Instrumentation for Durability and Longevity Testing of InGaAs/InAlAs Quantum Cascade Lasers

Bryan Bruce[1], Claire Gmachl[1], Anthony Hoffman[1]
[1] Princeton University, Princeton, NJ 08544, U.S.A.
email: bbruce1@umbc.edu

The study of Quantum Cascade Lasers (QCL) has continued for fourteen years and the goal of making them usable for many applications is coming to a reality [1]. With this goal approaching and the reality of producing QCL-based devices for the marketplace, the question of whether these devices can withstand the test of time arises. Much research has gone into QCLs in an effort to make them as optimum as possible. Since many of the lasers that are grown are used to test only a specific theory, most QCLs are only used for as long as they are needed to study. This could be only several hours or days. In order to make reliable devices for the public, durability and longevity testing must occur to ensure consumers are putting their money to good use.

In this study, an automated, self-contained setup is being constructed in order to study the lifetime of QCLs. Most changes in devices occur in the beginning and end of the device's lifetime. In the first few hours of a laser's lifetime, the so-called "burn-in" effect will be examined to see how it will affect the performance of the lasers. Since lasers have the potential to emit a notable amount of heat, lasers will "burn" into their mounts, subsiding some of the stress they are under when the Indium of the submount softens. The emanated heat of a QCL, however, can also lead to degradation of the device, for defects have the capability to grow. An example would be the pinholes of the device enlarging, allowing excessive current to pass through at certain points and potentially damaging the laser. The stress that a laser undergoes within its first few hours will be examined. In the long run, tests will be performed to study how the lasers cope to various probable conditions. This includes a laser's performance response to various degrees of current and temperature changes over long periods of time as well as the effect of power failures on the QCLs. The setup in Fig. 1 has been designed and built and will be used to test both short-term and long-term effects and different failure modes of QCLs. This research is supported in part by MIRTHE (NSF-ERC).

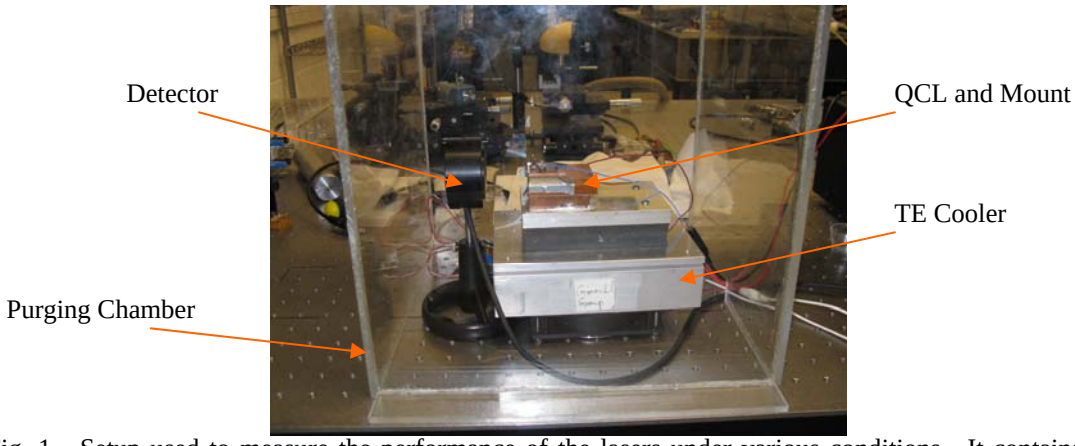

Fig. 1 - Setup used to measure the performance of the lasers under various conditions. It contains a thermoelectric (TE) cooler, power meter, QCL and temperature controller (not visible) contained in a Plexiglas box for nitrogen purging purposes. The temperature controller uses a PID algorithm to stabilize the TE cooler at a certain temperature, which will help test lasing abilities under various conditions.

[1] J. Faist, F. Capasso, D. L. Sivco, C. Sirtori, A. L. Hutchinson, and A. Y. Cho, "Quantum cascade laser," *Science*, vol. 264, pp. 553–556, 1994.