VCSELs for high-power single-mode applications

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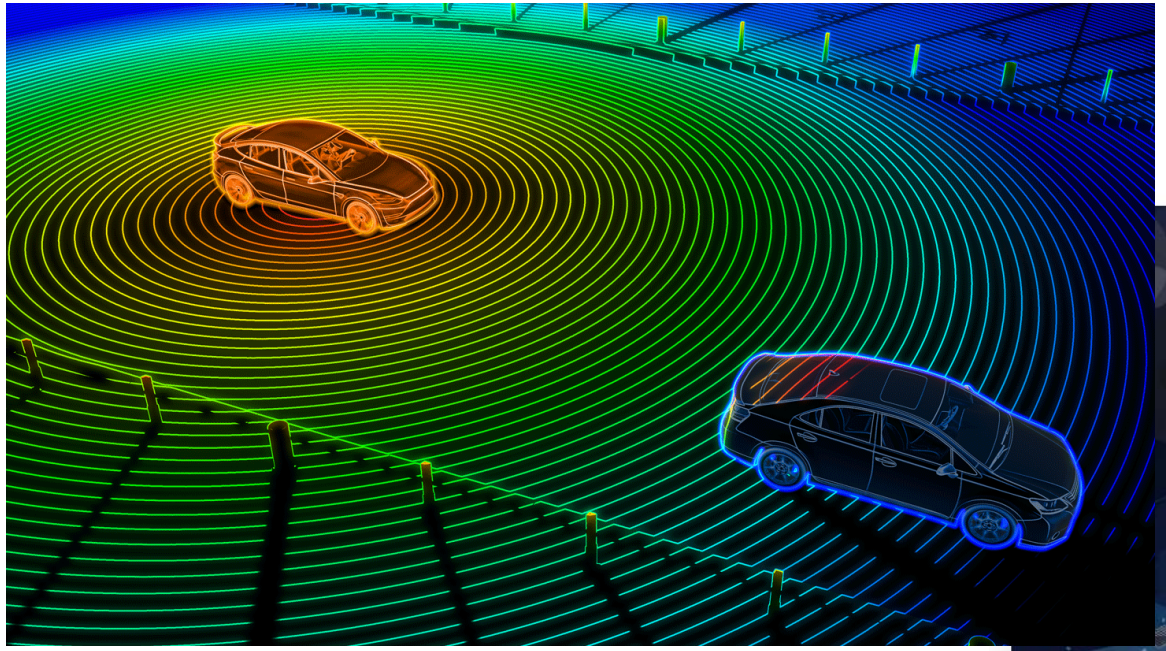
Politecnico di Torino

Consiglio Nazionale delle Ricerche
Institute of Electronics, Information Engineering and Telecommunications

PhD student:
Torrelli Valerio

Examples of high-power applications: sometimes the single mode is needed

LIDAR sensing for detecting obstacles tens of meters away



29/08/2022

TRUMPF VCSELs to fly to space in quantum sensors

TRUMPF Photonic Components enters the QYRO project, funded by the Federal Government of Germany // Compact and robust VCSELs as light source for quantum sensors // TRUMPF develops VCSEL with ten times more laser power // The first satellite controlled by quantum technology is scheduled to be launched into space in 2027

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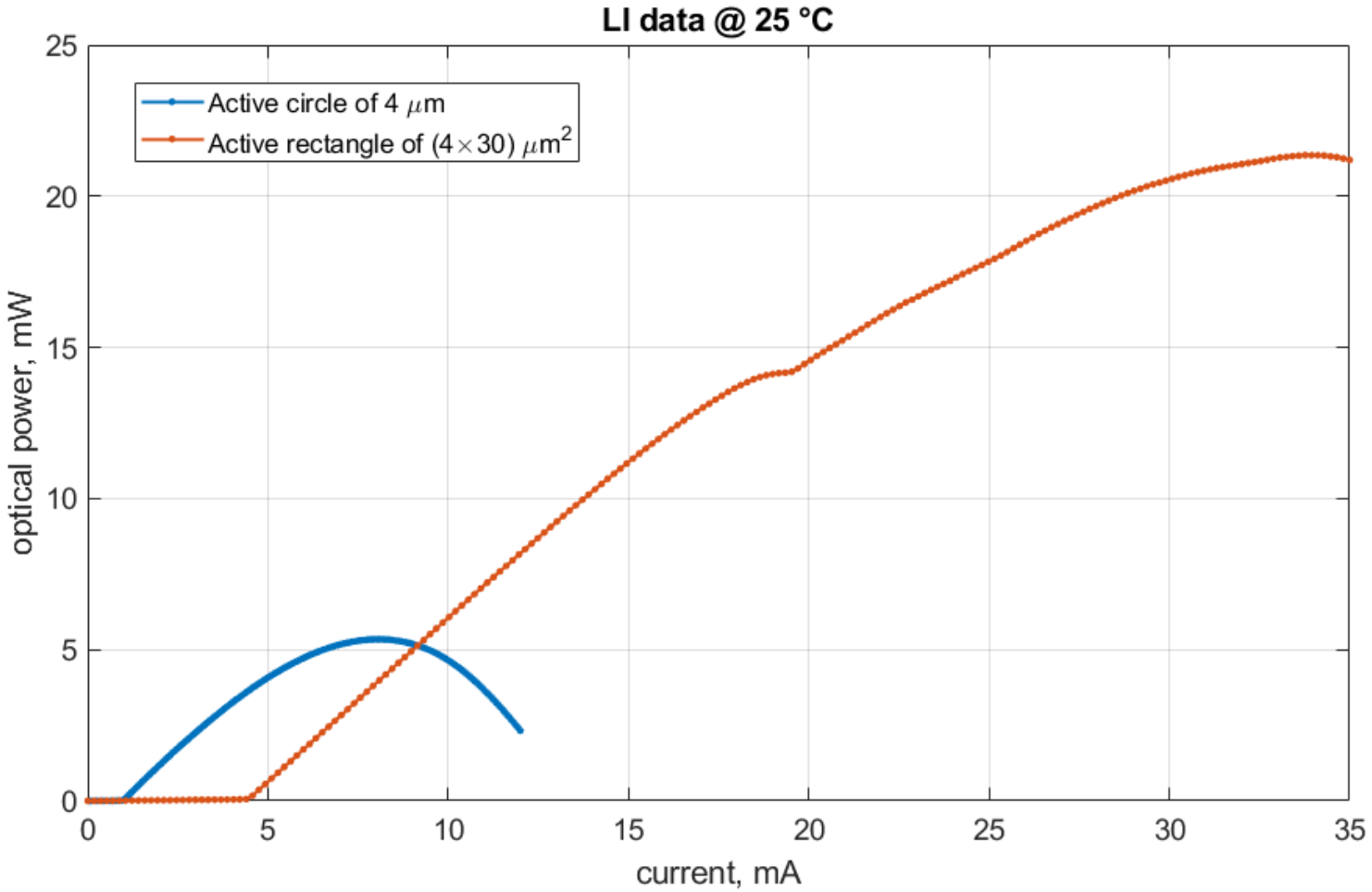
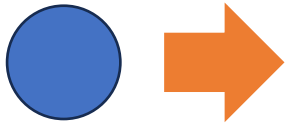
In this specific case the target is a **quantum gyroscope**, based excited atoms at very specific energy. A single mode emission is needed!

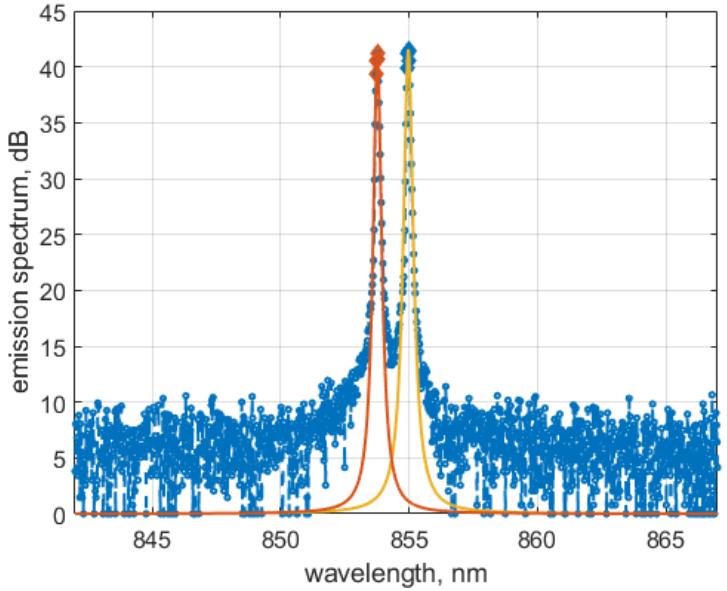
How to reach higher power? Simple… a larger active area!





Oxide aperture

Problem with increasing the area: multi-mode emission

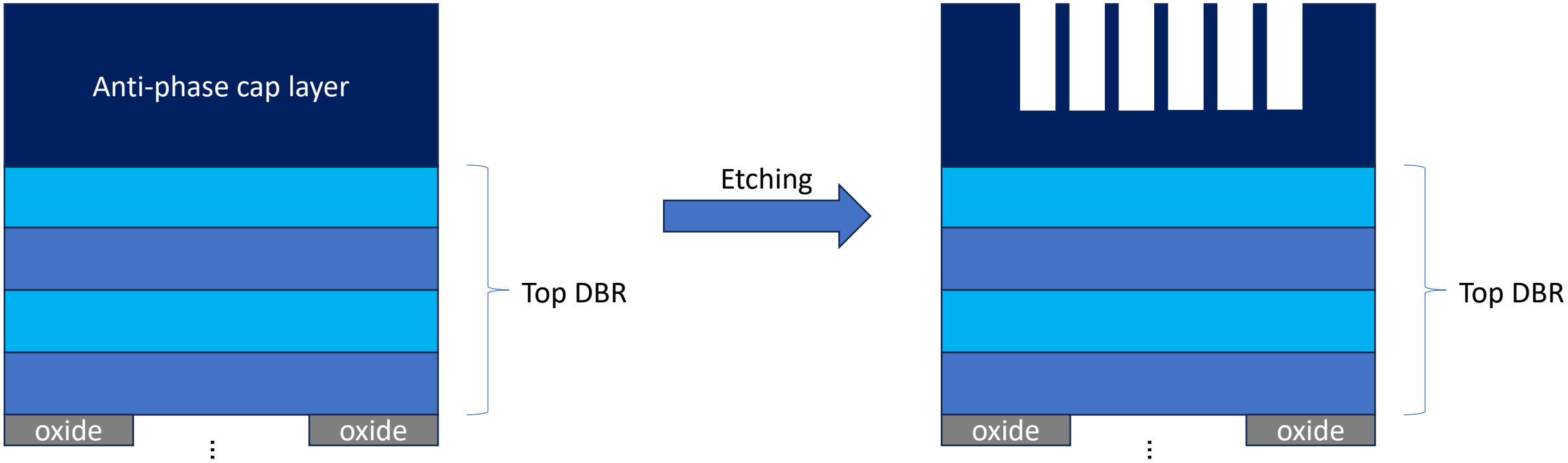


Spatial superposition of the modes & Multiple wavelengths

It is possible to suppress the superior modes with a grating relief (1)

Extremely high threshold gain for all modes

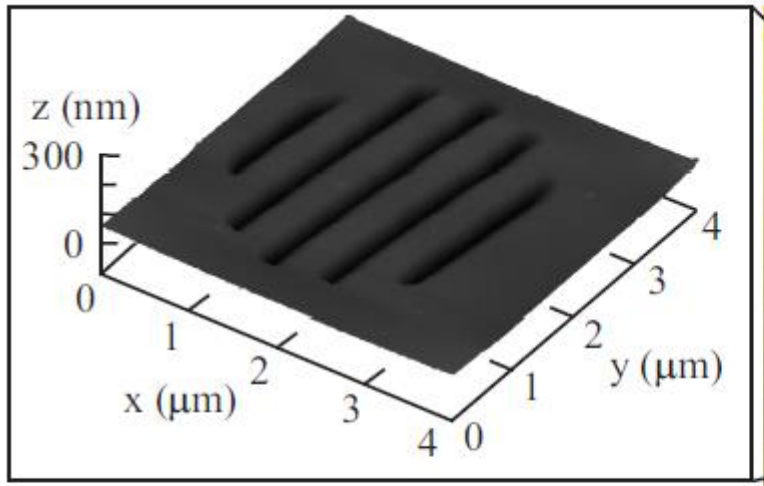
Grating relief: lower threshold for the fundamental mode, higher threshold for the superior modes

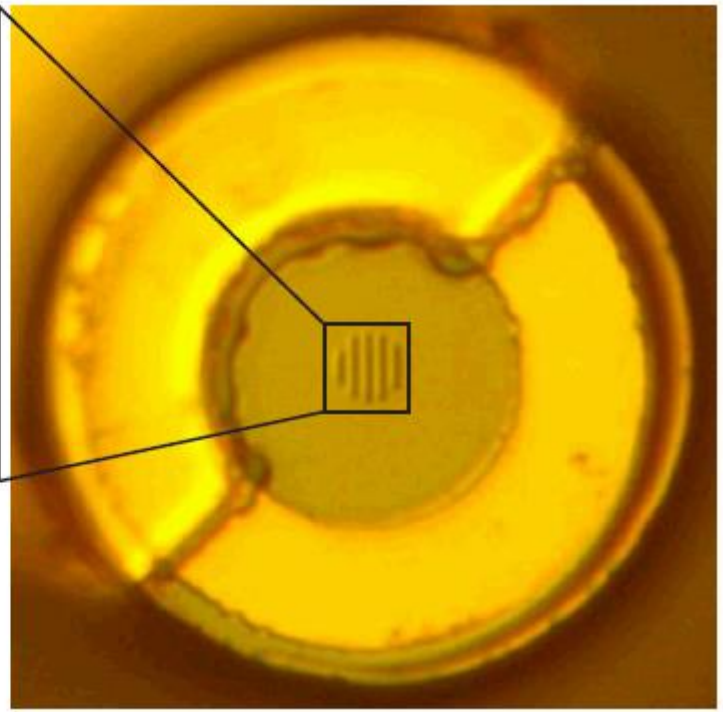


Active region
Bottom DBR
Substrate

Active region
Bottom DBR
Substrate

It is possible to suppress the superior modes with a grating relief (2)





The grating is used for polarization control.

Dynamic Characteristics of Inverted Grating Relief VCSELs for Cs-Based Microscale Atomic Clocks

Md. Jarez Miah, Ahmed Al-Samaneh, Dietmar Wahl, and Rainer Michalzik
Ulm University, Institute of Optoelectronics, Albert-Einstein-Allee 45, 89081 Ulm, Germany

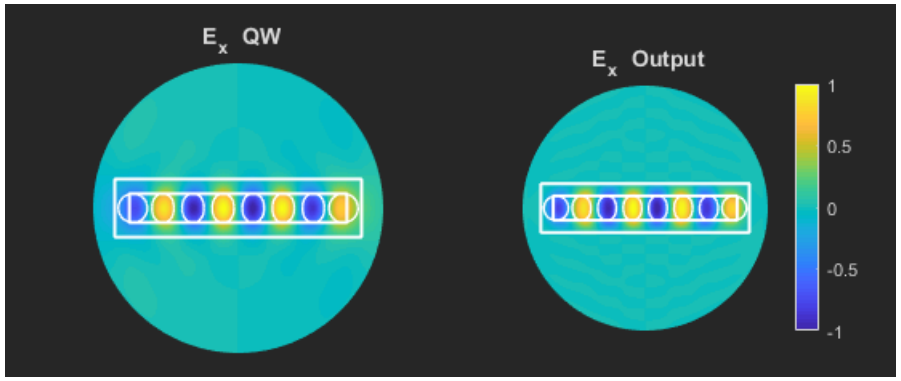
IDEA:

This holds for a standard VCSEL. We can apply the same idea to large area VCSELs patterning their outcoupling facet with arrays of grating reliefs

Large area VCSELs with patterned outcoupling facet

Coupled Mode Theory: A Powerful Tool for Analyzing Complex VCSELs and Designing Advanced Device Features

Pierluigi Debernardi and Gian Paolo Bava



Patterning of relief arrays at the outcoupling facet to ensure single mode emission!

Experimental validation with 8 reliefs