Due to their broad spectral bandwidth and superior temperature performance, resonant phonon quantum cascade laser (QCL) designs have become the active-region of choice for many of the leading groups in terahertz (THz) QCL research. These gain media can vary substantially in the number of wells and barriers as well as their corresponding thicknesses, but all such structures employ a common resonant phonon lower laser level depopulation scheme and a resonant tunneling mechanism for efficient current injection into the upper laser level. The presence of a strong anticrossing between the injector and upper laser level leads, under the right conditions, to a pronounced splitting of the emission spectra into high and low frequency lobe components around some central transition frequency. This spectral hole burning effect also manifests itself in the time domain as a form of pulse switching between signals corresponding to the two lobes of the split gain, as it has already been experimentally observed. This process was termed as a form of temporal hole burning (THB), which next to spectral and spatial hole burning, completes the plethora of dynamic "hole burning" phenomena encountered in
QCLs. In this work, we investigate the temporal dynamics of THz QCLs with a strong injector anticrossing via numerical solution of the Maxwell-Bloch laser equations. Our simulation results show remarkable agreement with experiment and we further outline the development of a theoretical model which intuitively explains this effect. © (2017) COPYRIGHT Society of Photo-Optical Instrumentation Engineers (SPIE). Downloading of the abstract is permitted for personal use only.

Stichworte: Frequency combs; Quantum cascade lasers; Terahertz radiation; Hole burning spectroscopy; Lasers; Phonons; Simulations; Numerical analysis


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