Vixar Portfolio and Capabilities

Kevin Kruse and Phai Vue | Spring 2021

Light is OSRAM

Vixar

OSRAM
Opto Semiconductors

Agenda

1. **Vixar / OSRAM – Company Overview**
2. VCSEL Applications
3. Vixar Portfolio
4. VCSEL Innovations

OSRAM Company Overview

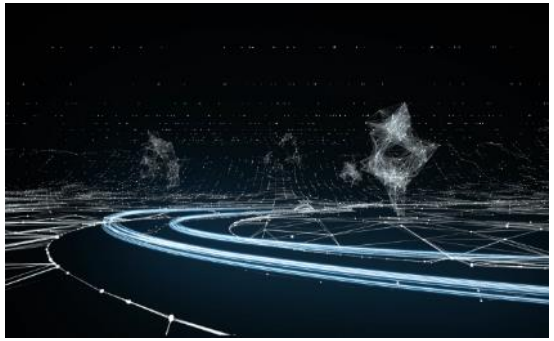
OSRAM Opto Semiconductors at a glance – Innovation & Passion

Global No. 2
Industry position

15bn / 19bn
2019/2024 Market size in €bn[1]

€1.5bn
Revenue 2019

~11,700
Employees worldwide



Product portfolio **Automotive**
~60% of revenue

Product portfolio **Sensing**
~10% of revenue

Product portfolio **Visualization**
~10% of revenue

Product portfolio **Illumination**
~20% of revenue

1 Market for optoelectronic components | Source: OS market model, external market models

OSRAM Company Overview

Four product lines drive photonics - and more

Automotive

Pixelated Headlamp

Interior Ambient Lighting

Rearlight

Illumination

Horticulture

Industry

Streetlighting

Visualization and Laser

LiDAR Sensors

Projection

Material Processing

Sensing

3D Sensing

Vital Sign Monitoring

In-Cabin Monitoring

Vixar Overview

Headquarters: Plymouth, Minnesota, USA

Market leader across a diversified VCSEL product portfolio

- Wavelengths from 670 nm to 940 nm (extensible to 1000nm)
- Single-mode designs to high power arrays (Power > 10W)
- Low cost surface mount packaging
- Custom subassemblies and optics integration

Vixar

AN

OSRAM

Opto Semiconductors

COMPANY

INNOVATION AND PASSION FOR VCSEL

Manufacturing infrastructure and supply chain

- Scalable manufacturing for hundreds of millions of units per year
- In production on both 4” and 6” wafer platforms for cost-efficient manufacturing
- Both domestic and off-shore packaging capacity
- Maintain multiple sources of standard processes with the flexibility to customize die or package configuration

High performance, high volume VCSEL products

High quality, highly reliable VCSEL products

Robust dual and triple sourced supply chain

Best in class package options

OSRAM Company Overview

OSRAM Opto Semiconductors - key locations and key markets worldwide

USA | NAFTA
Sunnyvale I Novi | Exeter

Headquarters NAFTA
- Sales and Marketing
- Application Centers
- LED Preproduct Production

Europe | EEM
Regensburg

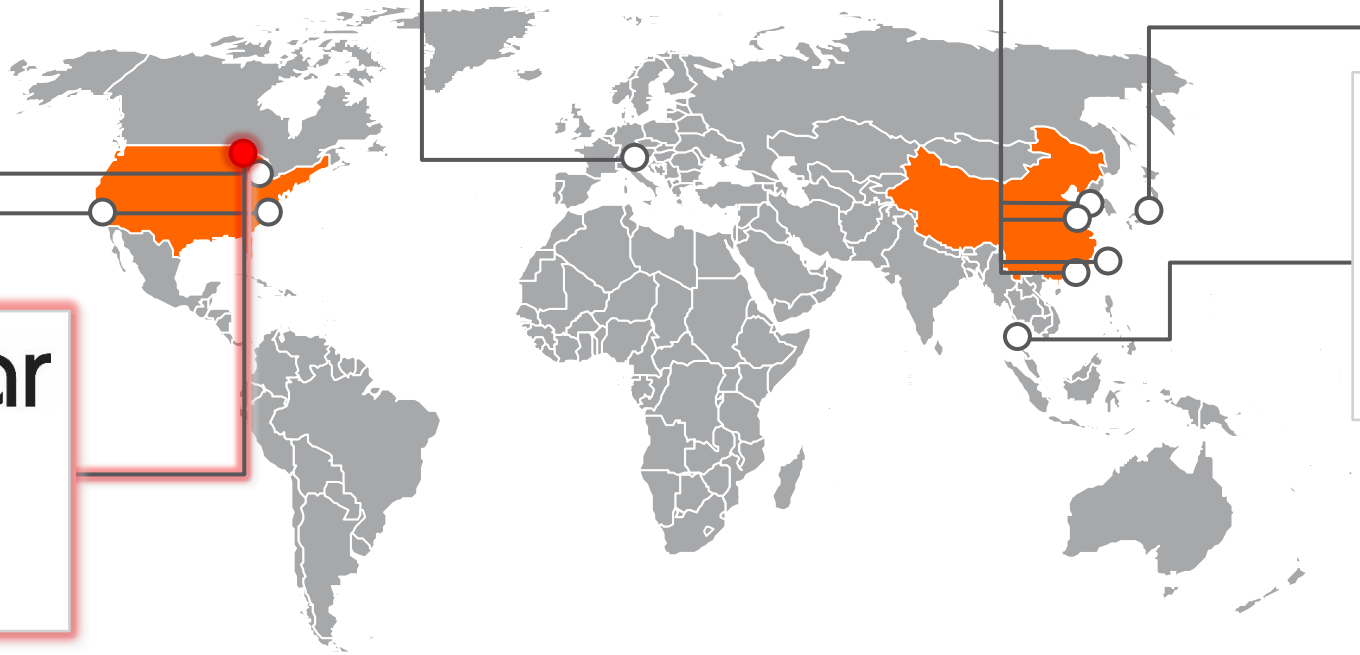
Global Headquarters, R+D
- Chip Production
- Sales and Marketing
- Application Centers

Asia | China
Hong Kong I Shanghai I Wuxi | Taiwan

Headquarters Asia Pacific
- LED Assembly, R+D
- Sales and Marketing
- Application Centers

Asia | Japan
Yokohama

- Sales and Marketing
- Application Centers



Asia | Malaysia
Penang | Kulim

GL Headquarters
- Chip Production
- LED assembly
- R+D

NAFTA |
Plymouth, MN

Vixar

Headquarters Vixar
- VCSEL R+D
- Sales and Marketing
- Application Engineering
- Foundry Operations

Vixar OSRAM Opto Semiconductors

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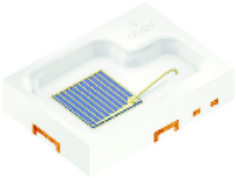
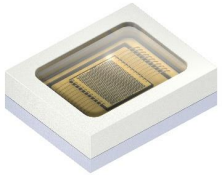
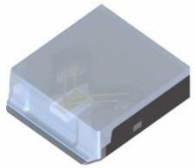
4 VCSEL Innovations

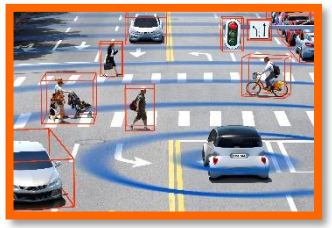
The OSRAM Advantage: VCSEL, EEL and IRED

Comparison

	IRED Cost Optimized 	VCSEL Fast and Stable 	EEL Powerful Solutions 
Power [CW]	~ 4 W – Scales with Area	~ 8 W – Scales with Area	Not for CW use
Power [ns Pulsed]	N/A	~ 120 W – Larger Area	~ 120 W – Point Source
Power Density	Low	Mid	High
Beam quality	Lambertian / Very wide divergence	Symmetric / Low divergence	Asymmetric / Medium Divergence
Temperature shift	0.25 nm/K	0.07 nm/K	0.25 nm/K
Spectral width	20-30 nm	1-2 nm	3-8 nm
Speckle	Low	Low in an array	High
Switching time	ms	ns	ns
Packaging	Simple	Simple	Complex
Cost	Best	Good	Medium

*) based on Vixar and OSRAM assessment

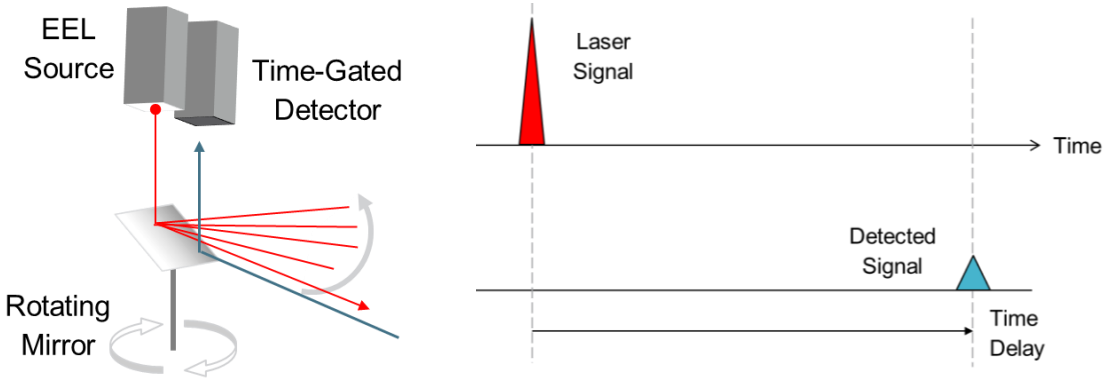
VCSEL Targeted Markets & Applications

	Markets	Application
	Industry	Proximity Sensing, 3D Sensing (ToF / Structured Light), Illumination, LiDAR, Atomic Sensors, Safeguarding, Self Mixing
	Mobile Devices	3D Sensing (ToF / Structured Light), Gesture/Facial Recognition, Biometric Metrology
	Medical	Light therapy, 3D Sensing (ToF / Structured Light), Biometric Metrology
	Automotive	3D Sensing (ToF / Structured Light), LiDAR, Gesture/Facial Recognition, Biometric Metrology

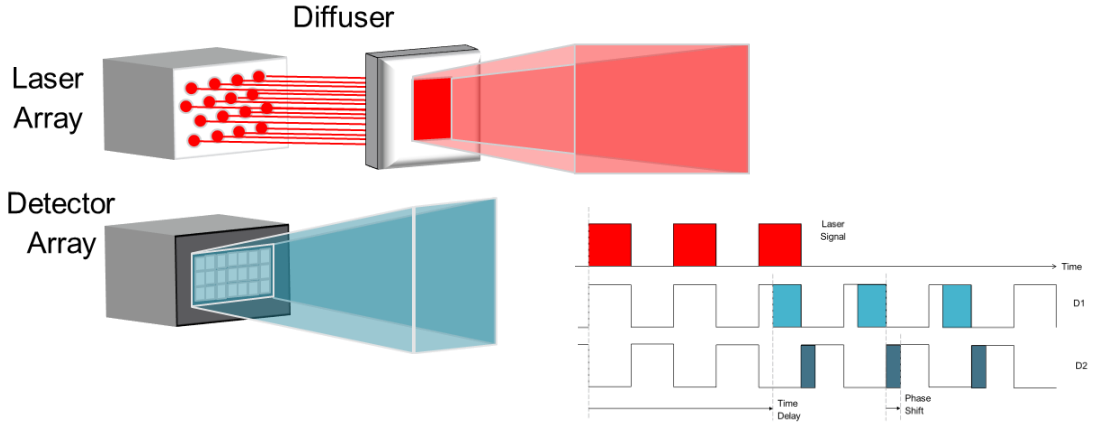
Sensing Target Applications

Measurement Techniques for Light Detection and Ranging (LiDAR)

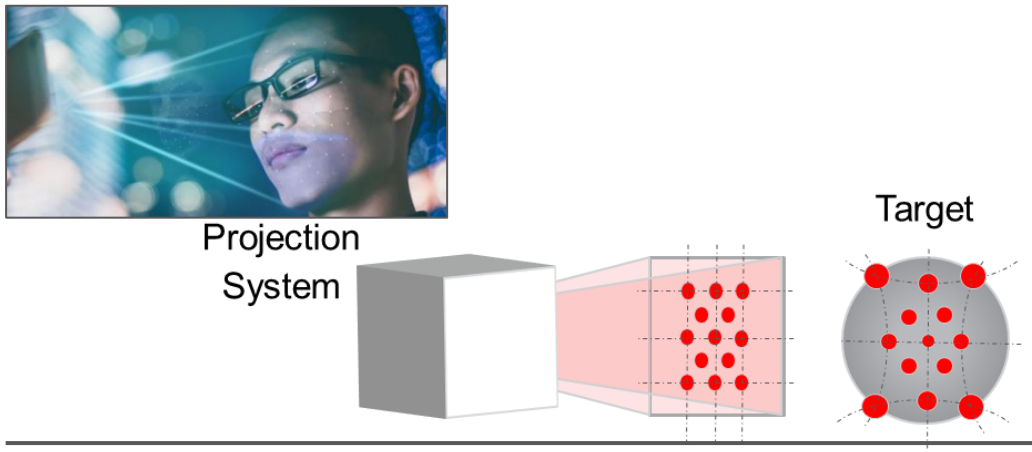
Direct Time of Flight (dToF)



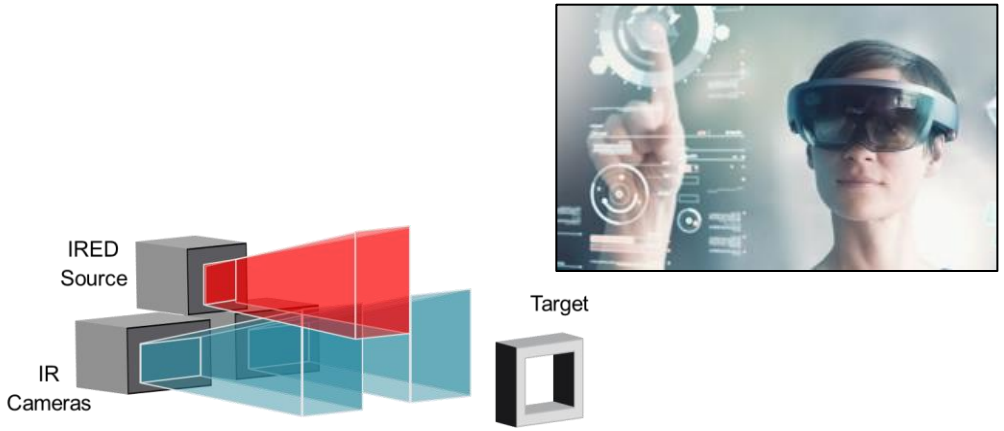
Indirect Time of Flight (iToF)



Structured Light



Camera Illumination / Stereo Vision



Sensing for Industry Applications

Wide market, many use cases and opportunities

Industrial LiDAR / 3D Sensing

Robotics

Smart Access

Machine Vision

3D Surveillance

more to come…

- Health & Security
- Medical
- etc.

Vixar OSRAM Opto Semiconductors

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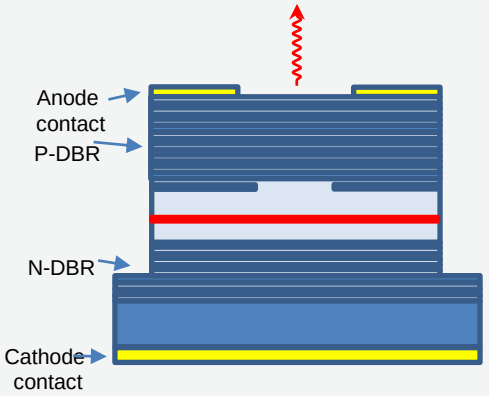
4 VCSEL Innovations

Vixar is Pioneering: VCSEL Technology Competence

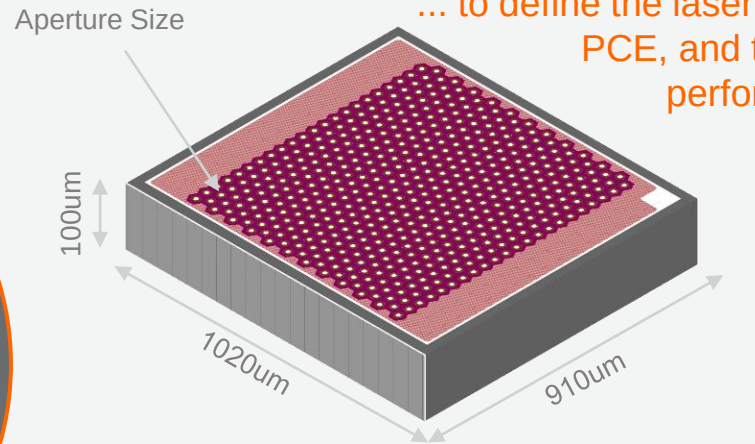
Epitaxy

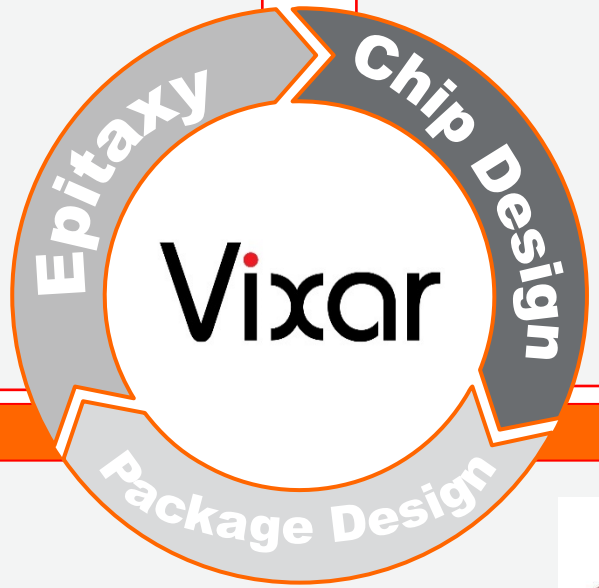
…to define the wavelength and internal quantum efficiency



Chip Design

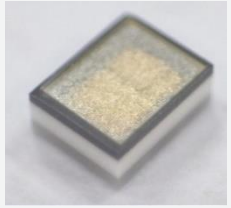
... to define the laser power, PCE, and thermal performance

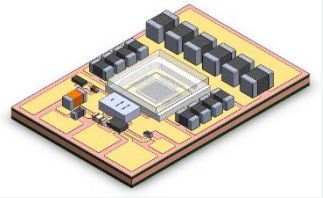




Packaging & Electronic Solutions

... to define the robust packaging and light beam profiles



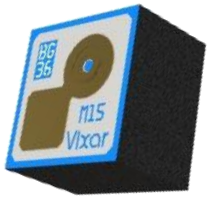


... to define high peak power and narrow pulse widths

VCSEL Portfolio

VCSEL Low Power – Bare Die

Wavelength	Number of Emitters	Part Number	Number of Junctions	Recommended Peak Power 100µS, 1% DC	Recommended Peak Power 5nS, 0.1% DC	Recommended Peak Power CW, 100% DC	Application Example(s)
680 nm	1	V00146	1	15mW	-	7mW	Biosensing Industrial Sensor Light Therapy Pilot Beam
795 nm	1	V00145	1	-	-	0.15mW	Atomic Clock Magnetometer
895 nm	1	V00140	1	-	-	0.2mW	Atomic Clock Magnetometer
940 nm	3	V00101	1	180mW	0.13W	18mW	Proximity Sensor



V00146

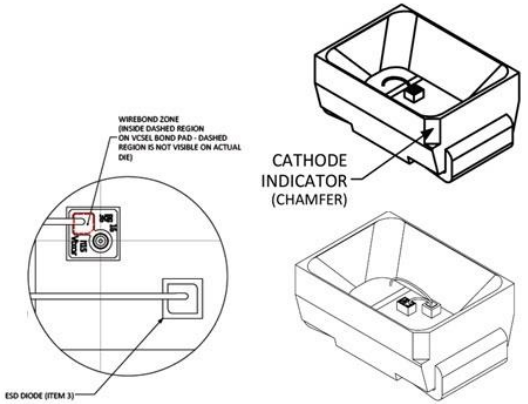
V00140 / V00145

V00101

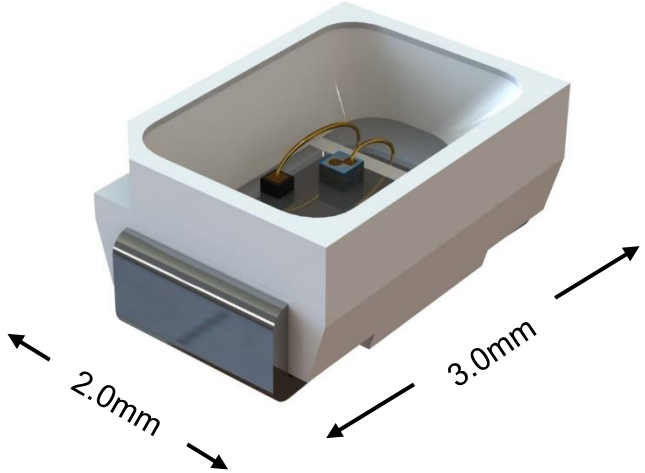
VCSEL Portfolio

VCSEL Low Power – 3020 PLCC Packages

Wavelength	Number of Emitters	Part Number	Optics	Recommended Peak Power 100µS, 1% DC	Recommended Peak Power 5nS, 0.1% DC	Recommended Peak Power CW, 100% DC	Application Example(s)
680 nm	1	V00002	None	15mW	40mW	7mW	Biosensing Industrial Sensor Light Therapy
		V00013	None	3mW	8mW	1.5mW	
850 nm	3	V00147	None	0.15W	0.7W	70mW	Industrial Sensor



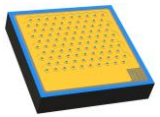
PLCC Packages



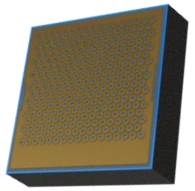
VCSEL Portfolio

VCSEL High Power – Bare Die

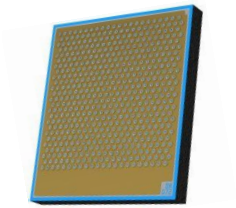
Wavelength	Number of Emitters	Part Number	Number of Junctions	Recommended Peak Power 100µS, 1% DC	Recommended Peak Power 5nS, 0.1% DC	Recommended Peak Power CW, 100% DC	Application Example(s)
850 nm	100	V00151	1	1.2W	9.5W	0.5W	Time of Flight (ToF) 3D Sensing Gesture Recognition Long Range Sensing LiDAR
	281	V00027	1	6W	38W	2W	
	550	V00124	1	9W	52W	3W	
	770	V00029	1	12W	62W	4W	
	1672	V00133	1	20W	100W	6W	
940 nm	281	V00059	1	5.5W	38W	2W	Time of Flight (ToF) 3D Sensing Gesture Recognition Motion Control Long Range Sensing LiDAR
	550	V00081	1	8W	52W	3W	
	550	V00155	2	10W	70W	4W	
	550	V00156	3	12W	115W	4W	
	770	V00063	1	11W	62W	4W	
	1672	V00132	1	20W	100W	6W	



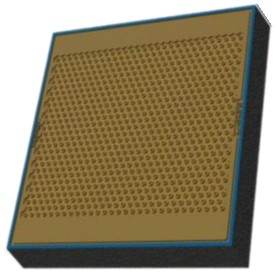
V00151



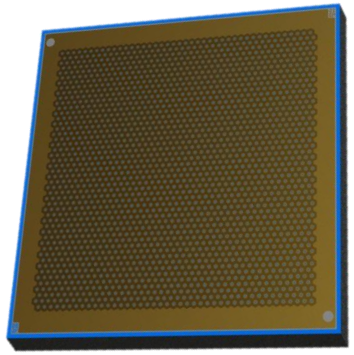
V00027 / V00059



V00124 / V00081
V00155 / V00156



V00029 / V00063



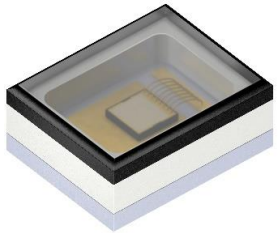
V00132 / V00133

Vixar OSRAM Opto Semiconductors

VCSEL Portfolio

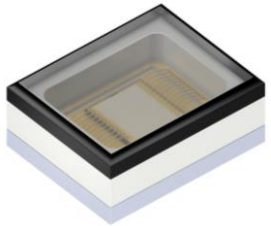
VCSEL High Power – 2835 Ceramic Packages

Wavelength	Number of Emitters	Part Number	Optics	Eye Safety Feature	Recommended Peak Power 100µS, 1% DC	Recommended Peak Power 5nS, 0.1% DC	Recommended Peak Power CW, 100% DC	Application Example(s)
850 nm	281	V00024	60° x 45°	-	5.5W	32W	1.5W	Time of Flight (ToF) 3D Sensing Gesture Recognition Motion Control
		V00028	60° x 45°	MPD				
		V00100	72° x 58°	-				
	770	V00038	60° x 45°	-	10W	52W	3.5W	
		V00129	72° x 58°	-				
		V00103	110° x 80°					
		V00042	None	-	12W	62W	3.5W	
940 nm	281	V00056	60° x 45°	-	5W	32W	1.5W	Time of Flight (ToF) 3D Sensing Gesture Recognition Motion Control
		V00061	60° x 45°	MPD				
	550	V00065	60° x 45°	-	7W	44W	3.5W	
		V00079	60° x 45°	MPD				
		V00105	72° x 58°	MPD				
		V00128	110° x 80°	MPD				
	770	V00075	60° x 45°	-	10W	52W	4.5W	
		V00130	72° x 58°	-				

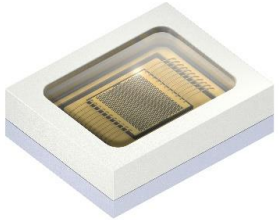


281 / 550 apertures
Diffuser Optics

281 / 550 apertures
Diffuser and MPD



770 apertures
Diffuser Optics



770 apertures
No Optics

Vixar OSRAM Opto Semiconductors

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VCSEL Innovations

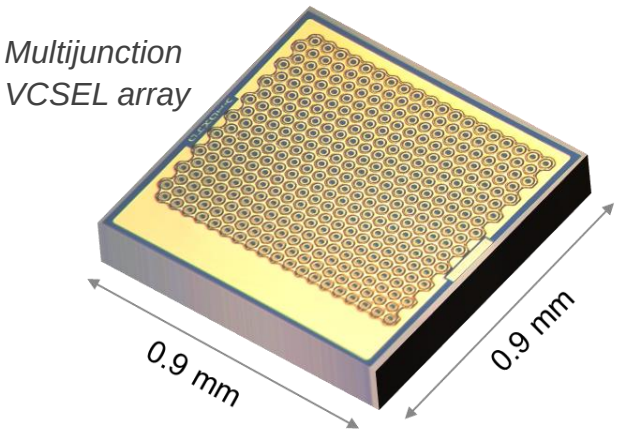
Multi-Junction VCSEL Technology

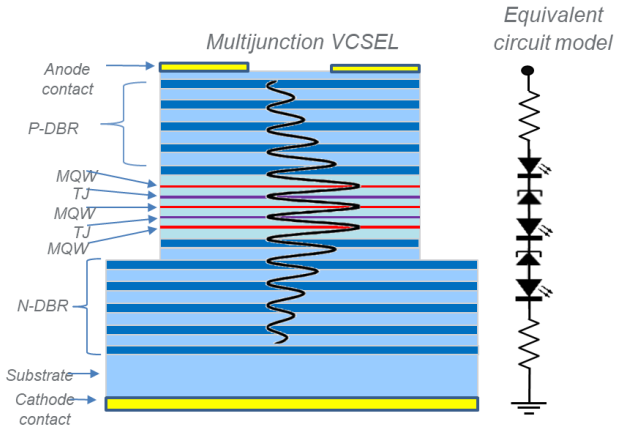
Fabricated high power VCSEL array die:

- Chip footprint : 0.9 mm x 0.9 mm
- 361 apertures (10µm diameter)
- Operating condition: 100µs, 1% DC, T=20ºC

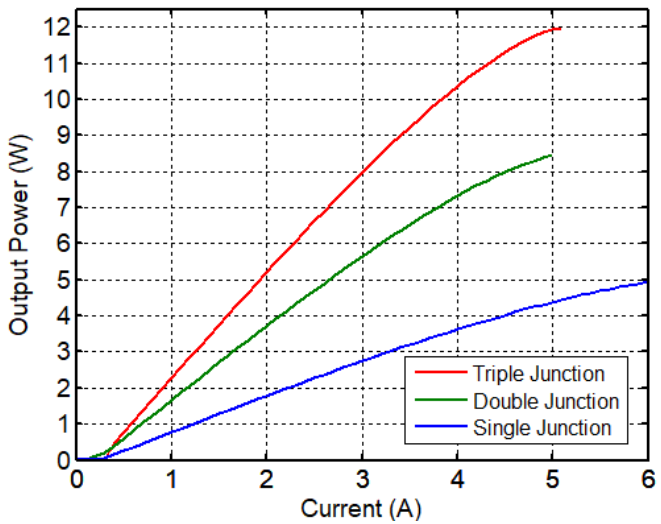
LIV Comparison:

- Peak efficiency of > 53%
- Peak slope efficiency: 3.0 W/A
- > 10W power at 4A

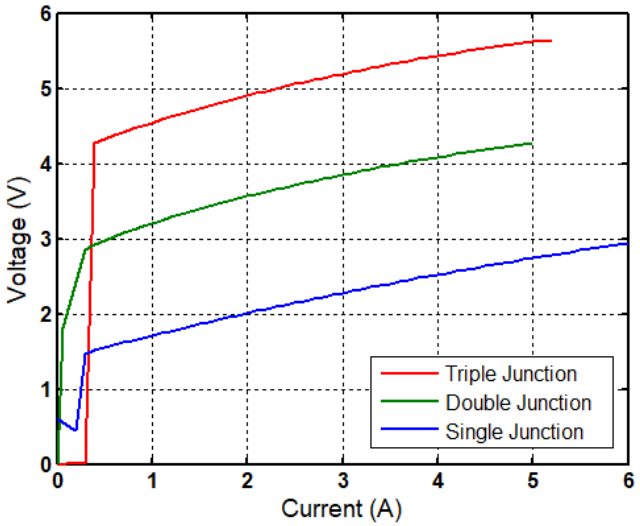




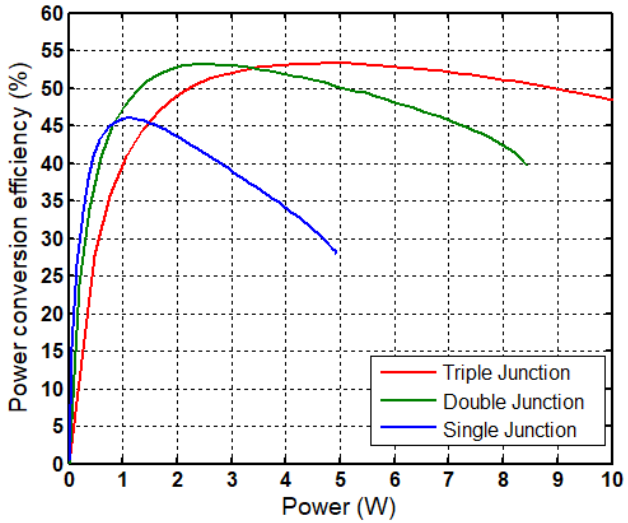
Power



Voltage



Efficiency



VCSEL Innovations

Narrow Beam Divergence VCSEL Technology

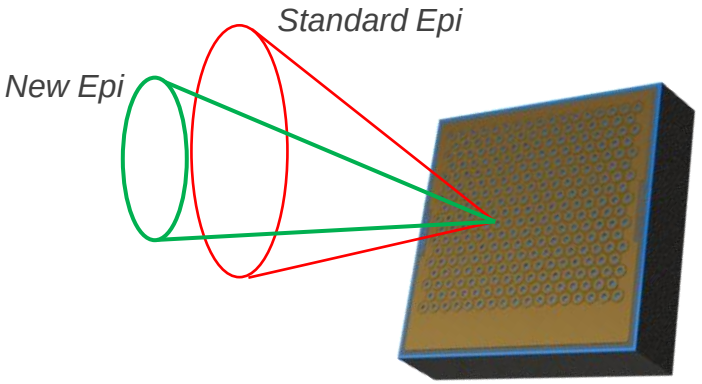
	Wavelength	Spectral width	Conversion Efficiency @ 45°C	Wavelength shift	Beam Divergence (1/e²)
Standard Epi	940±10nm	<1.5nm	>38%	<0.07nm/C°	< 26°
New Epi	940±10nm	<1.5nm	>35% to 36%	<0.07nm/C°	< 22° (average 18°)

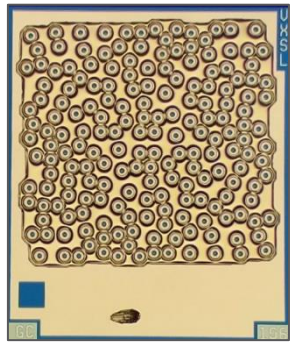
<u>New epi wafers available with low beam divergence</u>

- Improved coupling to optical components
- Enhanced DOE functionality
- Focus for structured light modules

<u>Immediately available for custom chip layouts</u>

- Demonstration samples available





VCSEL Innovations

Bottom Emitting Flip-Chip VCSELs

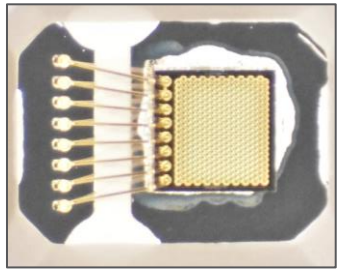
Flip-Chip VCSEL Advantages:

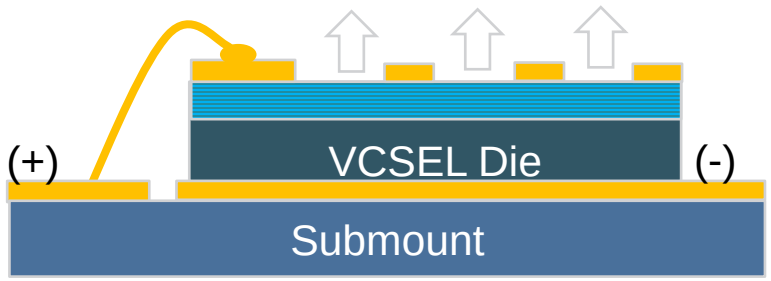
- Reduced Packaging Footprint
- Low-Cost Packaging
- Lower Inductance
- Improved Beam Quality
- Reduced Thermal Resistance
- 2D Array Addressability

Available for custom chip layouts

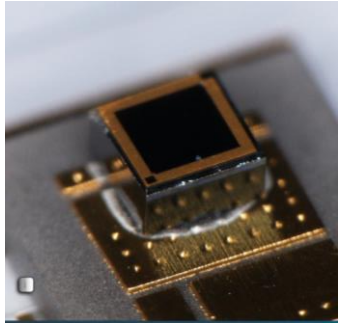
- First demonstration samples available

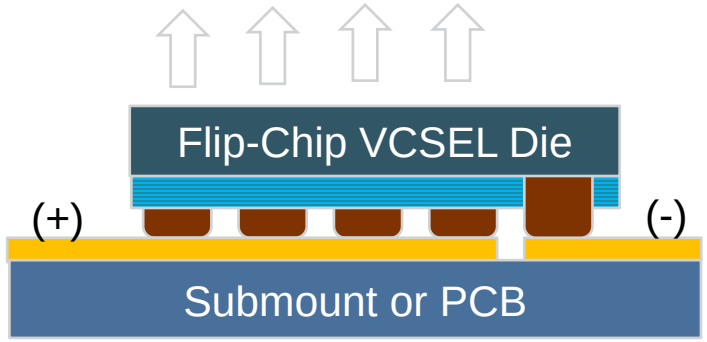
Top Emitting VCSEL





Flip-Chip VCSEL





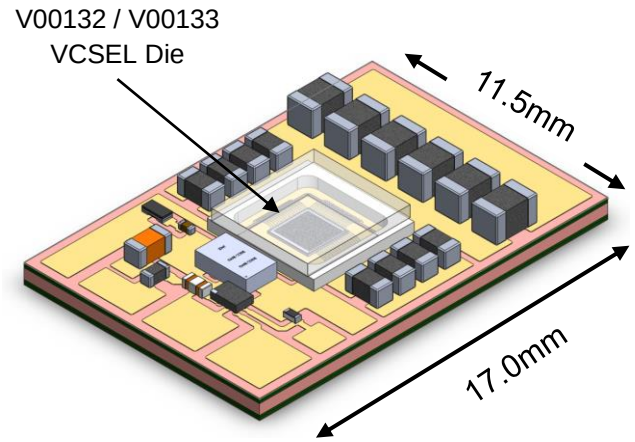
VCSEL Innovations

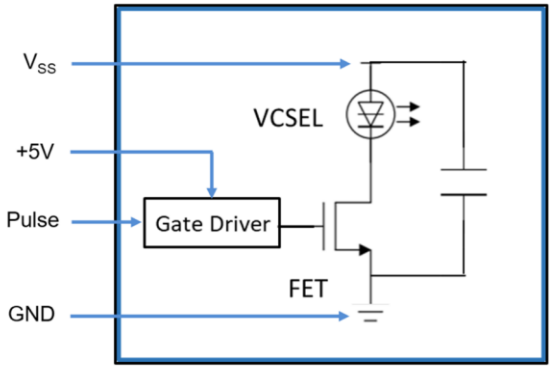
VCSEL TOF Driver Reference Module

Fast short-pulsed laser with an integrated driver circuit incorporates GaN FET & VCSEL on a Copper Core PCB with Cu pedestals

<u>This approach benefits customers by offering:</u>

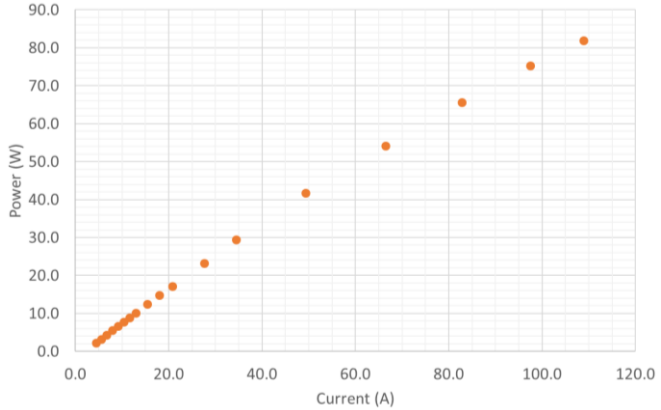
- **Reduced inductance**
- **Rise / fall times of 12 ns**
- **Pulse width from 10 to 100ns**
- **Minimal wavelength shift over temperature (<0.07 nm/K)**





Wavelengths	850nm, 940nm
Supply Voltage	< 50V
Pulse Current	<100A
Pulse Width	10ns – 100ns
Peak optical Power	80W
Temperature Range	-40C to 105C

Pulse Data : t_p = 50ns; DC = 1%



Thank you.