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ibeo automotive

VCSEL IN AUTOMOTIVE 4D SOLID-STATE LIDAR APPLICATION

EPIC Meeting at Sony in Stuttgart, 17.-18. of October 2019

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Document class: Public

INTRODUCTION TO IBEO AUTOMOTIVE SYSTEMS



Foundation of ibeo Automobile Sensor GmbH in 1998



Headquarters based in Hamburg, Germany Offices in Eindhoven, Netherlands, Detroit, USA and coming soon: China



380+ employees in 2019 Amongst Hamburg's best employers 2019 Amongst Germany's top 100 innovative companies 2019



Worldwide technology leader in the field of LiDAR sensors, associated products and software tools

Sales increase from 2014 to 2018 - 342%

IBEO'S AREAS OF EXPERTISE





Friederieke Gorris / VCSEL in automotive 4D solid-state LiDAR application

Hamburgs BESTE ARBEITGEBER





20 YEARS OF LIDAR AND PERCEPTION EXPERIENCE





Experience in development of LiDAR for automotive since 1998 Our LiDAR technology is in cooperation with Valeo in automotive serial production







KNOW HOW FOR AUTOMOTIVE GRADE PRODUCTION





Partnership with ZF

Production capacity in Brest together with ZF Autocruise already set up



LIDAR | "...IS ULTIMATELY A CRUTCH."



- LiDAR = light detection and ranging
 - distance, velocity, vibration, high resolution mapping
- Drawbacks of LiDAR technology
 - High costs, low robustness, large devices
 - Related to mechanical scanning

Solution:

Solid-state LiDAR sensor





LIDAR SENSOR QUESTIONS TO ASK



1. Measurement process?

Time-of-flight!

2. Beam steering?

3. Emitter/Laser?

4. Receiver/Photodetector?



LIDAR SENSOR | BEAM STEERING







SOLID-STATE LIDAR | SEQUENTIAL FLASH









SOLID-STATE LIDAR | SEQUENTIAL FLASH





- Small size, good range, no moving parts
- Limited horizontal field of view
- Angular resolution fixed
- High NRE

Specific challenges from LiDAR system

- VCSEL array + laser driver ASIC
- SPAD array + receiver ASIC + timecorrelated single-photon counting
- > All components need to work together!



SOLID-STATE LIDAR | SEQUENTIAL FLASH



- General challenges for automotive application
 - Too expensive
 - Moving parts
 - Large, "ugly" devices
 - High power consumption
 - Weather
- Specific challenges from automotive application
 - Small objects at high velocity
 - Overhanging load
 - Fast lane switching
- Specific challenges from automotive manufacturers
 - Different!
 - Modular arrangements (flexible field of view and resolution)



VCSEL IN SOLID-STATE LIDAR | OPERATION WINDOW



ASTM G173-03 Reference Spectra

850 to 905 nm

- Si-based detectors
- Transmission in atmosphere

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• BUT 850 nm can be "visible"

1500 nm

- Eye-safety
- Solar background
- BUT IR detectors needed

VCSEL IN LIDAR FOR AUTOMOTIVE APPLICATION | CHALLENGES



Individually addressable emitter/emitter cluster

- Mechanical challenges (space, pitches, bonding, ...)
- Electronic challenges (bonding, charge transport, voltage drops...)
- Thermal challenges (duty cycle, pulse width, number of shots, …

One VCSEL array, one component, several devices

- Around 13k emitters at 100 devices on one component
- Classification
- Testing time

Friederieke Gorris / VCSEL in automotive 4D solid-state LiDAR application

VCSEL IN LIDAR FOR AUTOMOTIVE APPLICATION | CHALLENGES



Every emitter counts!

– Failure mechanisms and redundancy





11.2° Long range sensor

-1





VCSEL IN LIDAR FOR AUTOMOTIVE APPLICATION CHALLENGES



Operating conditions

- Operating temperature of -40 to 125 °C
- High current density
- Short pulses and rise/fall times

High slope efficiency

• Min. 3 W/A

Beam

- Shape and dip (Gaussian, no dip)
- Divergence (FWHM < 10 °)
- > Dependent on operating conditions
 - Early stages: Suitable driver needed (!)



VCSEL IN LIDAR FOR AUTOMOTIVE APPLICATION CHALLENGES



Testing and traceability

- On wafer level
- At room temperature
- > Early stages: simulations and correlations

Reach qualified products for automotive market

- for driving assistance systems and automated driving from level 2 up to level 5
- Qualification of the component at operating conditions (!)
- Time and schedule versus demand

4D SOLID-STATE LIDAR | WISHLIST



Better, smaller, cheaper!

- VCSEL *n*-typical behavior vs. high- lowside driver CMOS technology
- Common anode
- Backside illumination
- Individually addressable emitters







