Master thesis proposal

Measuring the thermal properties of optoelectronic devices

Background

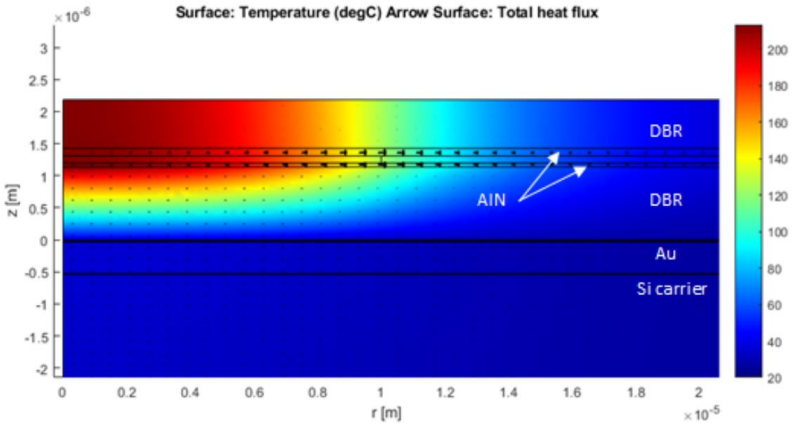
Due to their ever smaller size and consequently increasing power densities, most electronic and optoelectronic devices are performance-limited by heating effects. This is especially true for UV- and blue-emitting vertical-cavity surface-emitting lasers (VCSELs). In these devices, a III-nitride active region provides optical gain to a laser cavity formed by two distributed Bragg reflectors (DBRs). The best optical properties are obtained using dielectric DBRs. However, these DBRs suffer from poor thermal conductivity, leading to increased heating of the active region and reduced device performance.

Thesis scope

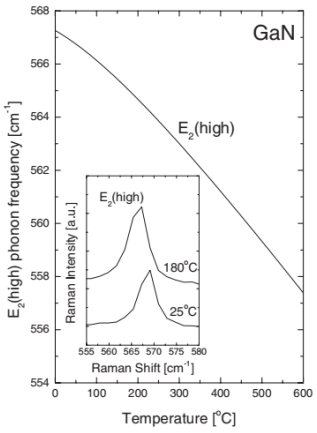
The goal of this thesis is to develop, build and test an experimental setup that allows to determine the temperature and thermal conductivity of optoelectronic devices with high spatial resolution. This setup will be based on micro-Raman measurements, potentially complemented with blackbody radiation mappings. Depending on the interests and time-restrictions of the student, the project could be extended to the optimization of the thermal conductivity of dielectric DBRs and/or III-nitride active regions.

Methods

You will work in the UV-blue spectroscopy lab of the Photonics Laboratory at the Department of Microtechnology and Nanoscience. You will use our high-resolution spectroscopy setup and expand it with micro-Raman capabilities. This includes adding the necessary lasers, optics and routines for data analysis in Matlab or Python. These routines will relate shifts of the Raman modes to local temperature. You will use the developed setup to characterize the thermal properties of LEDs, DBRs and VCSELs.



Calculated temperature distribution and heat flow in a UVC-VCSEL



Temperature shift of the E_2 (high) Raman mode in GaN. Kuball *et al.*, PSS(a) 202 (2005)

This work will be conducted within the Wide-bandgap Semiconductor Group at the Photonics Laboratory, Department of Microtechnology and Nanoscience. For more information, please contact

Joachim Ciers (joachim.ciers@chalmers.se), room B440
Åsa Haglund (asa.haglund@chalmers.se), room B437