Why Fraunhofer IAF?

Together with national and international partners from science and industry, Fraunhofer IAF plays a leading role worldwide in the research and development of photodiodes for various applications. Thanks to the expertise of its researchers, its large network and its unique research infrastructure, the institute covers the entire value chain: from design and material growth to device development and module construction.

In addition, Fraunhofer IAF has decades of experience in carrying out complex international research projects and collaborating with customers from industry and small and medium-sized enterprises. This enables an equally efficient and flexible cooperation in the application-oriented research and development of innovative optoelectronics as well as in the customized implementation of orders.

What we offer:

- Development of SPADs in the InGaAs/InP material system for the short-wave infrared (SWIR, $\lambda < 1.7$ µm) according to customer specifications
- Epitaxial growth of InGaAs/InP detector material
- Manufacturing of single-element detectors and detector arrays from prototype to small series production
- Development of front- and backside technology processes for detector arrays

Would you like to learn more about our research activities and services in the field of InGaAs/InP SPADs? We will be happy to present our work and various cooperation opportunities to you in person.

Fraunhofer IAF

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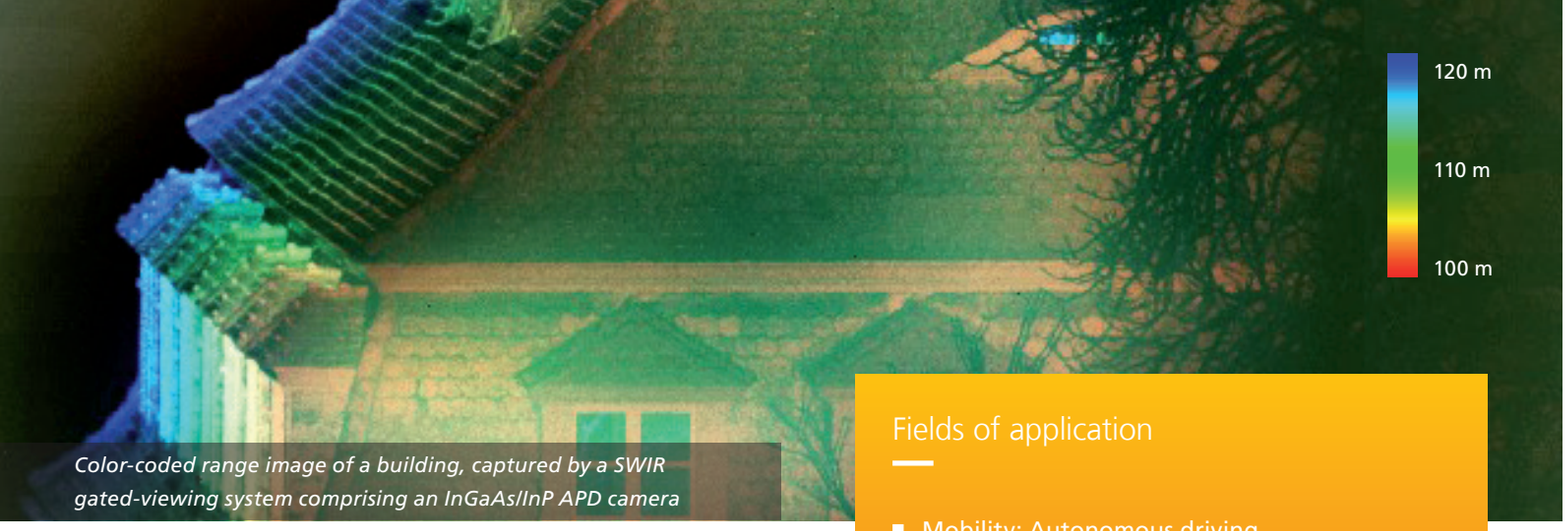
Photodetectors for security, industry, quantum communications, and more

InGaAs/InP-based single-photon avalanche diodes (SPADs)



Color-coded range image of a building, captured by a SWIR gated-viewing system comprising an InGaAs/InP APD camera

Single-photon avalanche diodes for short-wave infrared

Fraunhofer IAF develops single-photon avalanche diodes (SPADs) according to customer specifications for sensing applications that rely on the detection of single photons in the short-wave infrared.

Measure to the photon

Crucial applications in areas such as environmental sensing, autonomous mobility, Industry 4.0, or quantum communications demand for extremely sensitive sensors that detect even the weakest signals under the most adverse conditions. Avalanche photodiodes (APDs) that are operated in the Geiger mode are capable of detecting even single photons. With sensitivities in the short-wavelength infrared (SWIR), such SPADs are key components in laser-active 3D imaging and quantum key distribution.

Fields of application

- Mobility: Autonomous driving
- Industry: Robotics, smart factory
- Security: Surveillance and reconnaissance
- Communication: Quantum cryptography
- Space: Remote sensing

Light detection and ranging (LiDAR)

LiDAR systems use laser time-of-flight measurements to generate high-resolution three-dimensional images of the environment, from which information on distance, position, speed of objects or atmospheric parameters can be obtained, depending on the system. The 2D arrays of linear-mode InGaAs/InP APDs developed by Fraunhofer IAF enable high-resolution single-shot, yet eye-safe time-of-flight imaging systems at 1550 nm that are much faster and more robust than mechanically scanning LiDAR systems. Currently, Fraunhofer IAF is taking its InGaAs technology to the next level and develops SPAD arrays for future photon-counting cameras.

Quantum communication

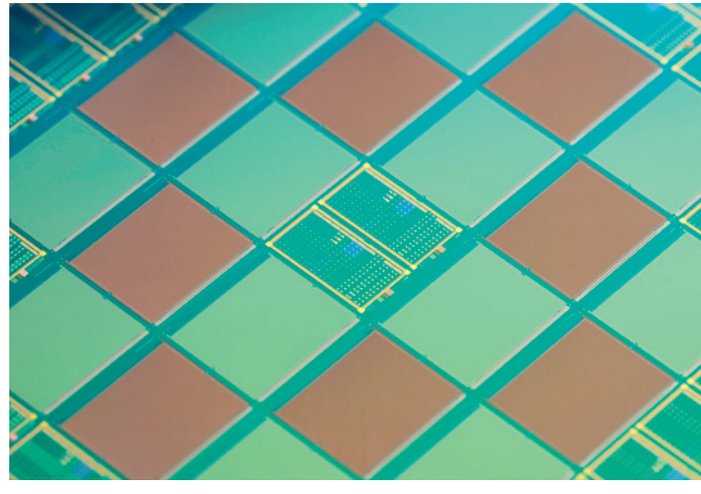
The future telecommunications infrastructure will rely on data security features based on quantum key distribution. Utilizing the quantum properties of entangled photon pairs, this technique requires SPADs for the SWIR spectrum to address optical fiber systems and robust long-range free-space links.

Use of the highly sensitive InGaAs material at wavelength of 1550 nm

Researchers at Fraunhofer IAF are developing SPADs for typical wavelengths around 1550 nm based on the compound semiconductor material system InGaAs/InP, which offers advantages in performance, reliability, compactness and cost. The use of tailored heterojunctions reduces dark signal and noise, hence maximizing the device performance. This technology makes it possible to produce customized, extremely sensitive SWIR single-photon detectors in single-element or array configuration.

Properties and customization

- Mature InP technology
- Spectral range: 1.0–1.7 µm
- Low noise and high detection efficiency
- Room-temperature or TE-cooled operation
- Single devices or array configurations
- Customization of photodiode chips
- Frontside or backside illumination
- Wire or flip-chip bonding



3-inch InGaAs/InP wafer comprising APD arrays and single-element devices for use at 1550 nm wavelength