Conference or Workshop Item:

Agnew, G, Grier, A, Taimre, T et al. (13 more authors) Prediction of Turn-on Delay in a Pulsed Terahertz Quantum Cascade Laser. In: 13th International Conference on Optoelectronics and Microelectronic Materials and Devices (COMMAD2016), 12-14 Dec 2016, Sydney, Australia. (Unpublished)

COM MAD 2016

Prediction of Turn-on Delay in a Pulsed Terahertz Quantum Cascade Laser

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***Précis*- The response time of terahertz (THz) quantum cascade lasers (QCLs) is of prime importance in high speed pulsed applications. Response times of typical THz QCLs are in the picosecond range, making their study in the laboratory difficult. An alternative means of exploring QCL turn-on dynamics is the use of an accurate rate equation model. In this work we present turn-on delay characteristics predicted by an accurate model of a 2.59 THz bound-to-continuum QCL.**

To date, model-based investigations of start-up delay, rise time, and overshoot characteristics of THz QCLs have made use of rate equations with fixed parameters, yielding results that are valid over a limited current and active region temperature range [1]. While such results are informative with respect to the general behavioral trends of QCLs, they do not provide the device-specific insight required to inform detailed application design. Here we demonstrate the use of an accurate, device-specific reduced rate equation (RRE) model [2], [3] to characterize the turn-on dynamics of a 2.59 THz bound-to-continuum QCL [4]. Figure 1 shows the optical output power response of the QCL to a 1.2 ns rectangular drive current pulse of amplitude 460 mA. The cold finger operating temperature used was 15 kelvin. Petermann's definition [5] of laser turn on time was used. The simulation was repeated at five temperatures (15, 35, 40, 45, 50, and 52 K) and three drive currents, 460, 470, and 480 mA, to produce the characteristics shown in Fig. 2. A future thrust of this research will be laboratory work designed for indirect observation of THz QCL dynamical metrics such as turn-on delay, pulse rise time, and modulation bandwidth, to be validated against the predictions of our RRE model.

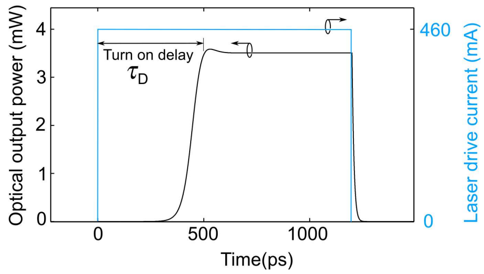

Fig. 1. Optical output response of QCL to a current step of 460 mA at 15 kelvin, showing turn on delay and overshoot.

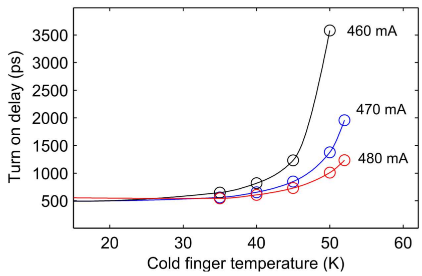

Fig. 2. Dependence of QCL turn-on delay on temperature and drive pulse magnitude.

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