

GaAs 系 THz 量子カスケードレーザーの 250 mW 動作

250 mW output power operation of GaAs-based THz quantum cascade lasers

理研光量子, テラヘルツ量子素子研究チーム ○林 宗澤, 寺嶋 亘、平山 秀樹

THz quantum device labotory, RAP ○Tsung-Tse Lin, Wataru Terashima, Hideki Hirayama

E-mail: ttlin@riken.jp

THz quantum cascade lasers (QCLs) [1,2] are promising high output power semiconductor THz sources to over Watt order peak power [3] with narrow bandwidth. It is still quite limited for the THz applications caused by the large cryogenic system and low duty cycle with low output power at high operation temperature. Output power is one of the most critical parameters for real applications. We demonstrated a 77 K liquid nitrogen Dewar condenser as a compromised compact portable THz source unit with our fabricated QCLs. They showed a stable few ten mW peak power with sub mW average power operation. Analysis the temperature performance of structures by Non-Equilibrium Green's Function (NEGF) method are discussed. The improvement of the active region and waveguide fabrication will also be discussed for high output power operation in order to exhibit the best performance of the compact 77 K Dewar system.

The devices toward high output power operation by using an active region design with larger injection and more vertical optical emission; adopting a semi-insulated surface plasma (SI-SP) waveguide with longer cavity length in order to get better far field patterns and lager output power. We achieved the maximum peak power of 250 mW and average power of 2.2 mW at 10 K, with the regular mesa size of ridge width 200 μm and cavity length 2 mm. At 78 K, this device delivered 10 mW peak power and 0.1 mW average power with duty cycle 0.1%. The output power decreased with temperature is discussed by NEGF method. The reduction of optical gain is consistent with experiment results. The large optical gain structure at low operation temperature results in increased of leakage pass at elevated temperature and rapidly reduce the output power when increase the operation temperature of THz QCLs.

[1] J. Faist *et al.*, Science **264** (1994) 553. [2] R. Köhler *et al.*, Nature **417** (2002) 156. [3] L. Li *et al.*, Electron. Lett. **50** (2014) 309.

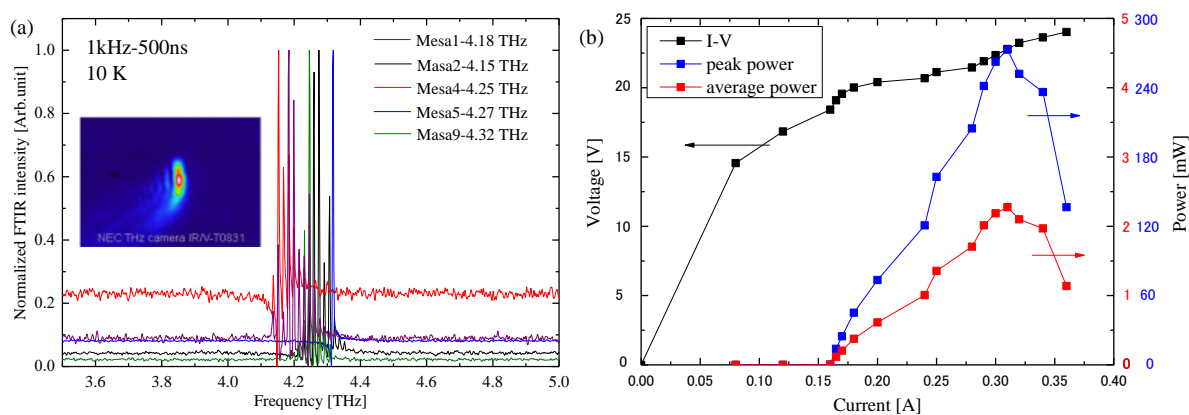


Figure 1 (a) Lasing spectrum of THz QCLs. (insert) Far field pattern of Dewar condenser measured by NEC THz camera IR/V-T0831. (b) Current density - voltage and current density - light output characteristics