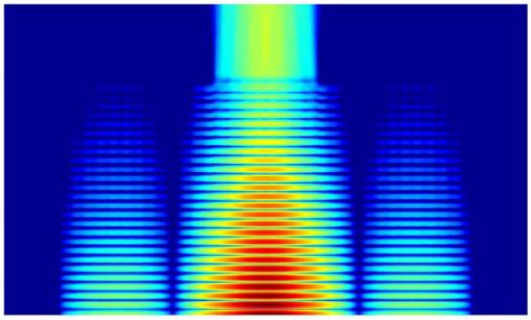
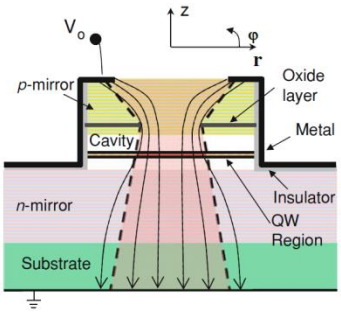
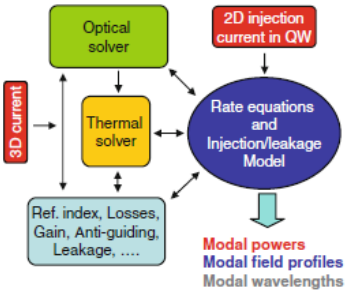
Multiphysical modeling of vertical-cavity surface-emitting lasers

The ever-increasing applications of optoelectronic devices are driving the growth of the semiconductor light source market. This is definitely the case of vertical-cavity surface-emitting lasers (VCSELs): due to their testability, reliability and manufacturability features and low-power operation, they are currently the standard for sensing and datacom systems, and are becoming the key components in a number of ICT innovations, ranging from Apple FaceID technology to Google self-driving cars.

Each new application must comply with different standards in terms of emission wavelength and maximum optical power, corresponding to different several material systems and technological processes. In this view, the only way to cut the extreme prototyping costs is represented by a comprehensive computer-aided design (CAD) approach. CAD tools are aimed at providing accurate forecasts of the laser characteristics by describing electrical, optical and thermal phenomena occurring in the device. For this goal, the Applied Electromagnetics & Electronic Devices (AE & ED) group in IEIIT-CNR is developing in-house a multiphysical VCSEL simulation code coupling drift-diffusion, optical and thermal models.







In this context, two classes of topics for MSc theses are available:

- (EXPERIMENTAL) producing experimental data to support model calibration. This activity would be carried on in the facilities of one of our technological partners, e.g. Ulm University.
- (THEORETICAL) extending the present spontaneous/stimulated emission models to new materials, compare them to the literature and/or to alternative approaches based on the non-equilibrium Green's function approach (NEGF). This subject would be carried out at IEIIT-CNR and in the Department of Electronics and Telecommunications of Politecnico di Torino.

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