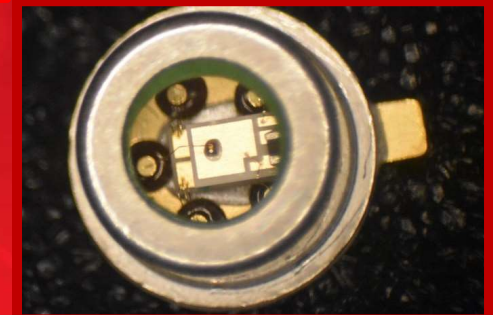
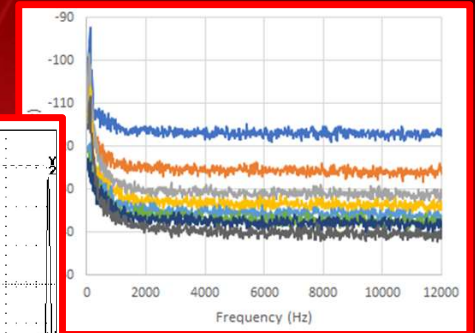
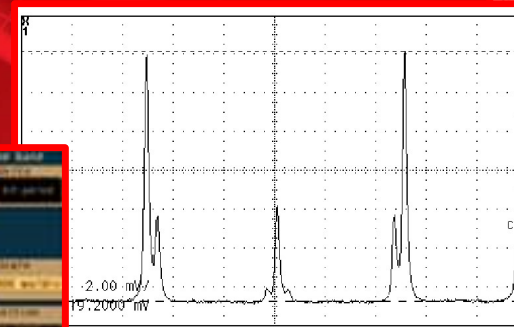
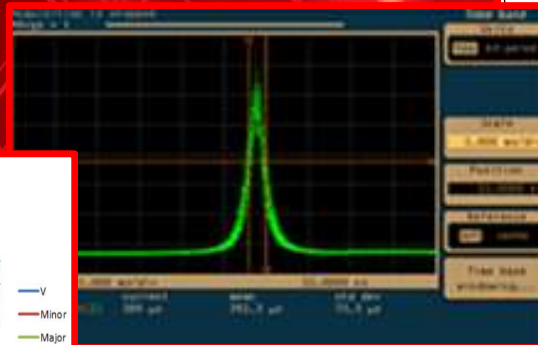
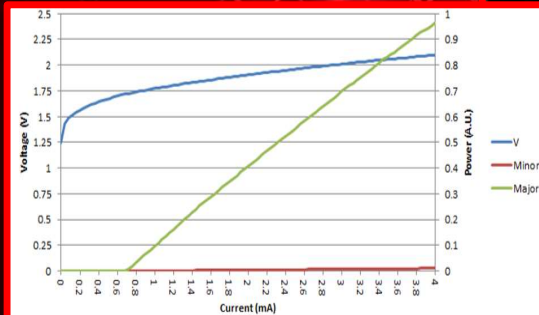


[www.osram-os.com](http://www.osram-os.com) | [www.vixarinc.com](http://www.vixarinc.com)



## VCSEL's for Atomic Sensors

### EPIC Technology Meeting on Atomic Clocks and Quantum Sensors

Klein Johnson | April 3, 2020 |

Light is OSRAM

**Vixar**  
**OSRAM**  
Opto Semiconductors

# Vixar Inc. Overview

Headquarters: Plymouth, Minnesota, USA



## Market leader across a diversified VCSEL product portfolio

- Wavelengths from **670 nm to 980 nm**
- Single-mode to high power arrays > 100's W
- Bare die
- Low cost surface mount packaging
- High-value custom packaging
- Custom subassemblies and optics integration



## Manufacturing infrastructure and supply chain

- World-class supply chain
- Scalable manufacturing for hundreds of millions of units per year
- Production on both 4" and 6" wafer platforms for cost-efficient manufacturing
- Both domestic and off-shore packaging capacity
- Rapid customization

## INNOVATION AND PASSION FOR VCSEL

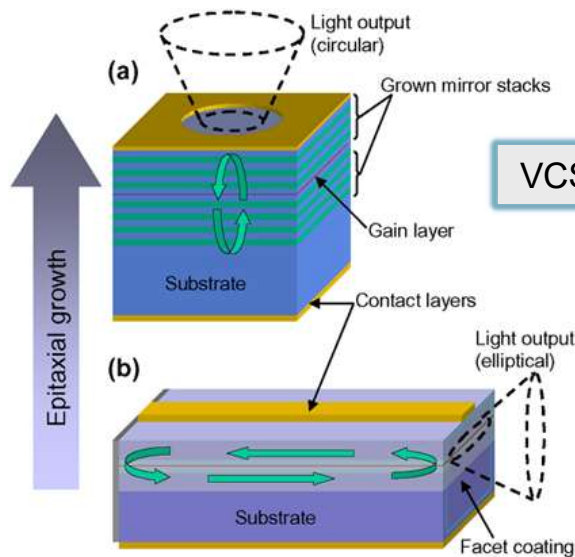
High performance, high volume VCSEL products

High quality, high reliability

Robust dual and triple sourced supply chain

Differentiated packaging options

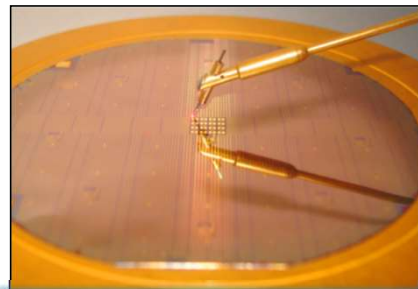
# VCSEL Technology: Laser Performance / Cost Structure of LEDs



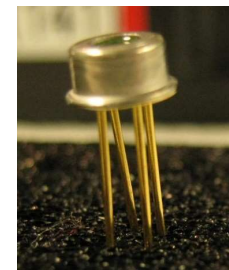
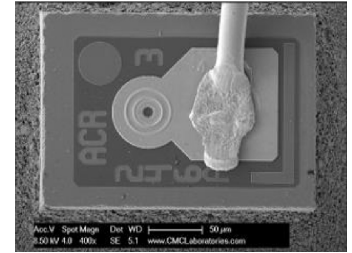
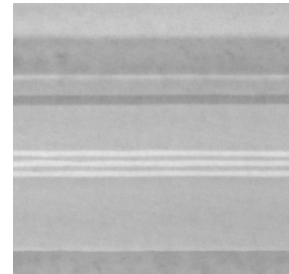
VCSEL vs. Edge-Emitter

## VCSEL Advantages




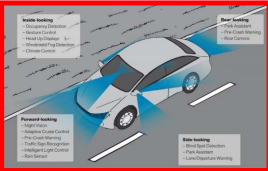
- Wafer level testing
- LED-style SMT and COB packaging
- 1D and 2D arrays
- Circular, low divergence emission
- High modulation rate
- Narrow spectrum
- High electrical efficiency
- High reliability
- Low  $d\lambda/dT$  vs EEL



~250K VCSELs per 6" wafer

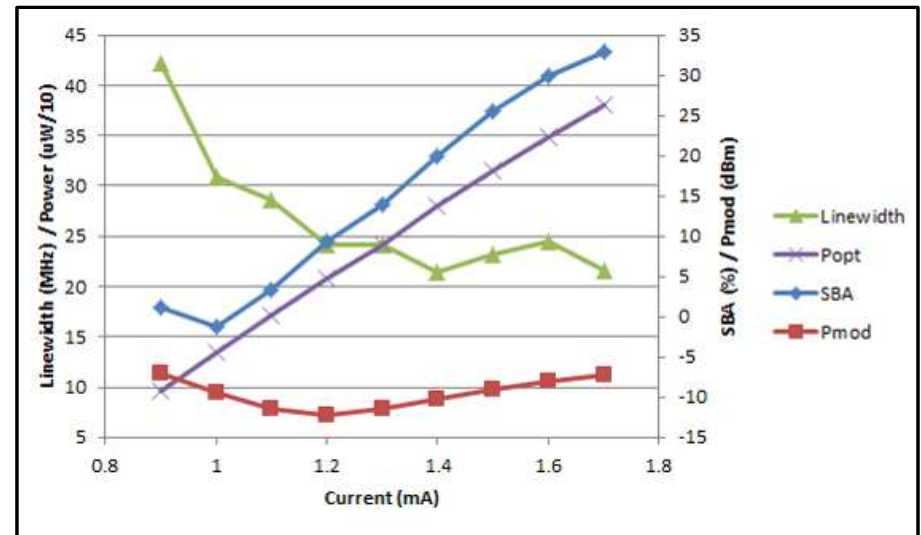


# Vixar Targeted Markets & Applications

Markets	Application
	Industrial Proximity Sensing, 3D Sensing (ToF / Structured Light), Illumination, LiDAR, <b>Atomic Sensors</b>
	Consumer / Mobile 3D Sensing (ToF / Structured Light), Gesture/Facial Recognition, Biometrics, AR/VR
	Medical Light therapy, Imaging, Biometrics
	Automotive Driver awareness, LIDAR

# Vixar VCSEL's for Atomic Sensors

- **Wavelengths**  
795nm → Rubidium D1  
895nm → Cesium D1
- **Configurations**  
Bare Die  
Custom Packaged Components  
Higher-level assemblies (TEC, Thermistor, QWP)
- **Specifications / KPI's**



## CPT Clocks

LI & IV	Wavelength
Stable Polarization	Linewidth (<50MHz)
Side-band Symmetry	Modulation Efficiency
SMSR	Divergence

## Magnetometry

LI & IV	Wavelength
Single-mode Power	RIN
Polarization	SMSR

## Comments and Questions

---

- **Outlook for atomic sensors appears attractive**
  - Uniquely enabling technology
  - Diverse application space
- **Challenging market**
  - Fragmented applications (widely varied solutions and requirements)
  - Extreme* specifications limit yields
  - Lack of production-worthy instrumentation for in-line QA
  - Low volumes and limited cycles of learning for yield enhancement
  - Price expectations
- **What does the future look like?**
  - What is driving demand today?
  - What are the emerging markets?
  - What will demand be in 1yr? 5yr? 10yr?

[www.osram-os.com](http://www.osram-os.com)

**Thank you.**

For additional questions, please contact:

[Sales@vixarinc.com](mailto:Sales@vixarinc.com)

**Vixar**  
**OSRAM**  
Opto Semiconductors