

Recent progress on Quantum Cascade Lasers development and Mid-IR applications

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BIOGRAPHY

Tadataka Edamura received B.S., M.S., and Doctor degrees, all in applied physics, from Keio University, Yokohama, Japan, in 1990, 1992, and 1995 respectively. In 1995, he joined the Central Research Laboratories, HAMAMATSU PHOTONICS K.K., Shizuoka, Japan. Since 2010, he has been the Senior Researcher of the Material Research Group. His current research interests include high power quantum cascade lasers, and their applications.



TECHNICAL ABSTRACT

During the last decade, the development of Mid-IR (4-11 μ m) Quantum Cascade Lasers (QCLs) has shown a substantial progress leading to the commercial availability of such devices. In developing newly high performance QCLs, we have focused high output power QCL for laser surgery. Recently, the selective caries removal treatment technique without serious thermal damage for a normal dentin has been required. The potential application of selective caries removal by high output power QCL emitting at 6 μ m wavelength range is investigated. This wavelength range is expected to be absorbed to organic matter (for example, Amide I -band) [1].

We developed a Fabry-Perot (FP-) type QCL emitting at 6 μ m [2]. The active region structure of QCL is based on InGaAs/InAlAs SPC structure (US-PAT No.8,068,528B2) grown by MOCVD [3] and the number of cascaded stages is 50. The output power can be easily scaled up by increasing the number of cascaded stages. The large number of cascaded stages has doubly advantageous. First, as the confinement factor is increased with thick active region, the modal gain coefficient is also increased and the lasing threshold in turn decreased. Second, since many photons are generated by one electron, the QCL is inherently a high output power light source. The HR coated FP-QCL chip is mounted epi-side down on Cu heat-sink. Fig.1 shows the current-light output characteristic at 0°C and the lasing spectrum is also shown in Fig.2. The threshold current density is 1kA/cm² and the average output power is >0.7W in quasi-CW operation (duty-cycle 50%) at 0°C.

We will present the latest status of the Mid-IR QCLs together with the some results of demonstrations for medical applications; selective caries removal treatment.

Keywords: Mid-IR, semiconductor laser, quantum cascade laser, laser surgery

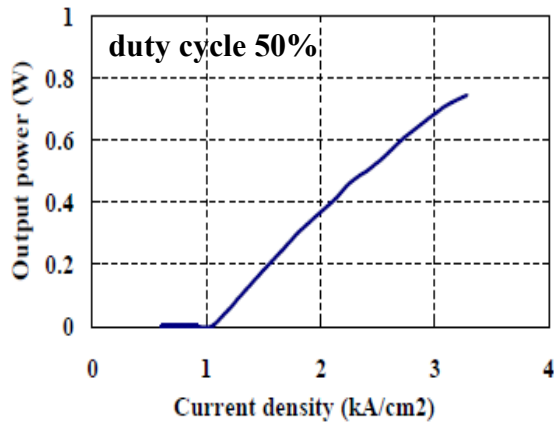


Fig.1. Current-light output characteristic of a 6 μ m FP-QCL in quasi-CW operation at 0°C.

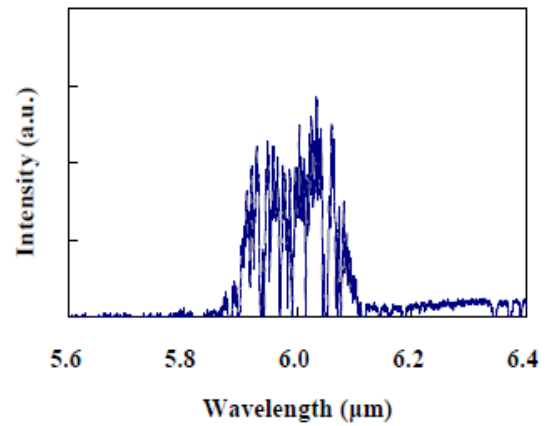


Fig.2. Lasing spectrum of a 6 μ m FP-QCL.

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