Spectral Modulation of Terahertz Quantum Cascade Lasers with Radio Frequency Injection Locking

H. Li* and J. C. Cao

Key Laboratory of Terahertz Solid State Technology, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, 865 Changning road, Shanghai 200050, China
*Contact: hua.li@mail.sim.ac.cn

The authors demonstrate the electrical beat note analysis and radio frequency (RF) injection locking of a continuous wave (cw) terahertz quantum cascade laser (QCL) emitting around 3 THz (~100 μm). In free running, the beat note frequency of the QCL shows a shift of ~180 MHz with increasing the drive current. The beat note, modulation response, injection pulling, and terahertz emission spectral characteristics in different current regimes are investigated. The results show that in the current regime close to the laser threshold we obtain narrower beat note, broader modulation bandwidth, and stronger response to the RF modulation at the cavity round trip frequency. As a result, in the beat note spectra in the low current regime we observe the strong pulling effect under the RF injection. In the meantime, we find that the terahertz emission lines can be strongly modulated by RF injection.

The authors are grateful to Dr. Stefano Barbieri for useful discussions. This work was supported by the "Hundred-Talent" Program of Chinese Academy of Sciences, the National Natural Science Foundation of China (61575214), the Shanghai Municipal Commission of Science and Technology (15560722000).

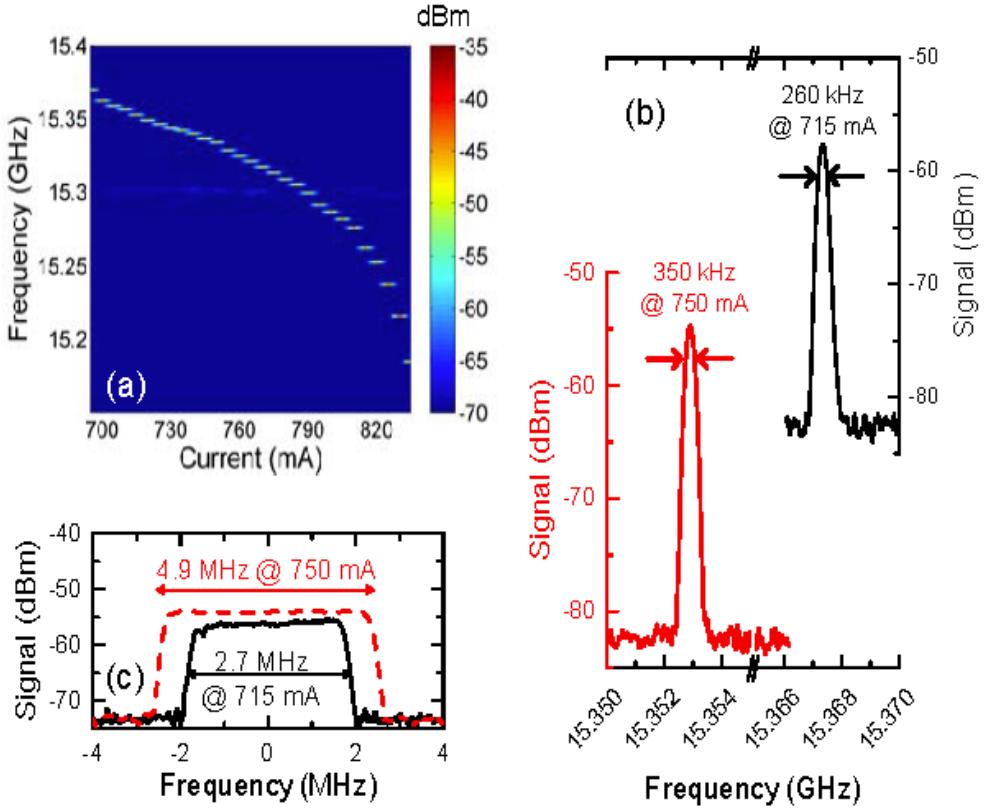

Fig. 1: (a) Free running beat note mapping of the terahertz QCL as a function of drive current measured at 10 K in cw mode. (b) Single shot beat note spectra recorded at 715 mA (black curve) and 750 mA (red curve) in free running. The arrows show the 3-dB linewidths of the free running beat note spectra. The resolution bandwidth is set as 300 kHz. (c) Beat note spectra measured with the "Max-Hold" function of the spectrum analyzer at 715 (black curve) and 750 mA (red curve) in a time duration of 3 minutes. Note that the centre frequencies are subtracted for clarity.