Vertical-cavity surface-emitting lasers (VCSELs) are widely used in short-distance telecomunication links and in time-of-flight sensors in new generation of mobile phones and in automotive industry because of their low manufacturing cost per unit, small size and high energy efficiency. Current VCSELs, however, are tens of micrometers thick and are relatively complicated devices. They consist of more than a hundred semiconductor layers that form the active region, a current and/or optical confinement scheme, and two high-reflectivity distributed Bragg reflector mirrors (DBRs). To make these devices more suitable for future applications, it is therefore necessary to achieve further downsizing and simplification.

The minimum possible thickness for an optical cavity is half of the emission wavelength which is less then 0.5 μm. The largest part of VCSELs, therefore, is now the DBR mirrors. It is not only their thickness, however, that is the problem. DBRs contain tens of pairs of two different semiconductor materials. Such complex mirror can be fabricated based on gallium arsenide (GaAs) materials, which emit in the 0.62–1.2 μm wavelength range.

In our approach we propose to replace bulky DBRs by what we name the subwavelength grating. Such grating can be made through shallow etching of almost any semiconductor material used in optoelectronics having properties similar to DBRs. However the biggest advantage of subwavelength gratings is that their fabrication requires only a few percent of epitaxial material that is necessary to produce DBRs and they open the way to construct VCSELs emitting almost any wavelength from ultraviolet to mid-infrared.

The proposal focuses on understanding properties of new class of semiconductor lasers using subwavelength gratings that already revealed a number of unexpected effects that on the one hand make new type of VCSELs more difficult to intuitive designing, but on the other hand allow for new functionality and require thorough investigations.