Thermal management of multi-emitter Quantum Cascade Lasers: towards photonic integrated platform

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Compact, multi-spectral laser sources emitting in the mid-infrared (mid-IR) are in high demand for applications such as absorption spectroscopy in the molecular fingerprint region and infrared countermeasures against heat-seeking missiles.

Integration of several multi-spectral, mid IR quantum cascade lasers on silicon-based waveguide platforms is a necessary step towards realization of functional and complex mid-infrared photonic integrated circuits.

This paper focuses on the thermal aspects of integration of multi-spectral QCLs toward the integration of QCL chips on silicon-based platform. In this work results of experimental investigation of temperature distributions of integrated multi emitter QCLs are presented. Experimental data was recorded by means of thermorefletance. The experimental results are supported by numerical simulations of heat dissipation.

The thermal processes were investigated by applying non-invasive optical technique: CCD (Charged Coupled Device) thermoreflectance. CCD - thermoreflectance is one of the optical modulation techniques relies on relative change in reflectivity induced by applying external, periodic perturbation to the sample. Thermoreflectance spectroscopy offers high spatial and high temperature resolution, fast mapping capability (~ few seconds) and noninvasive (non-destructive) character.

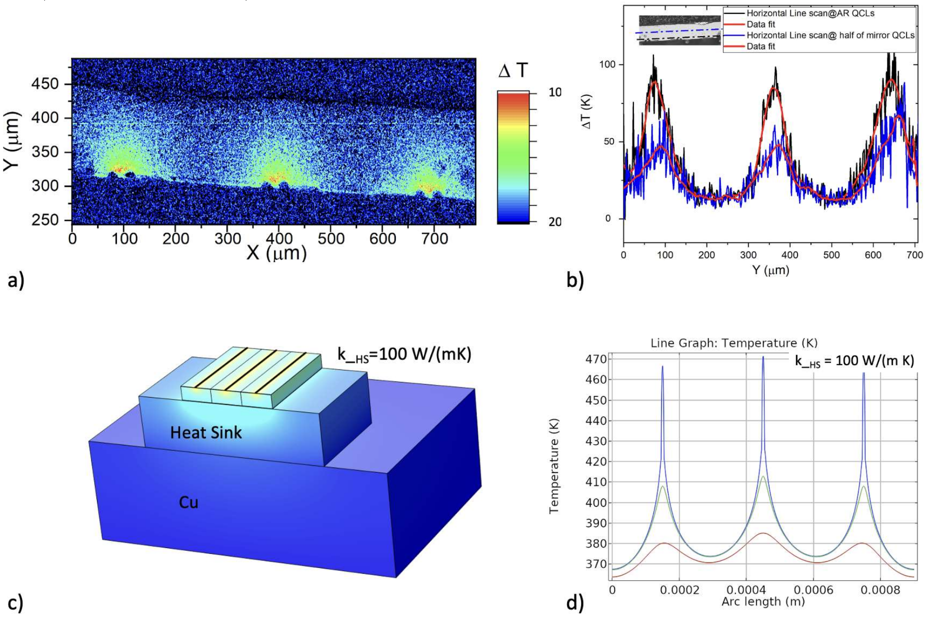

Fig. 1. a) Temperature distribution maps on the front facet of AlInAs/InGaAs/InP multi-emitter QCL, b) Horizontal temperature line scans for different positions at the laser facet, c) Numerical temperature distribution maps on the front facet of multi-emitter QCLs, d) calculated horizontal temperature line scans.