm $Ga_{0.56}In_{0.44}P$ quantum well (QW) layers. The barrier width separating the QWs has been varied (8nm, 16nm and 24nm) and are formed from $(Al_{0.30}Ga_{0.7})_{0.51}In_{0.49}P$.

Oxide-isolated stripe lasers (50µm wide), with cleaved uncoated facets and segmented contact non-lasing test devices (also 50µm wide) have been fabricated for each structure containing different barrier widths. Laser devices have been operated in pulsed mode (1KHz, 1000ns) to reduce self-heating effects. The temperature dependence of the threshold current was measured for lasers with cavity lengths of 1mm, 2mm and 3mm, from 280 K to 370 K.

The threshold current density, J_{th}, for the 2mm cavity length devices (figure 1) appears lower for the 8nm, than both 16nm and 24nm barrier widths. The lasing wavelengths of these devices have been measured and are found to be 761.8 nm, 759.5 nm and 756.0 nm for the 8 nm, 16 nm and 24 nm barrier width structures respectively, indicating a decrease in lasing wavelength with increasing barrier width. The modal gain and absorption using segmented-contact structures will also be presented.

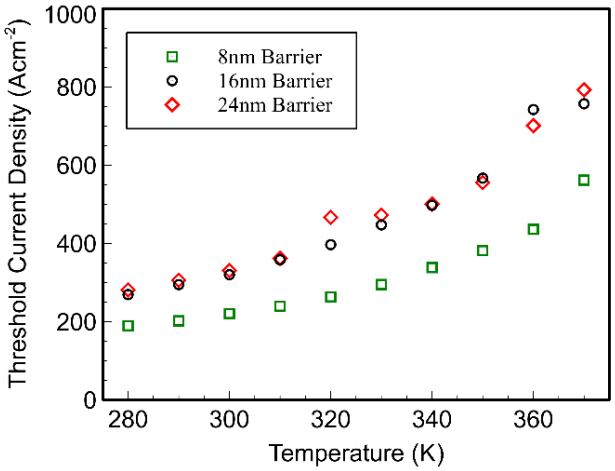

Figure 1: Threshold current density against temperature for a 2mm cavity length lasers, for each barrier width.

[1] P. M. Smowton et al, IEEE Photonics Technology Letters, vol. 22, no. 2, pp. 88-90.