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

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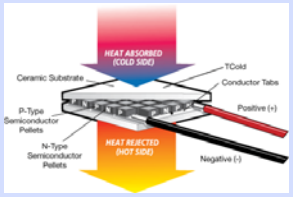
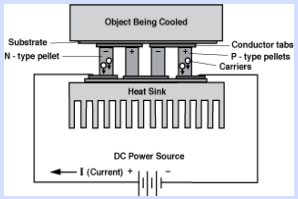
Motivation

With the reality of producing Quantum Cascade Laser (QCL)-based devices for the marketplace, the question of how reliable these devices will be 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 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. The goal of this work is to create an isolated and automated setup to test the reliability of QCLs.

Background

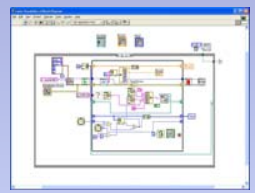
The setup used will focus primarily around a thermoelectric (TE) cooler. As a general overview, these devices use the Peltier effect to create a heat flux within the device. A solid-state active heat pump transfers heat against the temperature gradient (from cold to hot) with consumption of electrical energy. This results in a hot and cold plate.





Methodology

Initial setup: TE-cooler with a temperature controller, power supplies, detector

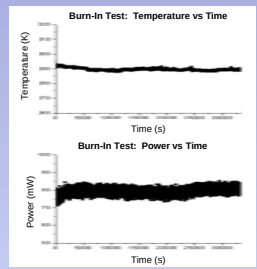


Problem: Higher cooling rates from the TE cooler resulted in condensation
Solution: Purge the device with nitrogen

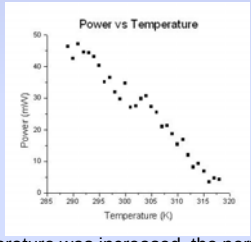
Problem: Poor performance of the laser
Solution: Indium foil and thermal compound to help with heat dissipation, strong contact between the laser and submount for better current flow

Problem: The purging box trapped heat from the hot plate of the TE-cooler, making the cold plate hot.
Solution: Isolate solely the cold plate

Results



While keeping the temperature constant for an extended period of time (roughly 8.5 hours), the respective power of the lasers remained invariable



As temperature was increased, the performance of the laser significantly decreased

Conclusion

The setup to test the durability of the lasers was relatively reliable. While there were not extensive tests run to test the limits of the QCLs, the preliminary tests show several ideas. “Burn-in” does not seem to greatly affect QCL performance. Also, the QCLs remain stable over long periods of time if environmental conditions are optimal. Additionally, overheating is a major concern. These lasers operate better at lower temperatures.