0.44 Watt power GaAs/AlGaAs THz QCL developed by reducing horizontal current leakage

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THz quantum cascade lasers (QCLs) are promising as compact and high output power semiconductor THz sources over sub-Watt [1] to Watt-order peak power [2] with narrow bandwidth. Based on the bottle neck of limited operation temperature around 200 K [3], practical applications of THz-QCLs are still quite limited caused by a requirement of the large cooling system and operated at low duty cycle with small average output power. Operation temperature and output power are the most critical parameters to be used at real THz applications. We reported an improvement of optical gain of THz-QCL by reducing a horizontal current leakage from upper lasing level to neighbor high energy levels under the guidance of theoretical calculations based on non-equilibrium Green's function (NEGF) method [1]. We design the different Al composition AlGaAs barriers-wells in short period structures in order to keep the lasing energy levels with artificially miss-alignment the coupling of upper lasing level to neighbor high energy levels. Dramatic increase of optical gain especially temperature over 200K was predicted by NEGF analysis. We fabricated GaAs/AlGaAs THz-QCLs with reduced horizontal leakage current based on the NEGF calculation results. The sample has standard resonant-tunneling injection type QC structure and semi-insulated surface plasmon waveguide. We succeeded in improving the output power of the THz-QCL and maximum power of 445 mW was observed at 5K.

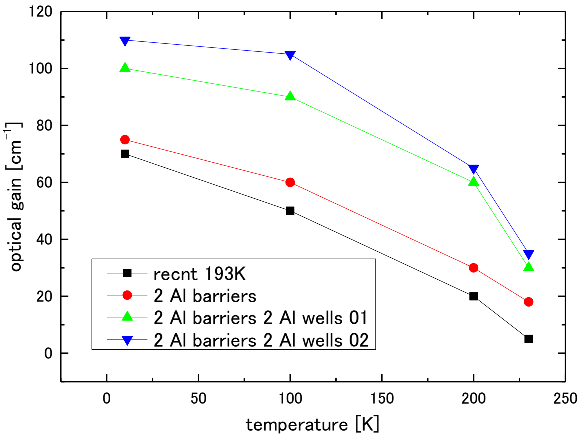

Fig 1. Simulation of temperature dependent of optical gain of 2-wells THz QCLs considering the horizontal current leakage.

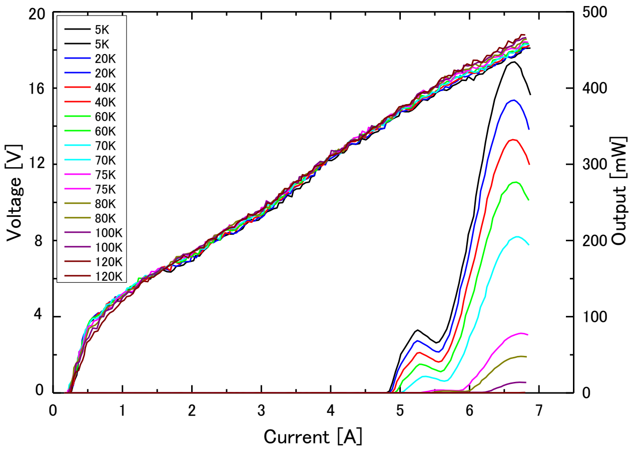

Fig 2. Experimental result of L-I-V of regular 4-wells LO depopulation THz QCLs with SISP waveguide by reduce the horizontal current leakage.

[1] T. -T. Lin *et al.*, APEX **11** (2018) 112702. [2] L. Li *et al.*, Electron. Lett. **50** (2014) 309.

[3] S. Fathololoumi *et al.*, Opt. Express **20** (2012) 3866.