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p 型ドープ InAs/GaAs 量子ドットレーザの閾値電流の温度依存性の測定

Measurement of Temperature Dependence of Threshold Current in InAs/GaAs Quantum Dot Lasers with p-Type Doping

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Since the proposal of quantum dot lasers (QDLs) by Arakawa and Sakaki in 1982 [1], there has been an impressive amount of R&D, culminating in the recent commercialization of the QDL [2]. The temperature dependence of QDLs is of great importance for applications benefitting from their improved stability compared to quantum well lasers, and is also of great theoretical interest. In this work, we report the measurement of the temperature dependence of threshold current in *p*-type-doped QDLs at low temperatures in the range 20 – 250K.

We measured the threshold current for a total of 6 InAs/GaAs QDL samples from 3 groups, each with 1e17/cm^3 doping, and either 6, 7, or 8 layers of quantum dots. The lasers were processed into ridge waveguides, with a cavity length of 375 μm, and facet reflectivities of 34% and 94% for the front and back respectively. The samples were bonded onto heat sink mounts for good thermal dissipation, and mounted in a cryostat. As shown in Fig. 1, each of the samples showed a similar trend, with a region of positive temperature coefficient (PTC) from 20 K – 100 K, followed by a negative temperature coefficient (NTC) above ~140 K. This behavior in QDLs was discovered in 1997 [3], and can be explained by a transition from a thermal carrier distribution around room temperature, to a non-thermal random population at low temperatures [4], however a satisfactory quantitative model has yet to be developed, and this area continues to be an active area of research to this day [4-6]. The dependence on doping concentration will also be discussed.

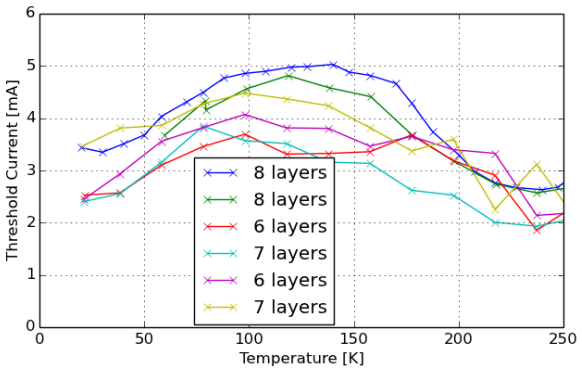

Fig.1 Threshold current vs. temperature for the QDL devices, showing 2 regions with different behavior.

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