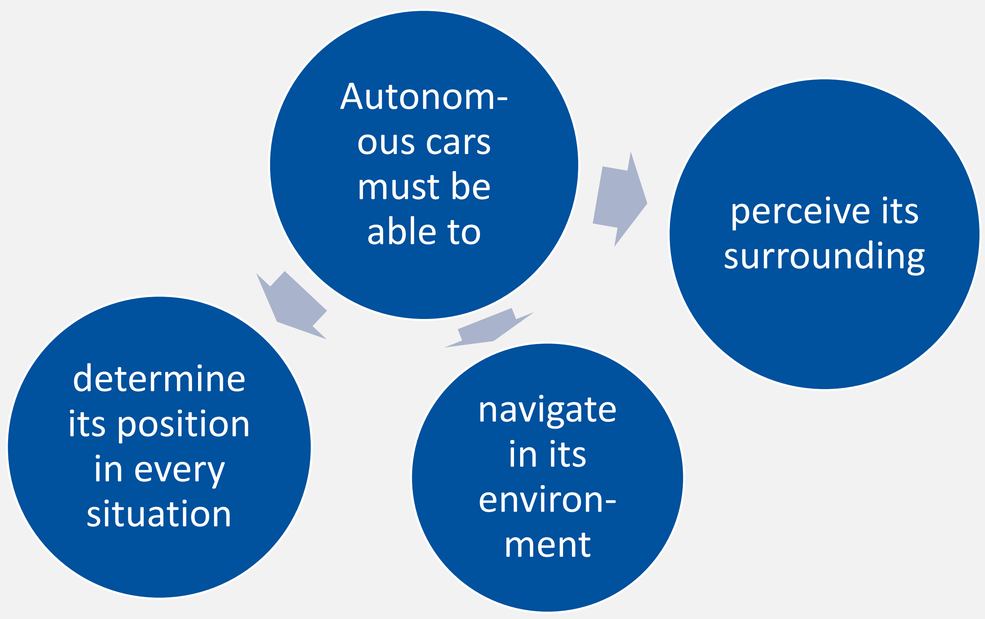
University of Stuttgart
Institut für Nano- und Mikroelektronische Systeme (INES)
Institut für Mikroelektronik Stuttgart (IMS Chips)
Prof. Dr.-Ing. Joachim N. Burghartz

Ann-Christin Köllner
Joachim N. Burghartz
Zili Yu

System Concept of a Germanium-on-Silicon Night Vision Camera for Autonomous Driving

I. Introduction

Safety is the highest priority in traffic. Nevertheless, 1.25 million people died in road traffic only in 2013. In the future, driver-generated accidents will be reduced by autonomous cars. Night vision cameras are crucial components to enable such fully autonomous cars.



II. Problem Description

Camera systems should enable a clear view both under bad weather conditions and at night. However, existing camera systems often fail in bad weather condition like rain or fog, because of absorption of the radiation.

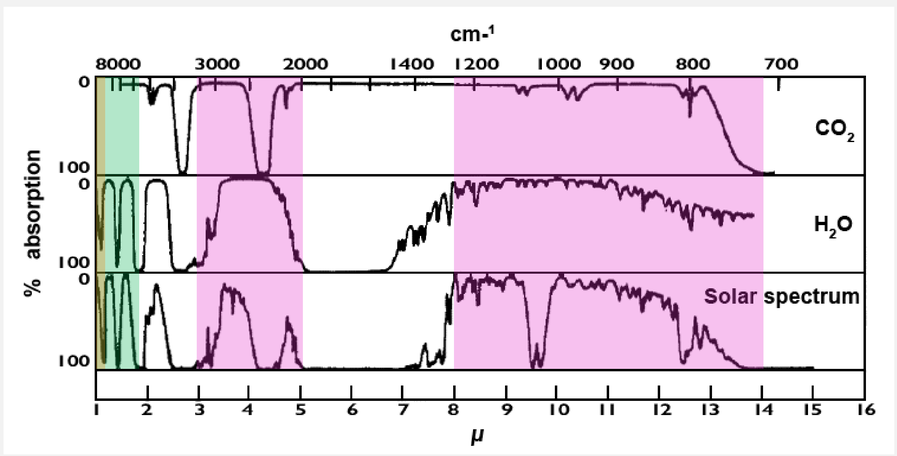
→ **NIR camera systems in the range of 1 – 2 µm can compensate these problems**

III. Types of Infrared Camera Systems

⊖ Si-Detector (0.3 – 1.1 µm NIR)

⊕ InGaAs-/Ge-Detector (0.9/0.4 – 1.7 µm NIR)

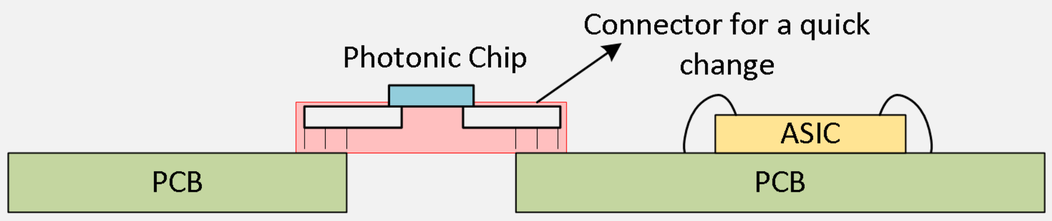
⊖ InSb-Detector (3 – 5 µm MWIR); GaAs/AlGaAs-Detector + Microbolometer (8 – 14 µm LWIR)



InGaAs is not compatible with the typically used CMOS technology + manufacturing is complex and expansive

→ **Ge is an alternative material which is sensitive in NIR!**

IV. System Concept

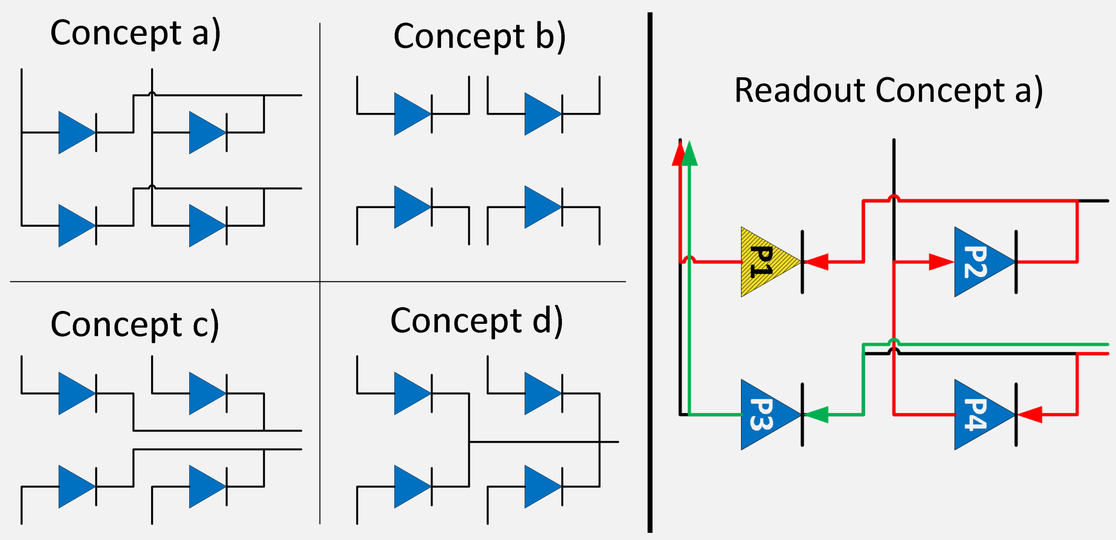


Concept of the Ge-on-Si Night Vision Camera

- Combination of two Chips (Ge-on-Si Pixel Array and readout ASIC) on a PCB; Later integration on one Chip
- Pixel Array only consists of Photodiodes
- Challenge: The signal of each pixel must be readout separately and without any active components on the photonic chip → requires clever wiring concept!

V. Evaluated Readout Concepts

Four different readout + wiring concepts are evaluated



The ideal interconnection concept is concept d). It is the best compromise of the pad number and provides a reliable and constant biasing at every cathode.

VI. Summary

- Ge is the ideal material for night vision cameras
- A night vision camera concept for every situation which tackles bad weather and night conditions is proposed
- Evaluation of the internal Interconnection

VII. Acknowledgment

This work was funded by the German Federal Ministry of Education and Research, BMBF contact number 03VP00412, in the NASIKA project, “Nachtsichtkamera für Automotiv-Anwendungen“.

Bundesministerium für Bildung und Forschung

INES Institut für Nano- und Mikroelektronische Systeme