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innovating photonics

Challenges and opportunities in hybrid integration of light sources and detectors in SMD packages for ultra-compact sensors

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Agenda

- Key facts about our company
- The schmaller, the better! → SMD Multi-Chip-Designs
- Wavelength selection
- Package selection
- Package selection and customization
- More challenges

Key Facts about our company

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Industrial leader
in the field of LED technology

- Location Berlin Germany
- Cleanrooms
- 80 Employees

focused on
the specific requirements
of our customers

TÜV SÜD ISO 9001

Chip process

SMD production

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Our answer to challenges and opportunities

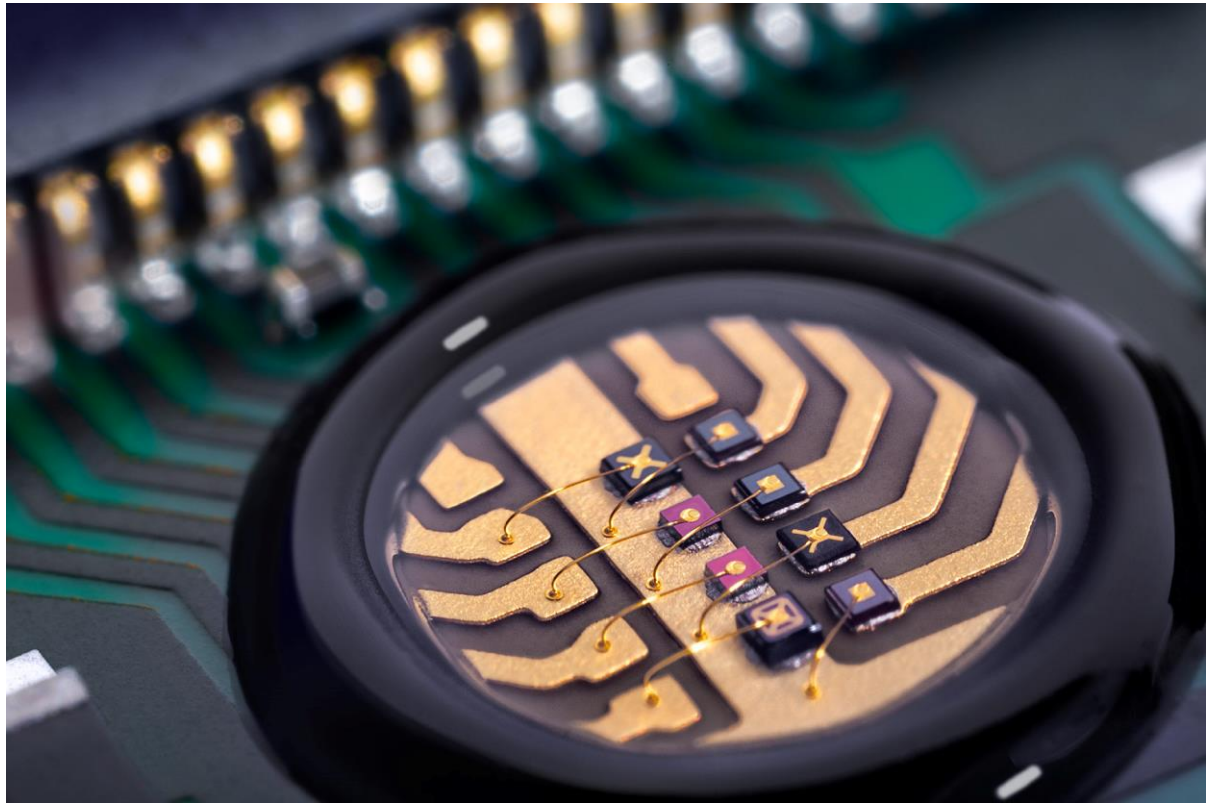
with SMD packages

is always a small and compact

Multi-Chip design

„Excitings times in microelectronics! The trend towards sensors is clear: the smaller, the better.“

LinkedIn post from Stefan Finkbeiner
CEO Bosch Sensortec GmbH 08-08-2024



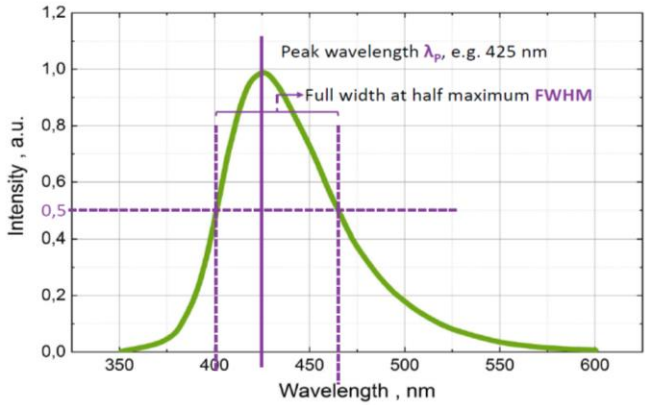
8 different LED-Chips
wire-bonded and ecapsulated
within less than 4 mm diameter

Wavelength selection

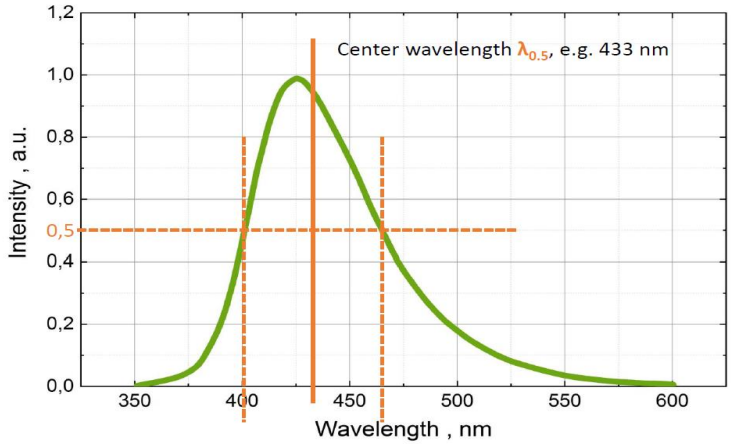
- Ultraviolet – Visible – NIR LED Chips in the range from 255 nm – 1720 nm
- Wavelength binning for peak or centroid wavelength up to +/- 3 nm
- In color science, the dominant wavelength is a way of describing light that would evoke an identical perception of human eye
- LEDs chips are Lambertian Emitters

Clear definition of the specific wavelength and spectral behaviour of the chips

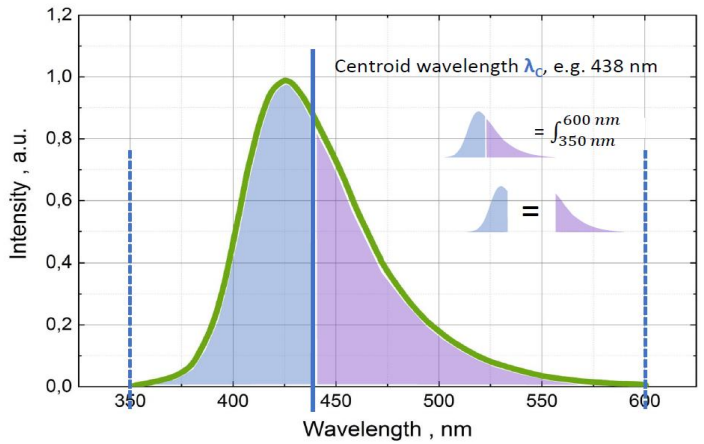
Peak wavelength λ_P



Center wavelength $\lambda_{0.5}$



Centroid wavelength λ_C



Package selection

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Standard package 1206

- **Size: 3.2 (L) x 1.6 (W) x 1.2 (H) mm**
- **Circuit substrate: FR4 material**
- **Encapsulation: Epoxy**
- **Wavelength range: 500 nm – 1550 nm**
- **Viewing angle: 140°**
- **Max forward current: 100 mA**

How many different light sources and / or photodiodes are required to be integrated in one SMD package?

Up to 3 Chips → Small standard SMD package

Advantages:

- Suitable for large series and mass production
- Every chip is separatly addressable
- Low cost

Applications:

- Wearables - Multi-sensor systems that are worn on the body to record vital signs, function reliably and provide high-quality data.
- Finger-Clip-Pulsoxymetrie
- Disposables

Package selection

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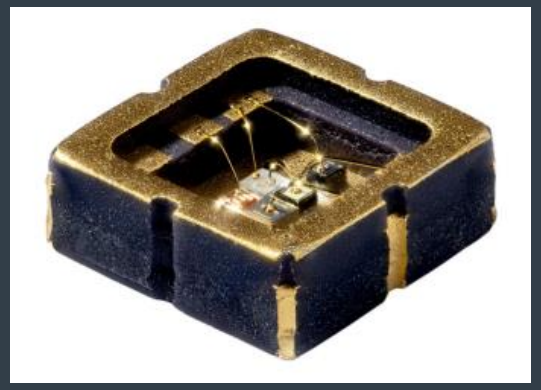
Standard ceramic package

- **Size: 3.0 (L) x 3.0 (W) x 1.1 (H) mm**
- **Circuit substrate: Al_2O_3Ceramic**
- **Encapsulation: Silicon or glass window**
- **Wavelength range: 355 nm – 1720 nm**
- **Viewing angle: 120°**
- **Max forward current: 100 mA**



Up to 5 Chips → Small ceramic SMD package 3 x 3 x 1
Up to 7 Chips → Small ceramic SMD package 5 x 5 x 1

Advantages:

- Suitable for medium series
- No NRE cost
- Optimized thermal management
- ESD protection with Z-diodes
- Distance between chips about 50 - 100 µm

Applications:

- Spectral photometers for water quality inspection
- Biomedical analyzers
- Online food and feed safety measurement
- Diagnostic of vital parameters

Package selection and customization

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- **Circuit substrate: FR4, IMS PCBs (Al- or Cu-based) Ceramic**
- **Encapsulation: Silicon, Epoxy, Glass**
- **Wavelength range: 255 nm – 1720 nm**

Ring sensor with 70 photodiode chips on FR4 material with glass cover plate and connector

Why and when customization is the key?

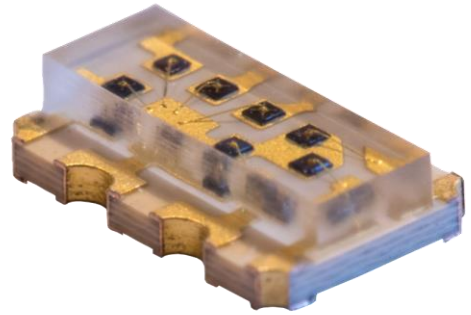
→ **More than 7 chips are requested for the light source**
→ **Specific dimensions to fit into the device**

Advantages:

- Optimized thermal management
- Positioning accuracy +/- 25 µm
- Intergated NTC
- Wide selection of substrat material
- Flex-PCBs and connectors
- ESD protection with Z-diodes
- Optional EPROM for data storage of parameters for every individal part
- Full support from development to series production

Applications:

- Diagnostic of vital parameters
- Industrial sensors
- Quality inspection systems



Infrared lighting for monitoring the dispensing of adhesives
15 Chips including NTC for temperature control
IMS copper-based PCB, connector

More **Challenges**

- Extended development times over more than 10 years → Example: **Detection of brain oxygen in high risk patients**
- Specification changes → Miniaturization

2013
Project start with components

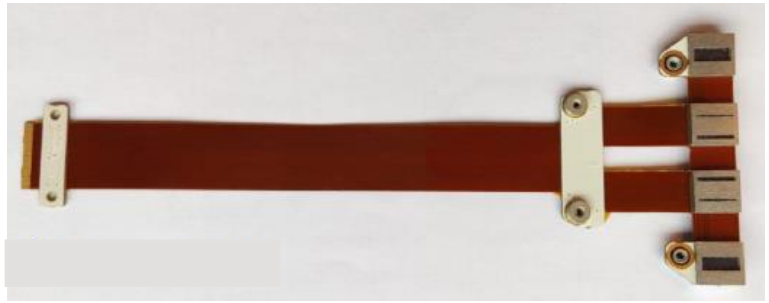
2017
First customized version

2022
Miniaturization of the design

2024
Optimization of prototypes

Selecting the set of wavelength for reliable measurement

Findings:
Too many ligth sources and detectors to realize the requirements with standard components



Establishing design rules

Findings:
The sensor must become smaller and lighter.
The new design must be suitable for series production.

Findings:
Increasing output power of the emitters.
Reducing failor rate within the production cycle

THANK YOU FOR YOUR ATTENTION!

Please meet us in hall 2 booth E2B

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