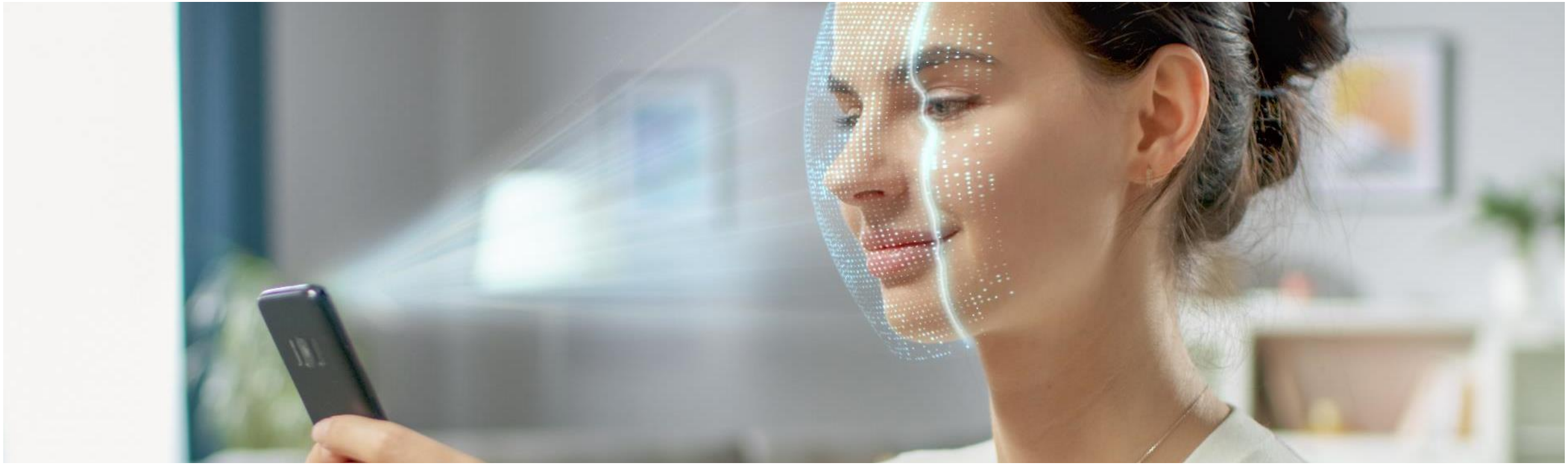


EPIC TechWatch at CIOE 2023

Smart VCSEL technology:
Added value by integrating advanced optical structures

Kevin Lu | TRUMPF Photonic Components

TRUMPF

Agenda

01 TRUMPF Introduction

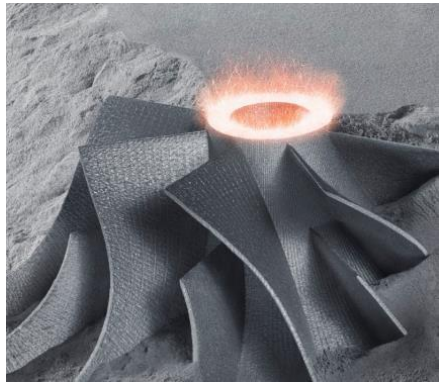
02 TRUMPF VCSEL world

03 VCSEL with integrated optical structures

TRUMPF is…

Family business since 1923

Technology leader in two business divisions

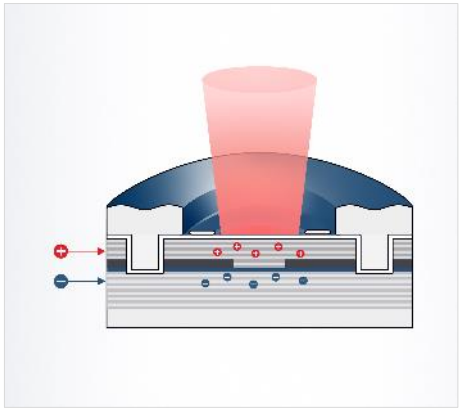


Innovation promise – holistically and constantly

Close to its customers with over 70 subsidiaries

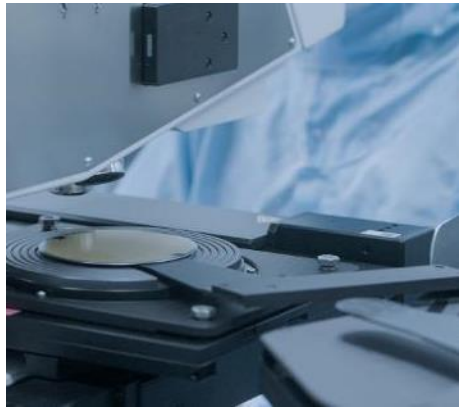
TRUMPF Photonic Components is…

5 reasons for a sustainable cooperation



20 years legacy in VCSEL & photodiode
Strong IP portfolio

Since April 2019 part of the TRUMPF team
Business acquired from Philips Photonics



High volume supplier into multiple markets
Over 2 billion dies shipped (>350 Million in 2021)

International footprint
German based company operating in multiple locations incl. Germany, Netherlands, China, Taiwan, Korea, USA

Strength in innovation
Investing with a 30% quota in R&D projects

TRUMPF VCSEL world

From datacom to sensing to industrial heating to automotive

Datacom

Data Centers

- Transceivers (TxRx), Active Optical Cables (AOC), embedded optical modules

High Performance Computing

Enterprise Networks

Consumer Datacom

- USB, Thunderbolt, HDMI

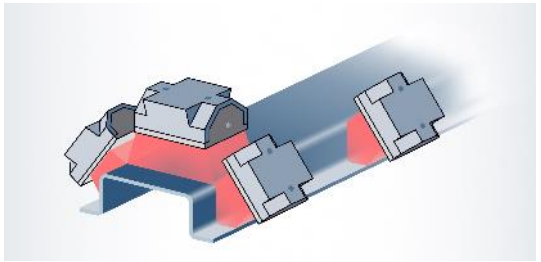
Sensing

Consumer Sensing

- Face recognition
- Proximity sensing
- Laser autofocus
- AR / VR
- User input device

Industrial Sensing

- Environmental and gas sensing



Industrial Heating

E-Mobility

- Battery foil drying
- Pouch sealing

Composite manufacturing

- Local steel treatment
- Pixelated heating
- Joining of plastic parts

Additive Manufacturing

Automotive

Data transfer

- In-vehicle optical network

Sensing

- In-cabin sensing, driver monitoring
- LiDAR

Heating

- Local softening of body steel

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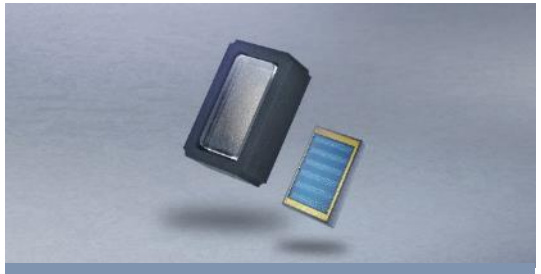
TRUMPF offers a broad product portfolio

World of VCSELs and photodiodes

Datacom

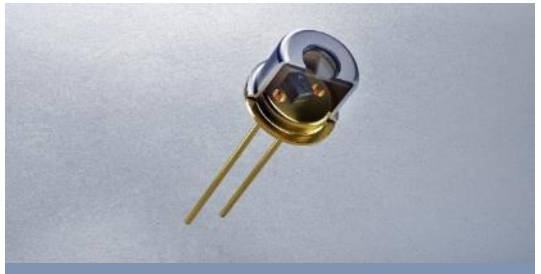
- 850 nm VCSELs and photodiodes up to 56 Gbps bandwidth, 100 G in development (release in ’22)
- Various array configurations (1x4, 1x12, …)
- Non-standard wavelengths (940 nm – 1310 nm)
- Single-mode and multimode VCSELs



Consumer Sensing

Smallest Chips
- 150 µm chip size
- 2 – 20 mW optical power
- 850 nm and 940 nm emission wavelength

VCSEL arrays
- 0.5 – 4 W (cw)
- High pulse power 10 x cw
- 850 nm and 940 nm emission wavelength
- Short pulses down to 1ns
- Large 2D arrays with addressable zones



Industrial Sensing

- 76x nm and 850 nm single-mode in TO package
- TEC optional

High Power Systems

- Many chips to scale the power to multi kWs
- Addressable zones
- Slope efficiency ~1 W/A
- 980 nm emission wavelength

Trends in consumer sensing

Miniaturization

Power consumption reduction

Performance increase

VCSEL technology has to become smarter!

Integrating advanced optical structures to address industry needs.

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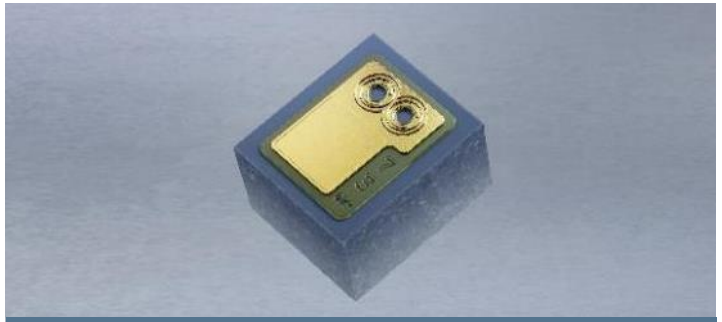
VCSEL with integrated optical structures

Added value



Integrated polarization control

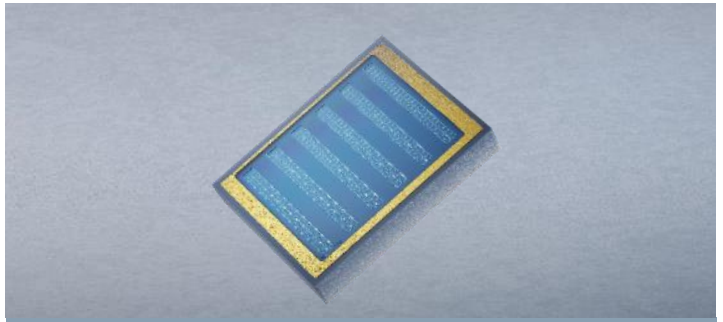
Characteristics
- Polarization stable locked by a surface grating
- Future: VCSEL addressing two polarization directions

Applications
- Underneath OLED display

Integrated photodiode

Characteristics
- Integrated photodiode into VCSEL
- 3 contacts on front, one backside

Applications
- Eye-tracking
- Speed and distance measurement
- Industrial sensing



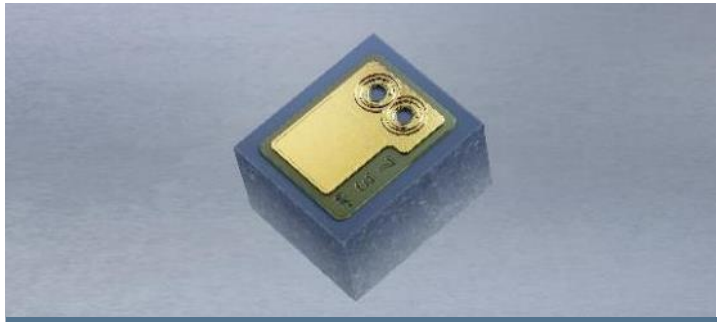
Integrated backside optics

Characteristics
- Monolithically integrated micro-optical elements

Applications
- LiDAR
- In-cabin sensing
- Driver monitoring

VCSEL with polarization control

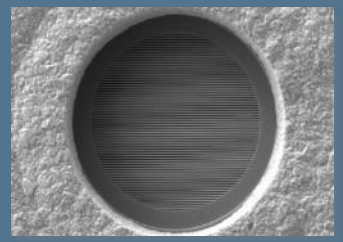
For consumer applications



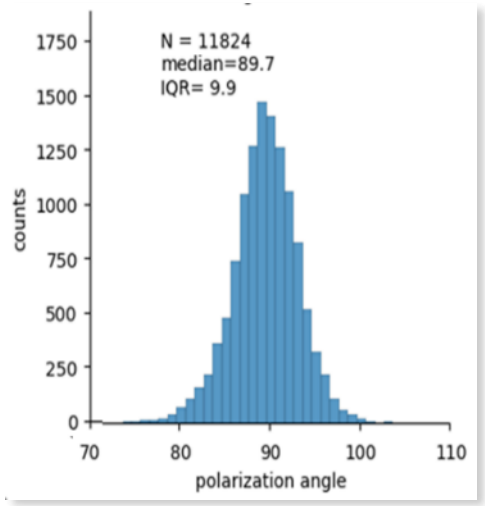
Integrated polarization control

Technical specs

- Polarization stable locked by a surface grating
- 2 - 8 emitter multimode VCSEL
- 940 nm wavelength
- 8 – 10 mW



Sub-wavelength grating etched into the GaAs



Measured on-wafer distribution of polarization angle wrt. chip edge

Application fields such as OLED displays

Improve illumination quality & resolution

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ViP - VCSEL with integrated Photodiode

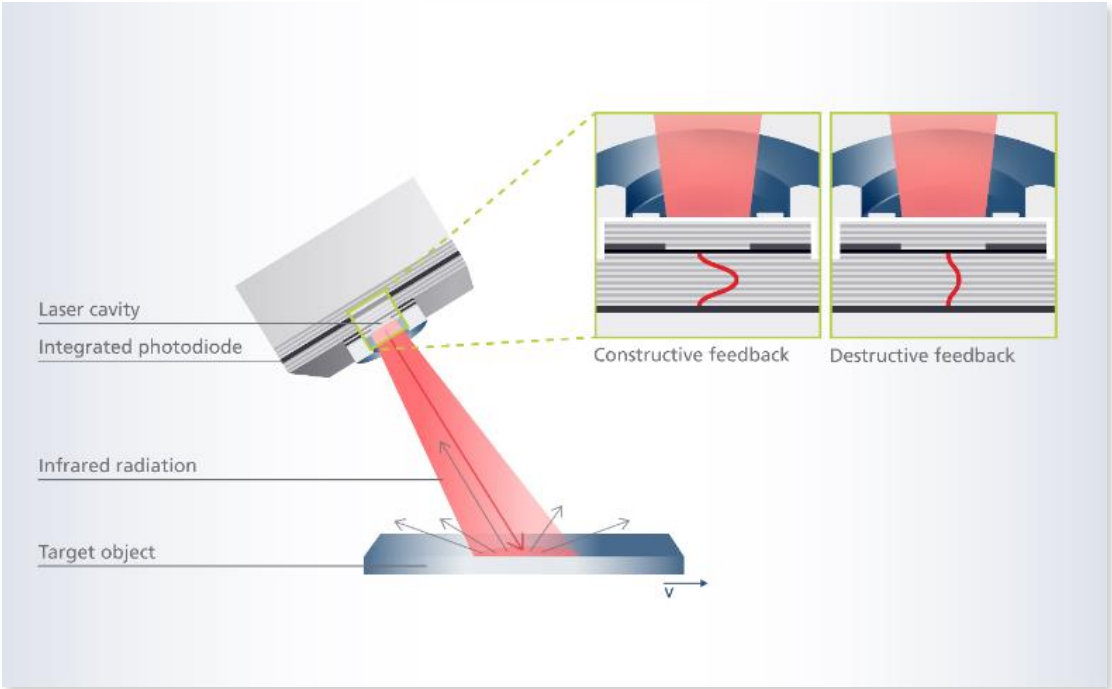
For consumer or industrial applications

Integrated photodiode

Characteristics

- 2 independent emitter and integrated photodiode
- 850 nm single-mode VCSEL
- 1-2 mW
- 3 contacts on front, one backside
- Grating for stable polarization

ViP as key enabler for SMI*, combining interferometric accuracy with compactness

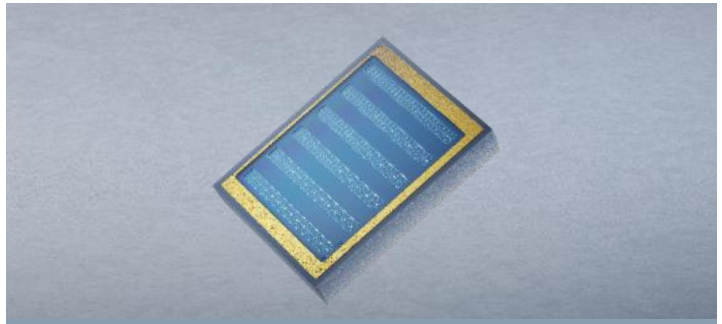


Support miniaturization

*SMI = self-mixing interference

ViBO – VCSEL with integrated backside Optics

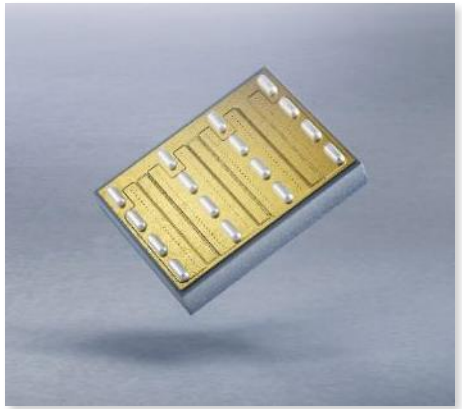
For automotive applications



Integrated backside optics

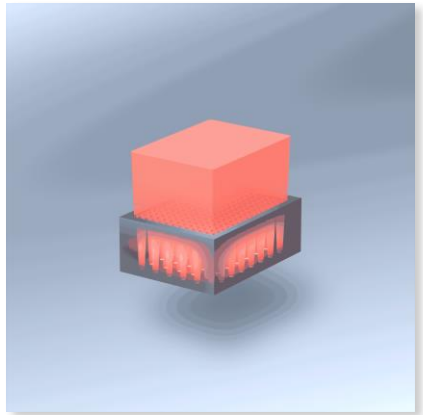
Characteristics

- Monolithically integrated micro-optical elements
- 940 nm multimode VCSEL
- Inherently eye-safe
- > 10 W peak power for short-range sensors
- > 100 W peak power for long-range



Backside view with preformed contacts

- Easy SMD mounting to the board or driver IC
- Custom addressability of illumination zones



Customize your immulination profile

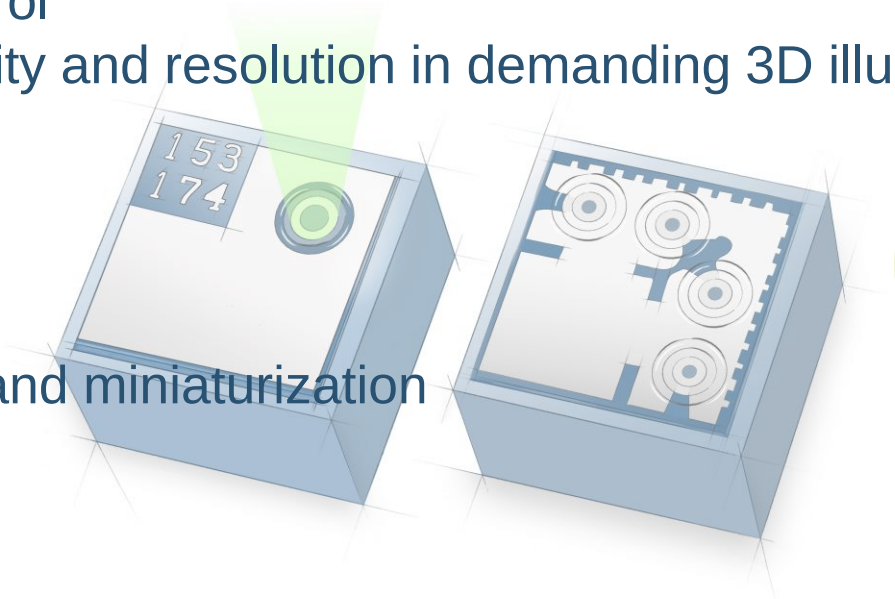
Support miniaturi-zation, higher lifetime, freedom in design

Smart VCSEL technology

Added value by integrating advanced optical structures

Reduce the complexity in your system design and assembly!

- Integrated polarization control
  to improve illumination quality and resolution in demanding 3D illumination applications
- Integrated photodiode
  to support SMI technology and miniaturization
- Integrated backside optics
  to enable miniaturization, increase lifetime and offer freedom in design



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