Proposition de Stage 2018-2019

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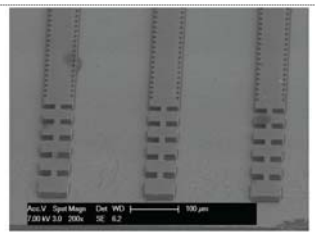

Frequency-tunable vertical external cavity terahertz quantum cascade laser

THz waves (1-10 THz) are non-ionizing radiation that can potentially find applications in a variety of domains. The most promising at this time is THz imaging – as a variety of important materials (plastics, ceramics) are transparent – and spectroscopy since THz radiation overlaps with major molecular fingerprint lines. THz quantum cascade (QC) lasers are semiconductor sources operating in this range, and their frequency tunability is important for applications.
In the mid-infrared, where QC lasers are more advanced, tunability relies on Littrow-configuration external cavity edge emitting lasers. In the THz frequency range, edge emitting QC lasers cannot be reliably implemented in an external-cavity configuration because of the tight electromagnetic confinement, and also because it is exceedingly difficult to implement anti-reflection coatings for the laser facets. This is even more problematic for metal-metal THz QCLs, that are plagued by diffractive effects at the laser edge.
A vertical emission geometry appears to be the only practical solution for an external cavity THz laser. However, vertical emission cannot be directly exploited in QCLs because intersubband transitions in semiconductor quantum wells are only coupled to transverse magnetic (TM) waves. A solution is to implement sub-wavelength diffractive structures, like photonic crystals or metasurfaces, to couple a normal incident wave to TM waves in the active medium.

But du stage/internship objectives: the goal of this project is to develop a frequency tunable THz Quantum Cascade Vertical External Cavity Surface Emitting Laser (QC-VECSEL). It will consist of an active medium made of an electrically pumped microstructured semiconductor/metal heterostructure, providing a reflective gain thanks to THz intersubband transitions, and an external semi-transparent mirror. It will be frequency tunable thanks to the use of an external mirror made of a blazed grating, that will provide a narrow band adjustable feedback. Beside this, the device will have significantly improved beam-quality, which is a limiting property in standard edge emitting QCLs, but can be achieved by design in a VECSEL configuration.

Techniques utilisées /used methods: Numerical modeling of the optical properties of waveguide, meta-structures and inter-sub-band-transition in semiconductor heterostructure. Optical characterization of meta-structures, optoelectronic characterization techniques.

Qualités du candidat(e) requises/ required skills: Basic knowledge in optics and electromagnetics, semiconductor physics, optoelectronics, ability to work in groups, like the experimental work

Possibilité de continuer en thèse : OUI