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Fourier-transform spectroscopy of interband cascade laser structures

Interband cascade lasers (ICL) are known to be perfect laser sources emitting in the spectral region of mid-infrared beyond 3 μm. Due to its very low drive power requirement, the ICL is increasingly viewed as the laser of choice for mid-IR (meaning the entire λ = 3–6 μm spectral band) laser spectroscopy applications that do not require high output power but need to be hand-portable and/or battery operated. With ICLs already beginning to find use in fielded systems to detect methane, formaldehyde, and other trace chemicals, it is anticipated that this role will expand substantially over the coming decade.

Since ICLs exhibit a number of advantages with respect to quantum cascade lasers (i.e. much lower power consumption), there is a huge demand to further improve their operational parameters, and alter emission properties to enable new functionalities and applications. To name a few, a wide spectral tenability and high output optical powers were not realized yet. Another key feature not realized yet and strongly anticipated is a mode-locked ICL, a single-mode ICL emitting beyond 7 μm, and an ICL with polarization-independent gain. The abovementioned aspects are the key objectives of the PhD thesis.

To objectives are achieved by means of optical spectroscopy of active and passive regions of different ICL's designs. In order to study the emission and absorption properties of ICL structures, fourier-transformed infrared spectrometer was utilized. The vast number of experimental data, supported by simulations of the band structure, provided an information about the optical properties of studied active regions, as well as the free carrier concentration in the claddings of the long-wavelength ICL's plasmon-enhanced waveguides.