ドーピング構造設計最適化による 3～4THz 帯 QCL のワットクラス高出力化

Watt-class Output QCL in 3-4 THz by Optimizing of Doping Structure Design

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Recently the semiconductor-based large output sources are in great required for the fast progressed THz application such as next generation communications and imaging, sensing. A 1.31 W peak power and 52 mW average power THz quantum cascade laser (QCL) is presented by variable Al composition active structure with high doping concentration based on Non-Equilibrium Green Function (NEGF) method design. Device has thick growth active layers and large mesa size with the consideration of heat dissipation. A 4-wells based THz QCL utilizes different Al composition at each barrier and well. Those optimizations of Al composition achieve the carrier's operation via the designed energy levels alignment for injection, emission and extraction only. The not welcome alignment and interaction of operational energy levels with high energy confined levels (which did not direct participate in the designed QCL's operation and cause the horizontal current leakage) is reduced. Higher doping concentration is expected to give more effective carriers through the designed structures, augment the flowing current and populations in the expected subbands, thus increase the optical gain and current dynamic range. High doping concentrations with a strong band bending effect due to the Poisson effect, which causes re-alignment of the energy levels, is also considered in the design of the active region. Figure 1 shows the experimental temperature dependent current - voltage - light output characteristics of the redesigned THz QCL. And the duty cycle dependence of the average output power is shown in Figure 2. The peak output power decreases as the duty cycle increases due to the heating effect, and consequently, the average power is increases until duty 5%, which the heat effect becomes overwhelming.

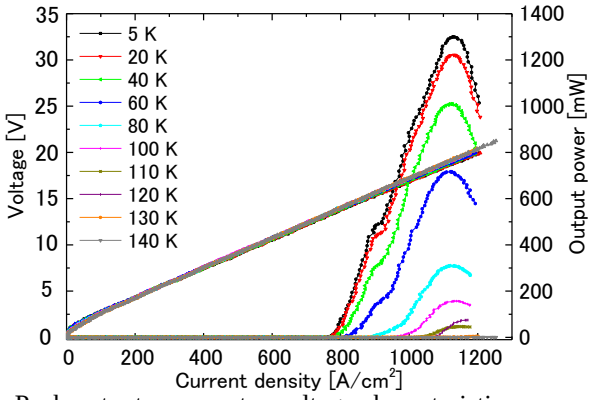

Fig. 1. Peak output – current – voltage characteristics at duty 1%

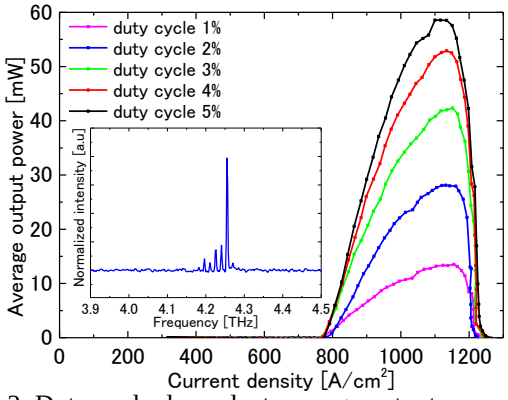

Fig. 2. Duty cycle dependent average output power and spectrum.