A Double-Metal QCL with Backshort Tuner

M.R. Mertens[1], M. Justen[1], C. Bonzon[2], K. Ohtani[2,3], M. Beck[2], U.U. Graf[1] and J. Faist[2]

The development towards many-pixel arrays for astronomic terahertz heterodyne detection has led to an ever-increasing demand for high power local oscillator sources. Quantum Cascade Lasers provide high optical power in particular at frequencies above ~2 THz, where frequency multiplication techniques are severely limited. The main drawback with QCLs is the fixed operating frequency with only a few GHz of tuning bandwidth.

We have recently developed a new tuning technique based on mechanical variation of the cavity length. The system consists of a double-metal QCL with a design frequency of 1.9 THz which is terminated with a patch antenna array on one side [1,2] and is coupled by a taper section to a microstrip transmission line. On top of this microstrip we position a Bragg-reflector made from a series of perpendicular gold stripes on a thin silicon membrane. In this way the total cavity length can be controlled by changing the tuner membrane position using piezo actuators.

Our measurements confirm that a tuning range over a complete FSR of 30 GHz is attainable with the fabricated device (L~1mm). Although the q-factor without tuner membrane is sufficiently high that lasing occurs at high currents, both optical output power and threshold current improve significantly when the membrane is applied.

The QCL provides enough CW power to pump an heterodyne array while consuming a moderate electrical power of 1.6W. We operate the device with a low vibration Stirling cooler at 50K.

[1] 1. Physikalisches Institut, University of Cologne, Cologne, Germany.
[2] Institute for Quantum Electronics, ETH-Zürich, CH-8093 Zürich, Switzerland
[3] now with: Niels Bohr Institute, Condensed Matter Physics, Copenhagen, Denmark.

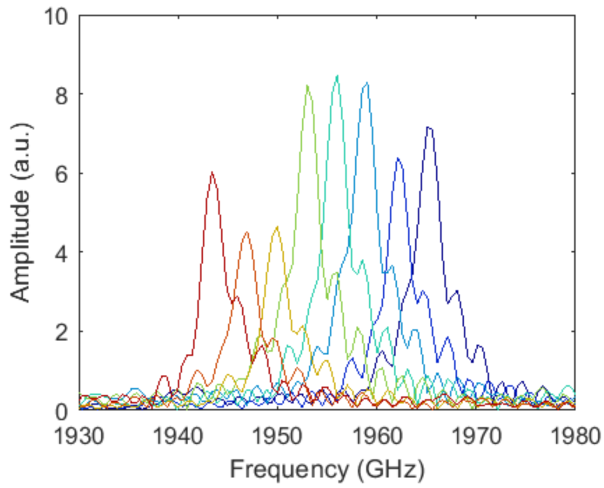

Fig. 1. Recorded spectra for different tuner membrane positions. The tuner membrane was moved between each measurement to change the cavity length, resulting in a shift of the laser emission frequency. Peak shape is influenced by zero-padding of the FFT.

References

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