THz Quantum Cascade Lasers with Superconducting Double-Metal Waveguides

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Quantum cascade lasers (QCLs) are promising sources for future applications in the terahertz (THz) regime like spectroscopy or imaging. The waveguide is crucial for the performance of the device. Double-metal waveguides are commonly used, where the active region is located in between two metal layers confining the optical mode. The waveguide loss is a limiting factor and needs to be minimized. The main contribution is the absorption of the THz radiation in the metal layers, Drude absorption. We replaced the commonly used gold layers by a superconducting material, namely niobium (Nb), to reduce the waveguide losses. We used a 4 well longitudinal optical (LO) phonon depletion design for the active region, with a designed frequency of 2 THz. We fabricated disk shaped resonators, where the optical mode is guided via total internal reflection at the facets of the disk. In this way high lateral confinement is provided. A sketch of a device is shown in Fig. 1. The next steps would be to employ an active region with lower frequency and a superconducting material with higher critical temperature.

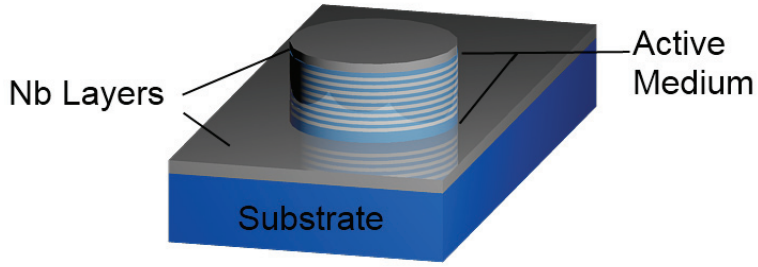

Fig. 1: Schematic of a THz QCL with a niobium disk resonator