

The Fraunhofer Institute for Applied Solid State Physics IAF is one of a small number of world-leading research institutes with expertise encompassing the entire value chain in the field of III-V compound semiconductors and synthetic diamond. Based on these semiconductors, IAF develops electronic and optoelectronic devices as well as integrated circuits and systems.

In a clean room of 1000 m<sup>2</sup> and additional laboratory space covering 3000 m<sup>2</sup>, epitaxy and processing equipment along with measurement technologies are available to realize high frequency circuits for communication technology, voltage converter modules for electrical engineering, infrared and UV detectors for safety and security applications, infrared laser systems for medical technology, and diamond devices for innovative applications in the field of quantum sensor systems.

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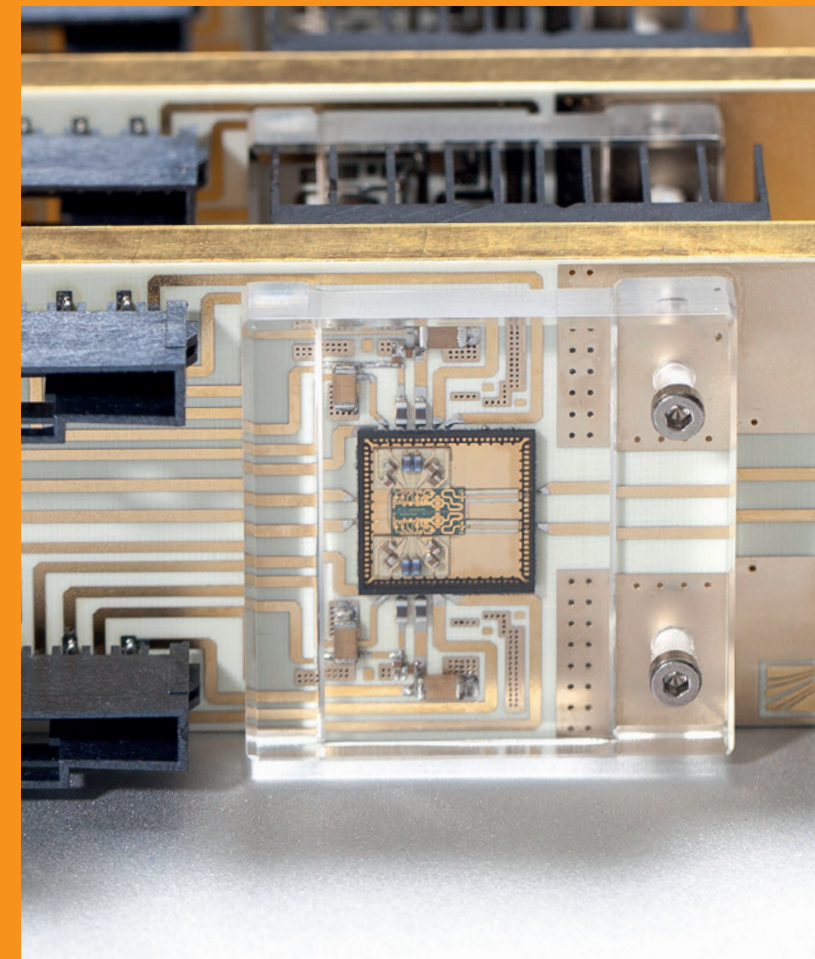
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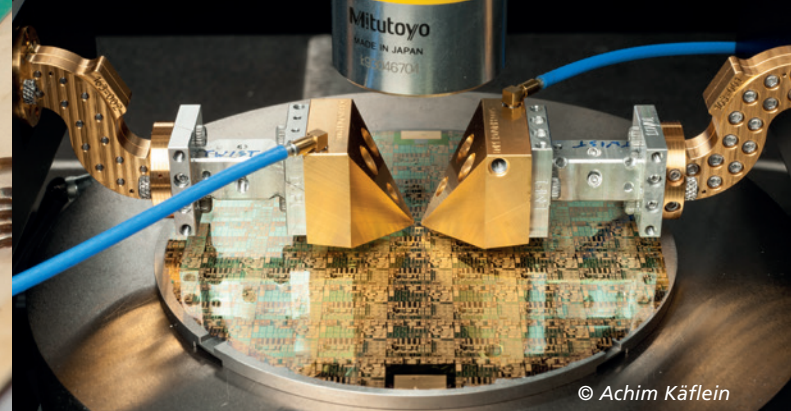
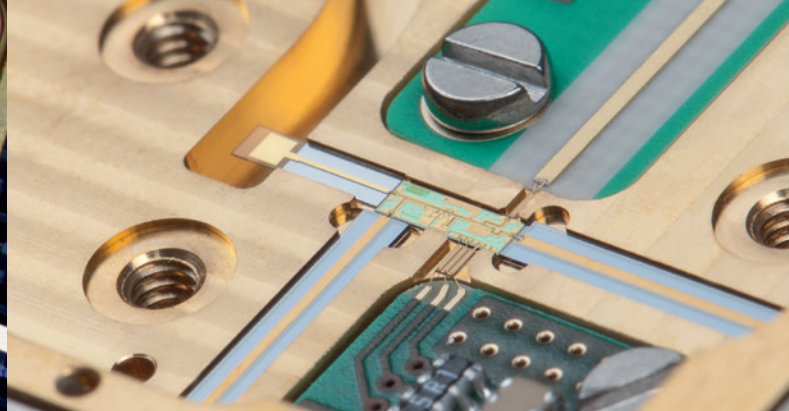
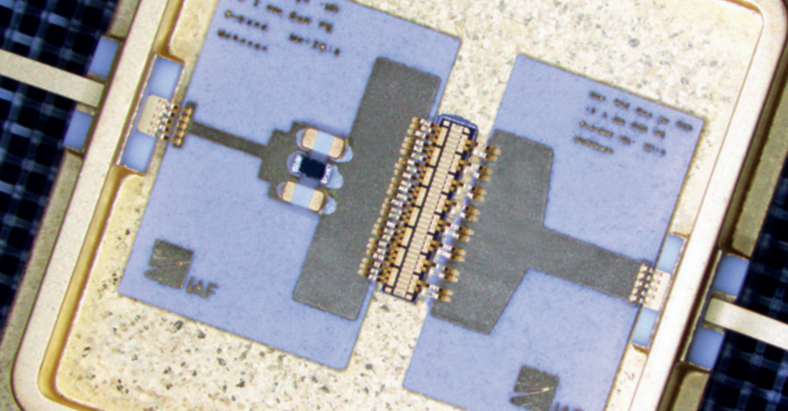


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## HIGH FREQUENCY ELECTRONICS





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### III-V compound semiconductor technology for high-speed applications

Fraunhofer IAF develops monolithically integrated microwave and millimeter-wave circuits (MMICs) and modules based on III-V compound semiconductors for sensors and communication technology featuring the complete MMIC technology chain, including simulation, characterization, design, small volume manufacturing and module packaging. Millimeter-wave radar systems enable precise geometrical resolution and also penetrate dust, fog, rain, snow and clothes. Communication systems with a large bandwidth result in a higher image resolution and higher data rates of wireless applications. MMICs for frequencies up to 670 GHz are developed using InAlAs/InGaAs metamorphic HEMT technology on 4" GaAs substrates. For power amplifier applications from 1 GHz to 200 GHz, AlGaIn/GaN HEMT IC technology enables highest-power operation to at least 150 GHz.

#### SERVICE OFFER

##### Manufacturing

- Epitaxy
- Characterizing
- MMIC processing
- Backside processing
- Device modeling
- MMIC design
- Packaging

##### Measurement setups

- S-parameter up to 1.1 THz
- Load-pull up to 1 kW/110 GHz
- Noise parameters up to 50 GHz
- Noise figure up to 750 GHz
- Power up to 500 GHz
- Intermodulation up to 50 GHz

### Integrated circuits and modules up to 670 GHz

Fraunhofer IAF is the European leader in the development of high frequency integrated circuits and modules. Amplifiers with ultra low noise figure, high gain and low power consumption can be provided. Metamorphic HEMT amplifiers set new records, one with 4.8 dB noise figure at 243 GHz and another featuring 670 GHz operating frequency. Furthermore, multi-functional MMICs are feasible, such as single-chip radars and transceiver circuits.

GaN HEMTs and ICs are used to manufacture power amplifiers, switches, and LNAs for frequencies between 1 GHz and 200 GHz, primarily used in radar systems, wireless applications, and data links. We develop in-package GaN microwave power transistors for radar and mobile communication with efficiency rates of more than 80% and typical output power levels of up to 1 kW for frequencies up to 3 GHz.

Our components are developed for applications in a variety of systems:

- Active and passive imaging systems
- Phased array radar
- Millimeter-wave sensors
- Wireless communication
- Space and earth observation
- Broadband and space communication

### High frequency measurement facilities

High frequency and power electronic circuits are characterized using the following measurement facilities:

- S-parameters up to 1100 GHz (on-wafer and in waveguides)
- Pulsed S-parameters up to 50 GHz
- Noise parameters up to 50 GHz
- Noise figure in 50 Ω system up to 210 GHz
- Noise figure in waveguides (hot / cold) up to 750 GHz
- Mixer characterization
- DC and RF measurements at cryogenic temperatures

We also perform power and large signal characterizations:

- Active load-pull up to 50 GHz both on-wafer and in fixture
- Pulsed power (50 Ω) up to 30 W and 40 GHz
- Active and passive load-pull (1 kW/4 GHz, 200 W/10 GHz, 5 W/50 GHz and 1 W/110 GHz)
- Power in 50 Ω systems up to 500 GHz (on-wafer, coax, waveguide)

Temperature accelerated lifetime tests are performed at DC and RF (48 slots available).

The measurement facilities are used to characterize a variety of MMICs and modules, e.g. amplifiers, mixers, frequency multipliers, oscillators, switches and phase shifters.