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Enhancing Semiconductor Laser Performance Using 3D-Printed Microlenses

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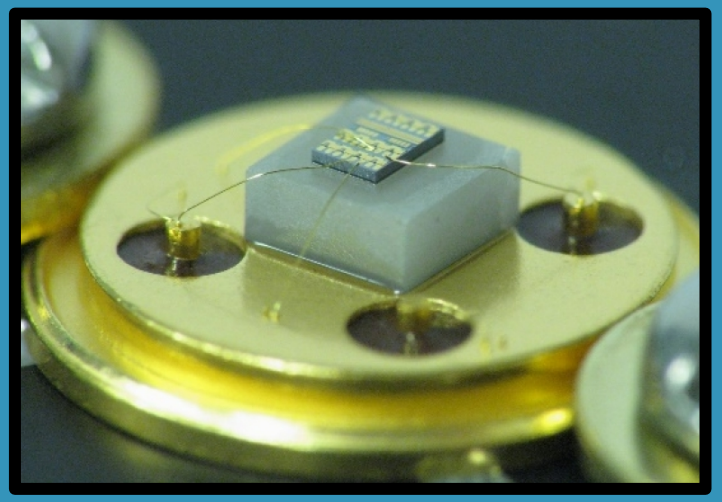

TEXAS
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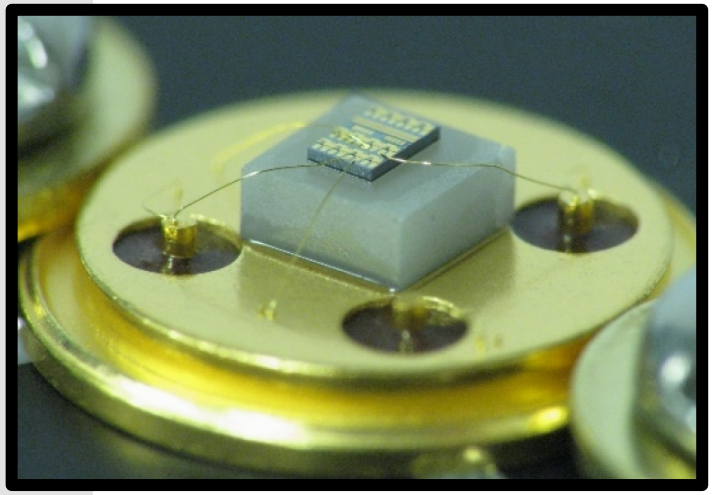
Motivatio

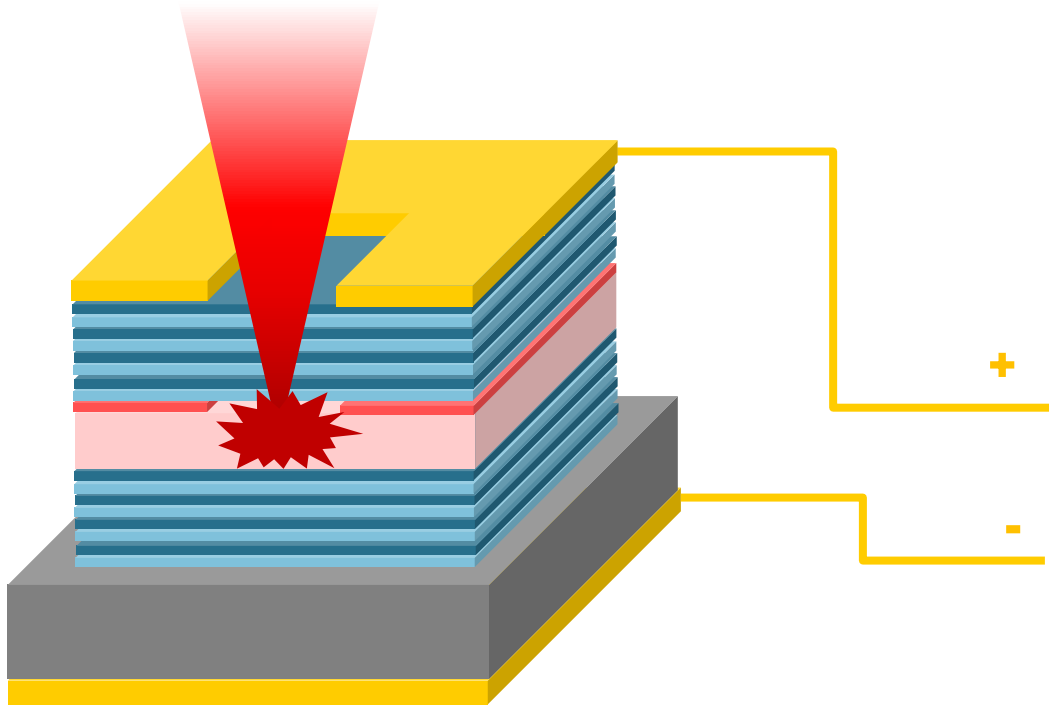
- Improve performance of Vertical-Cavity Surface-Emitting Lasers (VCSELs)



What is a VCSEL?

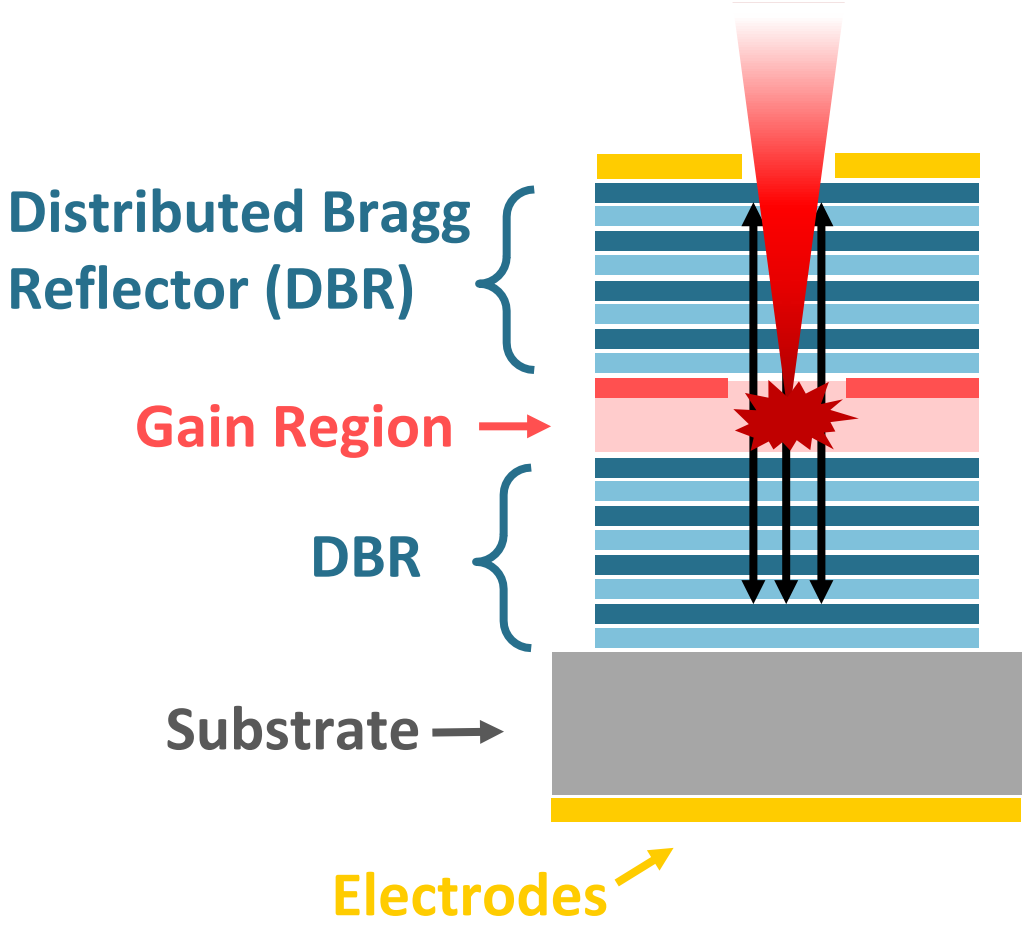
Semiconductor laser

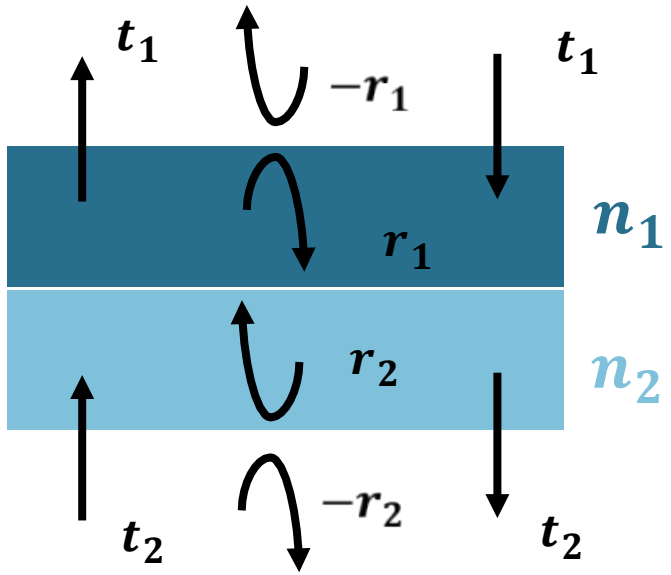
- Small size (µm)
- Easily fabricated
- Low threshold current (1mA)
- Round beam shape
- Low output power (<2mW)
- Frequency noise (>20MHz)



How does it work?

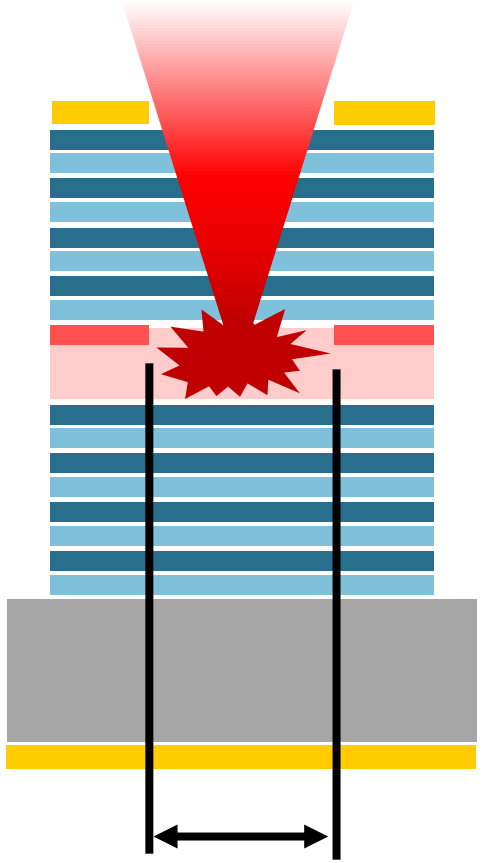
Light oscillates in the cavity causing the active region to lase



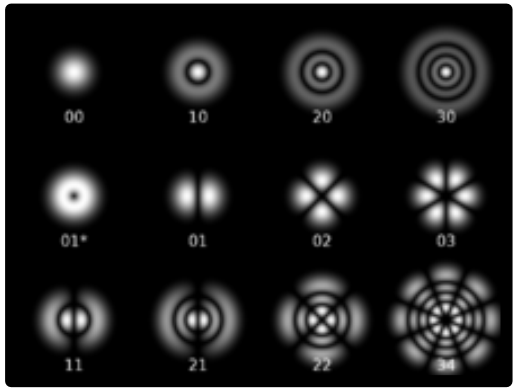


Improve Output Power

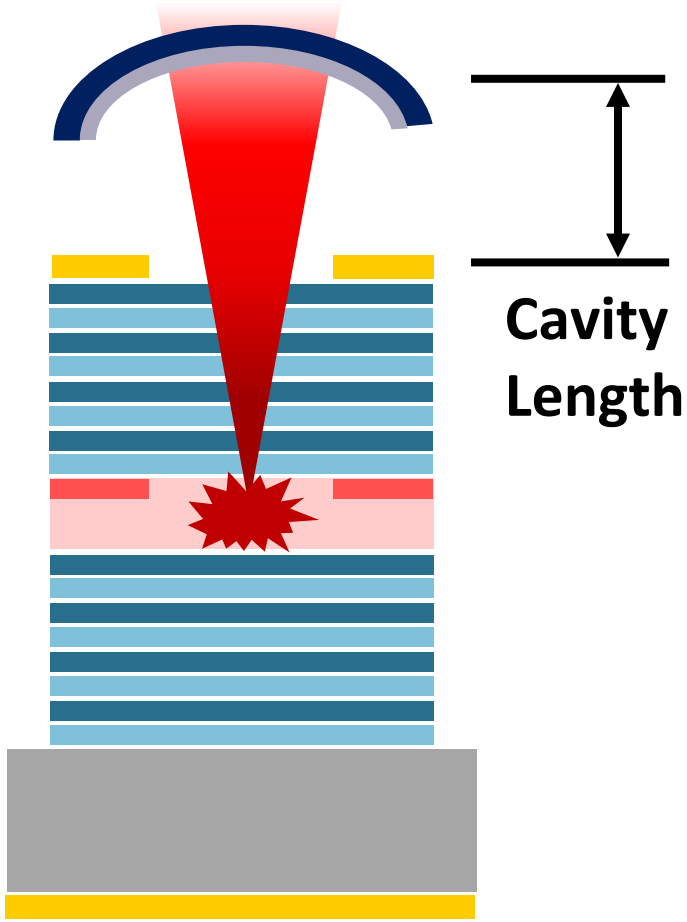
Exceed 2mW limit without sacrificing beam shape or linewidth



Increase Area



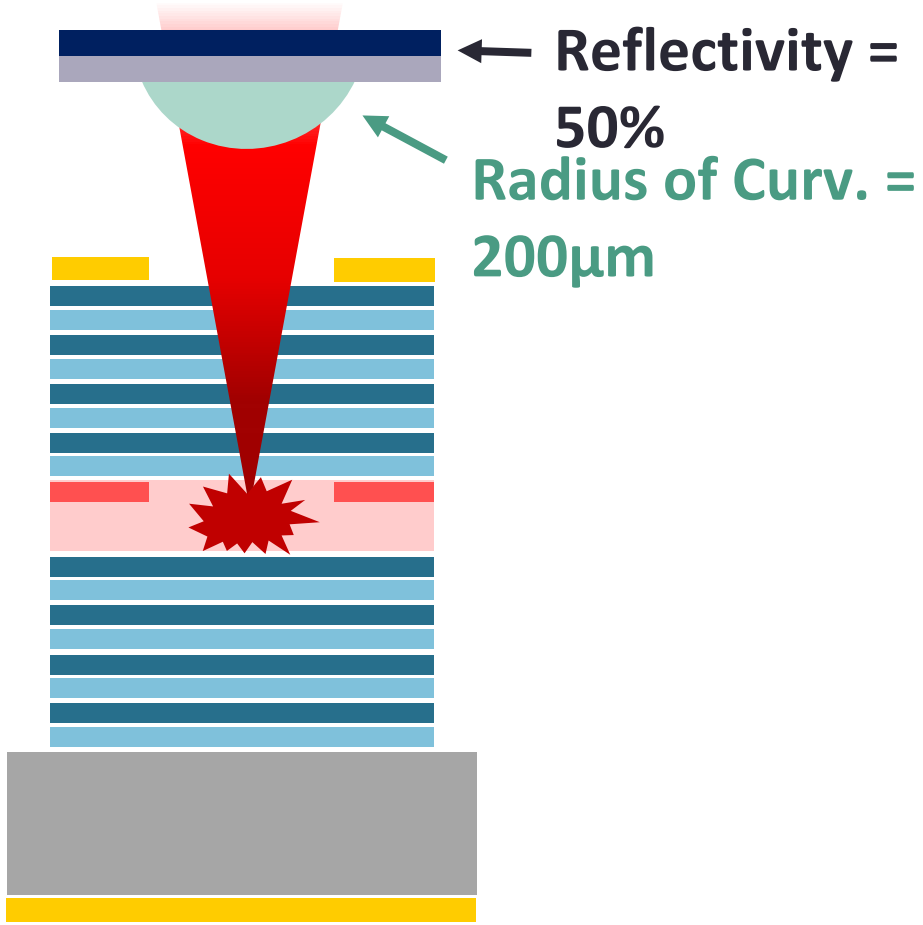
Beam Profiles

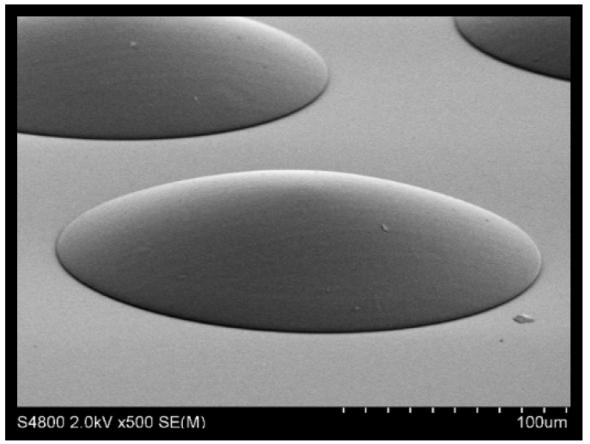


External Cavity

3D Microlenses as External Reflectors

3D printed lenses simplify testing process





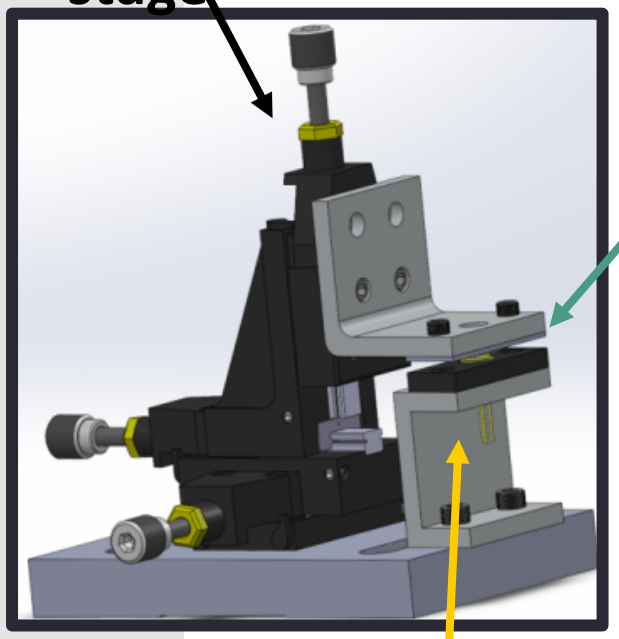
SEM of 3D-Printed Microlens

Accuracy: < 0.2µm

Experimental Design

Mounting microlenses on translation stage above VCSEL

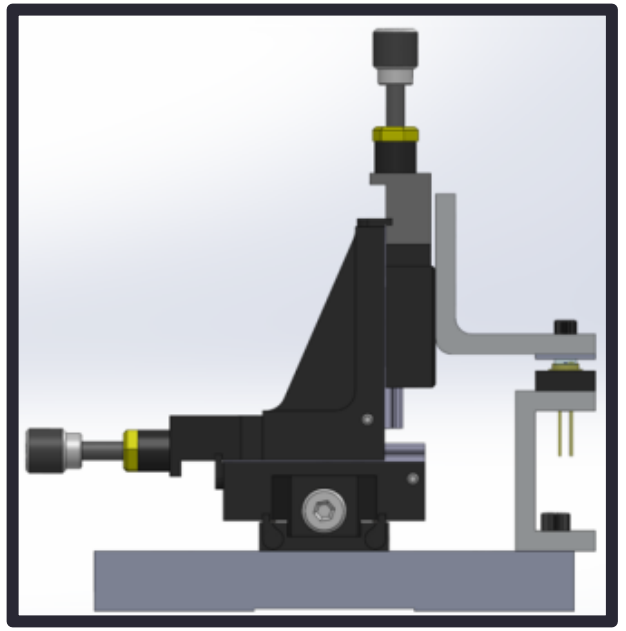
Translation stage

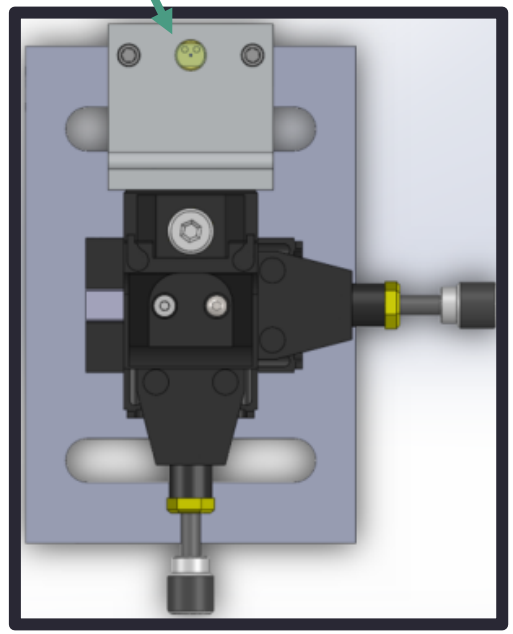


Lens substrate glued to mount

VCSEL

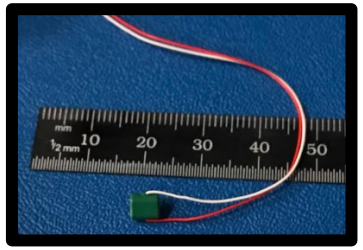
Window for viewing alignment

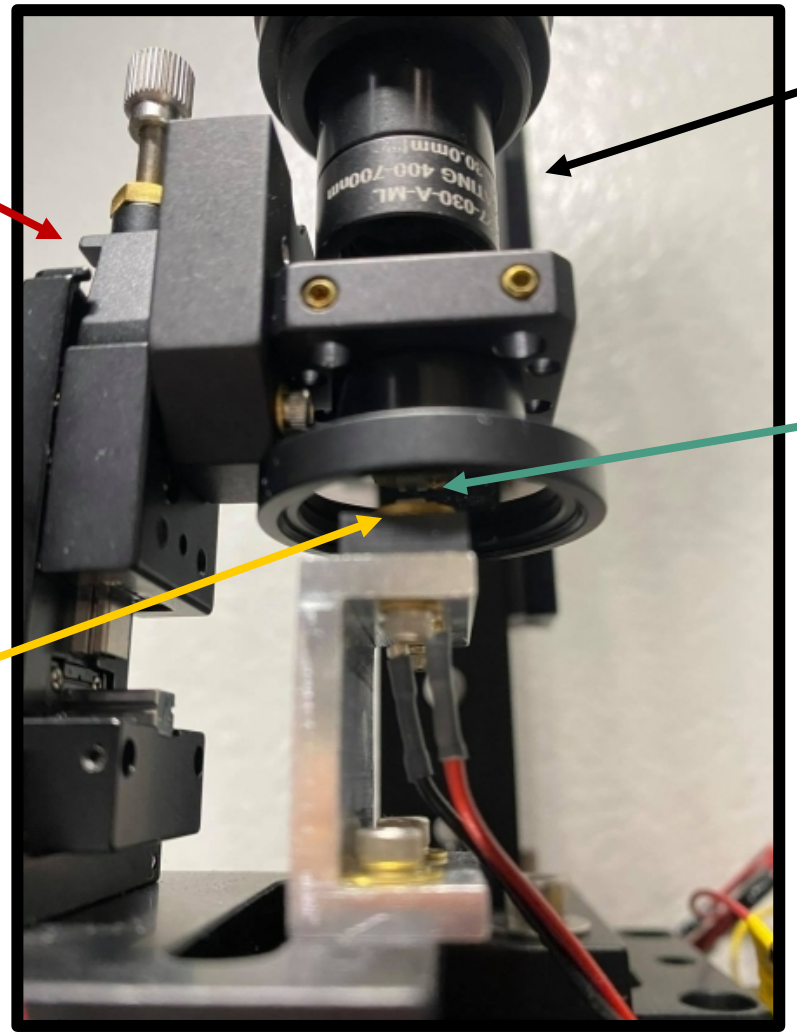




Design Setup

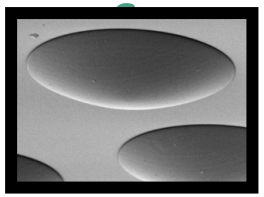
Piezo



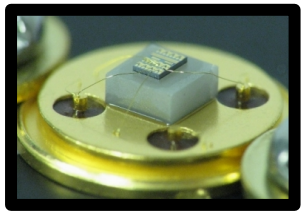


Microscope

Mounted microlense

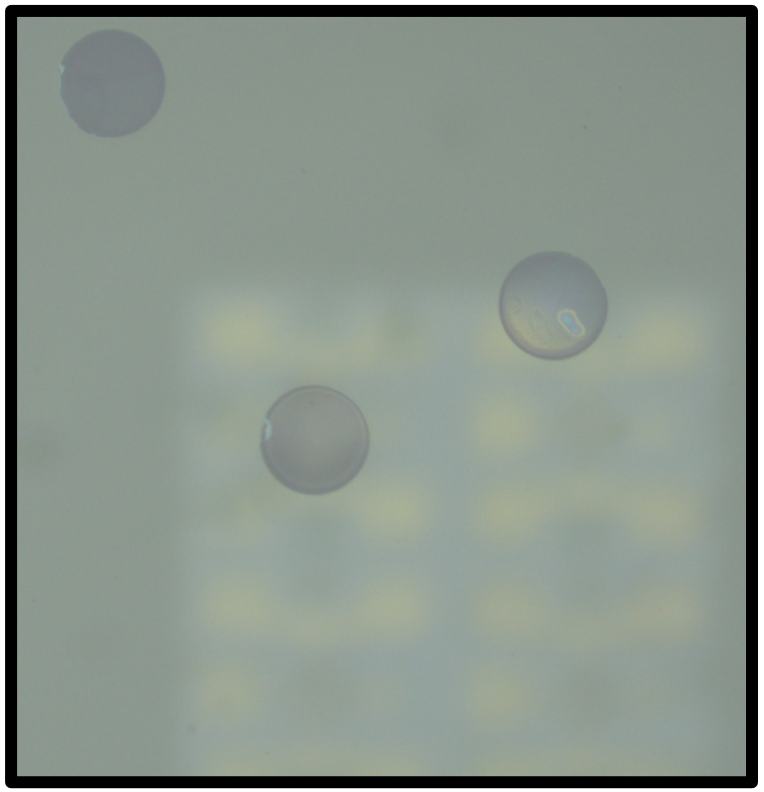


VCSEL

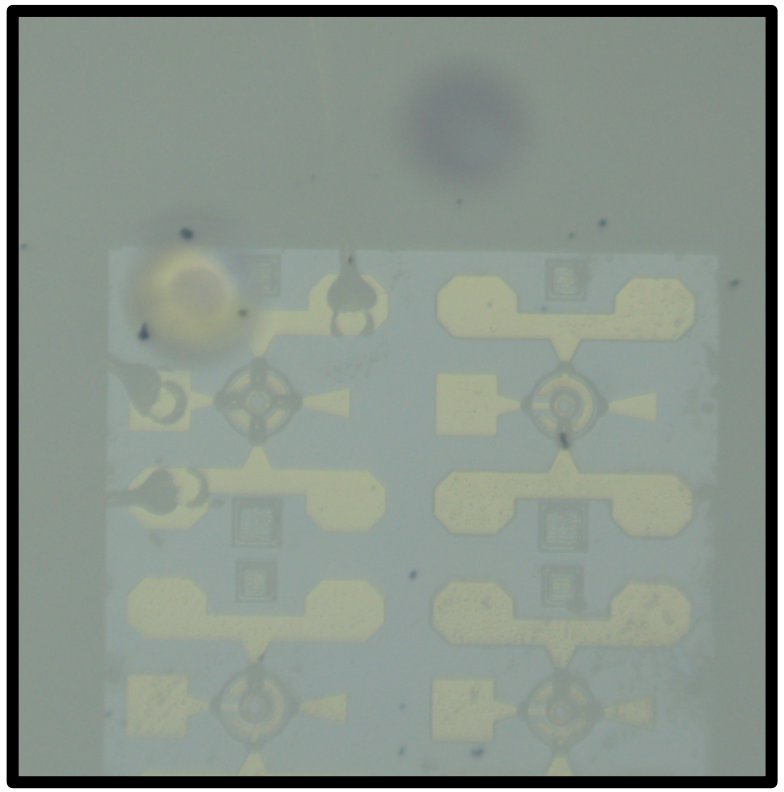


Experimental Execution

3D microlens positioned above lasing VCSEL



Microlenses in Focus



VCSELs in Focus

Experimental Execution

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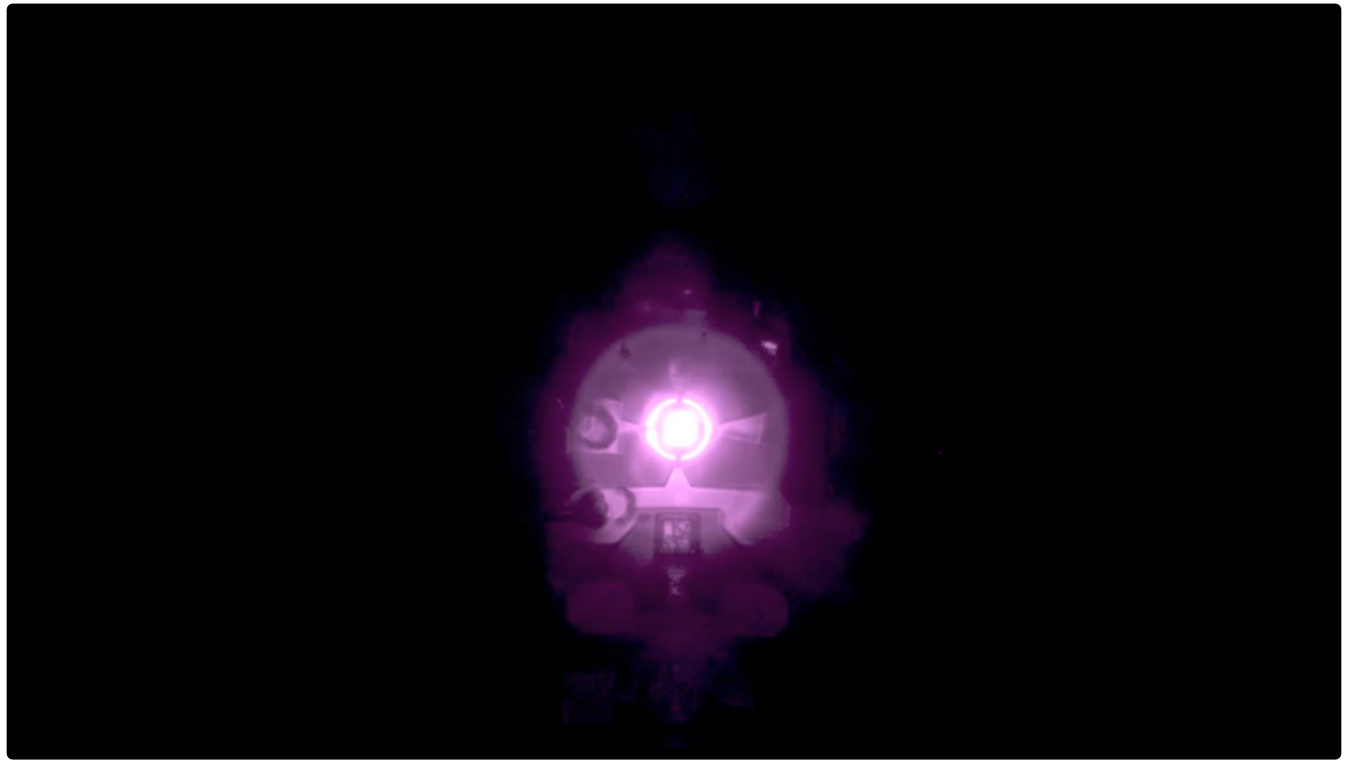

Aligning lens with VCSEL and adjusting height drastically improves output power

References

Literature

D. K. Serkland, M. T. Murillo, B. Kaehr, M. A. Gallegos, G. M. Peake, M. G. Wood, A. J. Grine, T. J. Morin, C. R. Tait, K. M. Geib,"Transverse mode control of VCSELs using 3D-printed micro-optics,"submitted on 8/26/2020 to the Vertical-Cavity Surface-Emitting Lasers Conference at the SPIE Photonics West Conference (scheduled for March 2021).

Sourced Images

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https://nypost.com/2020/02/03/russian-satellite-appears-to-be-stalking-us-satellite/

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