Frequency selection from a multi-mode THz quantum-cascade laser by a grating monochromator

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Abstract*— THz quantum-cascade lasers (QCLs) are very attractive for applications such as a local oscillator in a heterodyne spectrometer. First, their emission is narrow in frequency (less than 20 kHz), which allows for very high spectral resolution. Second, QCLs exhibit high output powers up to several tens of mW, sufficient for pumping large-format mixer arrays, and a third advantage is their broad gain medium, which in principle allows for a frequency coverage of several 100 GHz. Here we report on an approach to select the frequency of a multi-mode THz QCL by an external grating, which is not part of the laser cavity. The QCL, which is based on a two-miniband design and a Fabry-Pérot resonator, has been developed for high output powers and low electrical pump powers. Up to five modes at around 3.4 THz are emitted simultaneously. Each mode has more than 0.1 mW of power, which is sufficient for pumping hot-electron bolometric mixers. The QCL is mounted in a compact, low-weight Stirling cooler [1]. The emission modes of the laser are spectrally resolved and spatially separated by a reflection grating and imaged onto a microbolometer camera. With an exit slit at the output port of the grating spectrometer, a single mode can be selected. In order to demonstrate the performance of this approach, an absorption cell was placed between the QCL and the grating spectrometer, and the absorption spectrum of methanol around 3.4 THz was measured by integrating simultaneously the signal of each of the Fabry-Pérot modes on the microbolometer camera as a function of the laser driving current [2]. In this case, a rough frequency selection is obtained by the grating, while a frequency fine tuning, which is necessary for high-resolution molecular spectroscopy, is obtained by a variation of the operating current and temperature of the QCL.

[1] H. Richter, M. Greiner-Bär, S. G. Pavlov, A. D. Semenov, M. Wienold, L. Schrottke, M. Giehler, R. Hey, H. T. Grahn, and H.-W. Hübers, Opt. Express 18, 10177–10187 (2010).

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