Company Introduction

TRUMPF Photonic Components
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
About TRUMPF Photonic Components

Spin-off from University Ulm (HQ)

For 20 years: Top Player in VCSEL industry mainly addressing Datacom, Consumer Electronics and Industrial markets

Since 2019: Photonic Components (PC) business field of TRUMPF

~300 Employees at 5 sites worldwide

~ 2 billion VCSELs & Photodiodes shipped
What is so special about a VCSEL?

**vertical-cavity surface-emitting laser**

**Many**
>200,000 VCSEL chips on 4” wafer

**Small**
All functions integrated within 10µm

**Robust**
Works at all temperatures -40 to 120°C

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TRUMPF Photonic Components
Markets which we operate in

Marketing & Sales | TPC
Digital megatrends drive VCSEL demand

Big Data
- Optical interconnects in
  - HPC, data centers
  - Networks
  - Consumer

Sensors
- Scanning distance, speed, 3D contours, identification
  - Smartphones, IoT, etc.
  - Autonomous driving
  - Industrial Sensing

Digital Manufacturing
- Digital manufacturing flows
  - Additive manufacturing
  - Battery production
  - Tailored Industrial Heating
Application: VCSELs in smartphones (Sensing, Connecting)

- Display interconnect
- HDMI interconnect
- Optical microphone
- Identification
- 3D VR/AR
- Proximity
- Autofocus
- Picture enhancement
- LiFi
- Environmental sensors
# Industrial Applications

<table>
<thead>
<tr>
<th>Plastic / Carbon Heating</th>
<th>Metal Heating</th>
<th>Surface Treatment / Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Edge banding of furniture panels</td>
<td>➤ Local weakening of high-strength steel</td>
<td>➤ Drying of battery electrodes for e-mobility</td>
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<tr>
<td>➤ Battery pouch sealing</td>
<td>➤ Pre-heat 3D metal printing</td>
<td>➤ Solar cell ultra-fast regeneration and Semiconductor packaging</td>
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<td>✘</td>
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Products

Marketing & Sales | TPC
Our product categories

Single- and multi-mode VCSELs

Datacom VCSELs & photodiodes

VCSEL modules & sensors

VCSEL heating systems / pixelated heating
VCSELs designed to the application
VCSELs come in many forms: we have them all

**Consumer Sensing**

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

**VCSEL arrays**
- 0.5-4W (cw)
- High pulse power 10x cw
- 850 & 940 nm emission wavelength
- Short pulses down to 1ns

**SMD packages including integrated optics available**

**Datacom**

- VCSELs and PDs at 850 nm
- up to 56 Gb/s bandwidth
- various array configurations (1x4, 1x12, …)
- Large 2D arrays with addressable zones possible

**Power Systems**

- Many chips to scale the power to multi kWs
- Addressable zones
- slope efficiency > 1 W/A
- 850, 940 & 980 nm emission wavelength

SMD packages including integrated optics available
## Application: data communication

<table>
<thead>
<tr>
<th>VCSEL chip format</th>
<th>Wavelength</th>
<th>Status</th>
<th>Receiver PIN-Diode (Production)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Gbps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Gbps</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>14 Gbps</td>
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<td></td>
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<tr>
<td>25 Gbps</td>
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<td></td>
<td></td>
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<tr>
<td>56 Gbps PAM4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>112 Gbps PAM4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1x1</td>
<td>850 nm</td>
<td>Production</td>
<td>1x1, 1x4, 1x12</td>
</tr>
<tr>
<td>1x1, 1x4, 1x12</td>
<td>850 nm</td>
<td>Production</td>
<td>1x1, 1x4, 1x12</td>
</tr>
<tr>
<td>1x1, 1x4, 1x12</td>
<td>850 nm</td>
<td>New generation release Q2 2021</td>
<td>1x1, 1x4, 1x12</td>
</tr>
<tr>
<td>1x1, 1x4</td>
<td>850 nm</td>
<td>New generation release Q4 2021</td>
<td>New generation release Q3 2021</td>
</tr>
<tr>
<td>1x1, 1x4</td>
<td>850 nm</td>
<td>In development, release 2022</td>
<td>In development, release 2022</td>
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</tbody>
</table>
VCSEL solutions for consumer and automotive in-cabin sensing

Target applications:
- Consumer (smartphone): facial recognition, 3D sensor, AR/VR
- Automotive in-cabin sensing: driver monitoring, facial recognition, gesture control

Proposition:
- High power 850nm and 940nm VCSEL arrays
- Hybrid package or bare die
- Self Mixing Interference (SMI) know how and system designs
- Integrated optical designs
- Integrated driver designs
- Continuous wave and short pulse (ToF) designs
- Supports SMI, Structured Light, and (spot) ToF technologies
- Automotive qualified products (AEC-Q102)
Our USP: VCSEL with intelligent properties
Our latest development: VIP* - VCSEL with Intelligent Properties
* better known as VCSEL with Integrated Photodiode

Characteristics latest generation VIP:

- 2 VCSELs: individually addressable
- 3 front side contacts, 1 back side contact
- Chip size: 165x165 µm
- Chip thickness: 130 µm

The back side of the chip is the contact of the photodiode cathode.
VIP: the engine for laser Self-Mixing Interference technology

VIP enabled SMI applications allows compact detection of:

- Navigation movement (optical mouse)
- Small particles passing by (dust sensor)
- Observation of a membrane (optical microphone)
- Finger movement
- Industrial movement
ViBO - VCSEL with integrated backside optics
ViBO: monolithically integrated optics
Integrated optics reduce system size and complexity

Bottom emitter VCSEL

Light emission

Integrated micro lenses

Copper pillars (Copper + SnAg)

GaAs Substrate
Next generation products with structured electrode geometry
Bottom emitters allow straightforward 2d electrode patterns

Zone illumination (LIDAR)

Scanning Line Illumination (LIDAR)

Pattern resolution
- 50µm pitch (industrial process)
- 35µm pitch (development)
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