



**Fraunhofer**  
ENAS

FRAUNHOFER INSTITUTE FOR  
ELECTRONIC NANO SYSTEMS ENAS

# SHORT PROFILE





*Photo: Dirk Hanus*

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## PROFILE

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The Fraunhofer Institute for Electronic Nano Systems ENAS is your specialist and development partner in the field of Smart Systems and their integration for various applications. The challenge of combining micro and nano sensors as well as actuators, communication units and self-sufficient power supply to build Smart Systems is the main focus of Fraunhofer ENAS and hence, the base for the internet of things. Application areas of our R&D services are i.a. semiconductor industry (equipment and material manufacturer), aeronautics, automotive industry, communication technology, the security sector, logistics, agriculture, process technology and medical as well as mechanical engineering.

Fraunhofer ENAS develops single components, manufacturing technologies and system concepts, system integration technologies and actively supports the technology transfer for and with its customers.

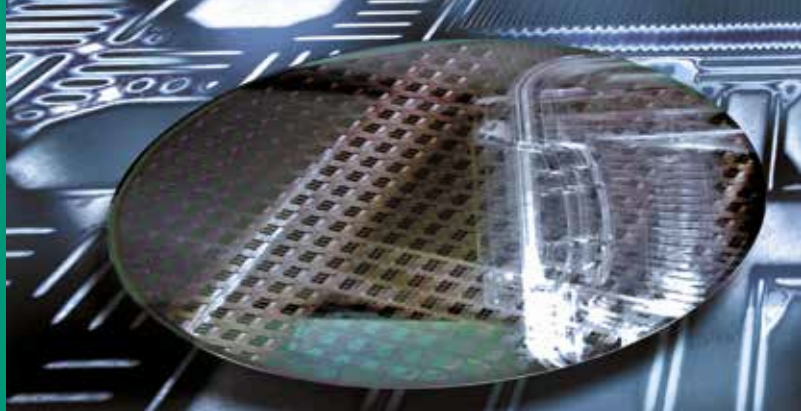
Whether you are a Start-up, SME or large enterprise, Fraunhofer ENAS offers you innovation consulting and supports customer projects, starting from the idea, via design and technology

development or realization based on established technologies up to tested prototypes. If standard components do not meet the requirements, Fraunhofer ENAS provides expert assistance in the realization of innovative and marketable products.

In order to focus its activities and to ensure a long-term scientific and economic success, Fraunhofer ENAS puts special emphasis on the five business units:

- Micro and Nanoelectronics
- Sensor and Actuator Systems
- Technologies and Systems for Smart Power and Mobility
- Technologies and Systems for Smart Health
- Technologies and Systems for Smart Production

The business units address different markets, different customers and different stages of the value chain depending on the required research and development services.



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## MICRO AND NANOELECTRONICS

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- Processes and technologies for micro and nanoelectronics with the focus on back-end of line and interconnects
  - » Development of individual processes (metal ALD, CVD, ULK processes, dry etching)
  - » Novel concepts for diffusion barriers
  - » Alternative interconnect architectures (air gaps, alternative ULK integration)
  - » Process and technology development for memristor crossbar arrays
- Modeling and simulation of technological processes, equipment and devices
  - » Simulation of processes and equipment (PVD, CVD, ALD, ECD)
  - » Device simulation and modeling of CMOS and nano devices (i.e. CNT FETs)
  - » Blackbox and event-driven modeling and simulation
- Beyond CMOS and RF devices, integrated circuits and technologies
  - » RF MEMS switches
  - » CNT FETs
  - » Memristive devices and circuits for neuromorphic computing and hardware security applications
- Packaging and (heterogeneous) integration (2D, 2.5D, 3D) for electronic devices
  - » Development of wafer level packaging (joining and contacting processes)
  - » Thin film encapsulation and screen printing for metallization and solder
- Electromagnetic and thermomechanic characterization and reliability evaluation
  - » Back-end of line components, chip-package interaction and reliability assessment of board and system level
  - » Thermomechanical reliability analysis
  - » Optimal layout for electronic components, devices and systems
  - » Simulative thermoelectrical reliability on a system (PCB) and package level



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## SENSOR AND ACTUATOR SYSTEMS

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- Inertial sensors
  - » High precision silicon-based sensors for measuring acceleration, vibration, inclination and angular rate
  - » Full value chain accessible (design, development of technologies, manufacturing of prototypes, characterization, test)
- Optical systems/MOEMS
  - » Silicon-based variable frequency optical filters and shutters
  - » Optical gratings
  - » Quantum dot-based LED and photo detectors
  - » Customer-specific spectral sensors
  - » Quantum dot-based material integrated light sources and display devices
- Electromagnetic sensors
  - » Multidimensional magnetic field sensors (TMR, GMR) for direct measurement of magnetic fields, distance, position and rotation
  - » Sensors for near field measurements of electromagnetic fields and determination of radiation characteristics
- Pressure and power transducer
  - » Silicon-based ultrasonic transducer
  - » Ambient pressure-sensitive resonators
  - » MEMS loudspeaker based on novel materials and technologies (i.e. sputtered metallic glass, printed magnetic layers)
- Material and structure sensors
  - » Silicon-based sensors for mechanical strain, stress and overload (detection of cracks)
  - » Nano composite-based overload and humidity sensors
  - » Sensors based on carbon nanotubes



Photo: pixabay

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## TECHNOLOGIES AND SYSTEMS FOR SMART POWER AND MOBILITY

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- Electric grid monitoring
  - » Monitoring of high- and medium-voltage lines including the transmission of data into the grid control center
  - » Increase of the ampacity of existing power lines
  - » Detection of ice load on the power lines
  - » Enhancement of safety and reliability of the electric grid infrastructure
  - » Detection and localization of ground faults
- Improvement of aerodynamic conditions of vehicles
  - » Optimization of the air flow around the vehicle for power saving by using synthetic jet actuators
- Analyzing suspected reliability issues of high power electronics
  - » Detection of cracks, delaminations and overheat situations
- Energy supply of mobile devices
  - » Wireless power supply (low and high power)
  - » Flexible, low-cost batteries

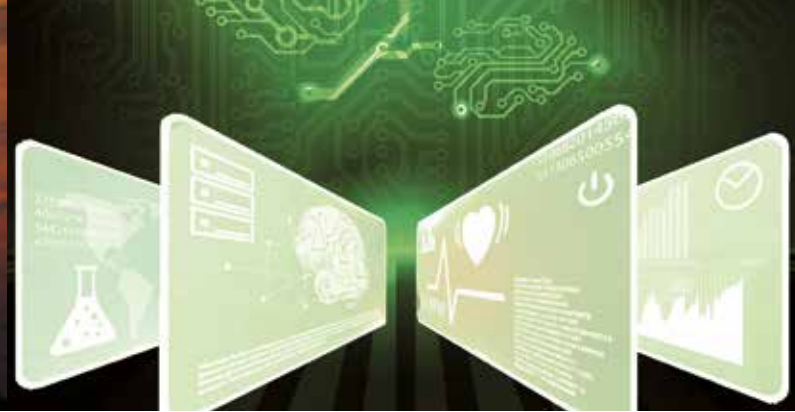


Photo: fotolia

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## TECHNOLOGIES AND SYSTEMS FOR SMART HEALTH

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- Medical implants
  - » Miniaturized sensor and actuator systems including system integration and biocompatible encapsulation for replacement, restoration and improvement of human senses and organs
- Medical devices
  - » Integrated sensors and actuators for the monitoring of patients
  - » Biocompatible materials for the interface between biological tissue and technical devices
  - » MRI-compatible materials
  - » Wireless data and energy transfer
- Measurement and analytical technologies
  - » Development of diagnostic test systems using micro microfluidic and/or spectroscopic components
  - » Miniaturization and automation of established analytical procedures into portable systems
  - » Novel systems and components based on micro and nano technologies



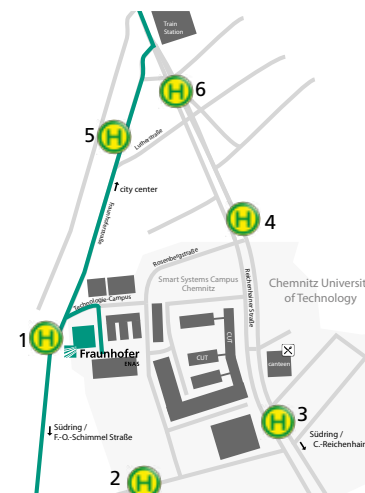
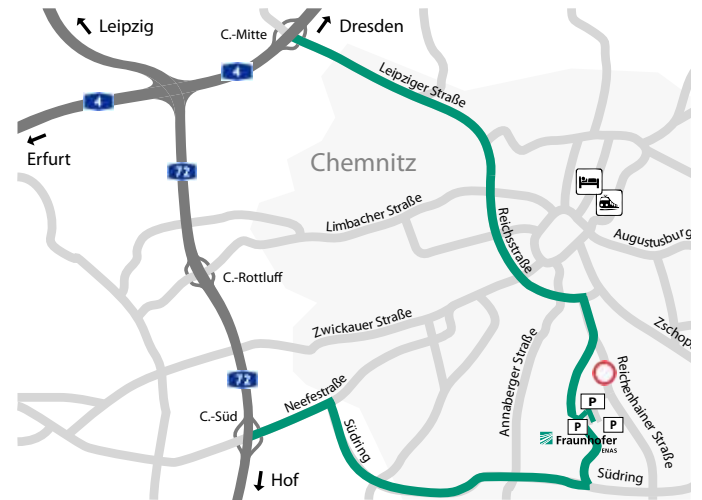


Photo: RF123 (Oliver Sved)

## HOW TO REACH US

### TECHNOLOGIES AND SYSTEMS FOR SMART PRODUCTION

- Smart digital production
  - » Providing technologies for flexibilization, individualization of products and sensor-based monitoring of production
  - » Resource-efficient mass production of intelligent and individualized products down to batch size 1 (inkjet and aerosol jet printing processes)
  
- Sensor systems for supporting production
  - » Sensor solutions for monitoring of machine conditions and processes during production
  - » Sensor systems for harsh environments
  - » Sensors for monitoring production resources (grease, oil, air)



Bus and tram stop:

- 1 »Fraunhoferstraße Süd«
- 2 »Am Technologie-Campus« and »Technopark«
- 3 »TU Campus«
- 4 »Rosenbergstraße«
- 5 »Fraunhoferstraße Nord«
- 6 »Stadlerplatz«

Directions:

[www.enas.fraunhofer.de/en/contact](http://www.enas.fraunhofer.de/en/contact)

## CONTACT

Director

Prof. Dr. Harald Kuhn

Phone: +49 371 45001-100

Email: [harald.kuhn@enas.fraunhofer.de](mailto:harald.kuhn@enas.fraunhofer.de)

Advisor to the institute management/  
manager marketing and public relations

Dr. Martina Vogel

Phone: +49 371 45001-203

Email: [martina.vogel@enas.fraunhofer.de](mailto:martina.vogel@enas.fraunhofer.de)

Fraunhofer Institute for Electronic Nano Systems ENAS

Technologie-Campus 3

09126 Chemnitz

Germany

Phone: +49 371 45001-0

Fax: +49 371 45001-101

Email: [info@enas.fraunhofer.de](mailto:info@enas.fraunhofer.de)

Web: [www.enas.fraunhofer.de](http://www.enas.fraunhofer.de)

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