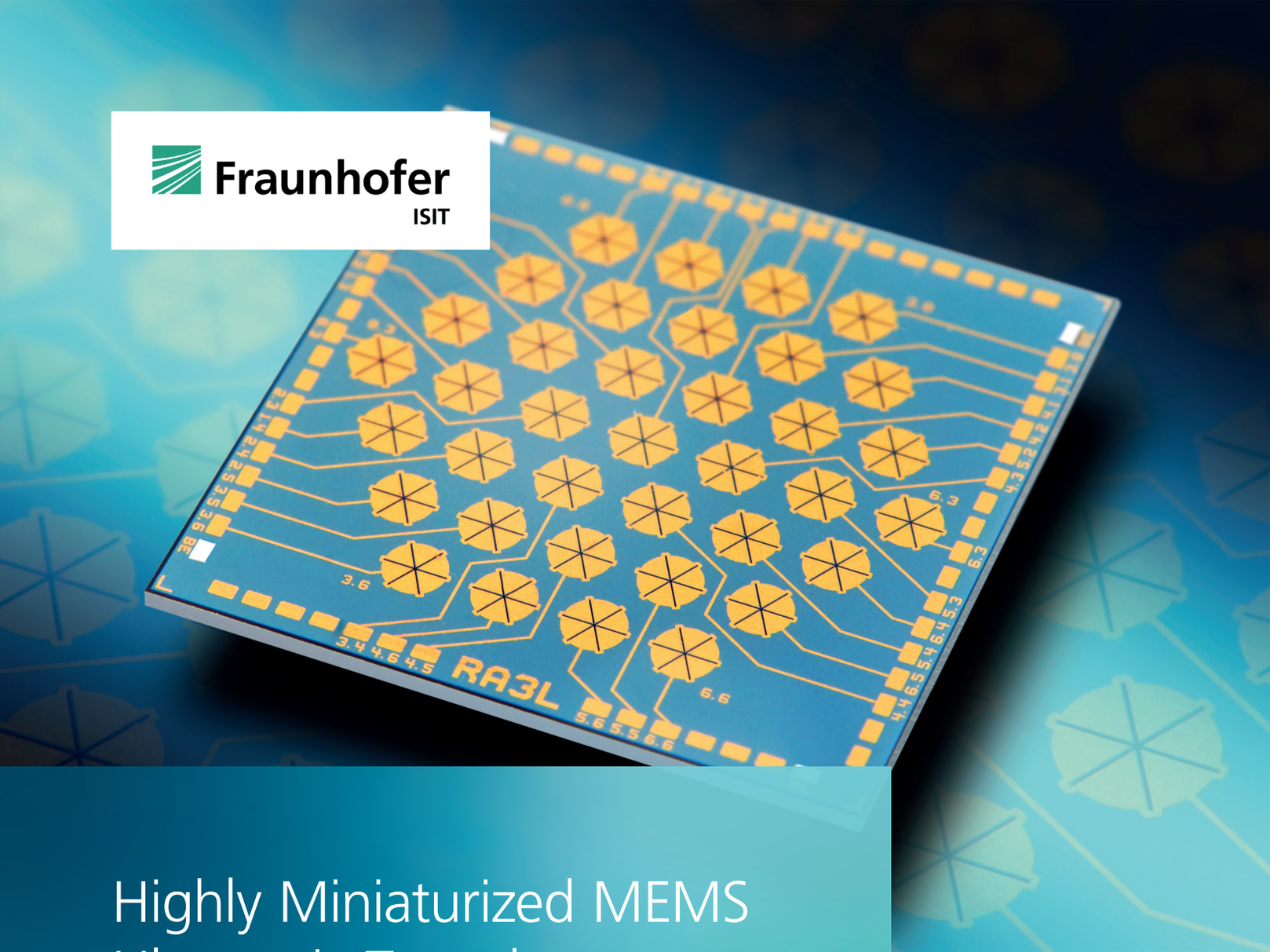
Fraunhofer ISIT



Highly Miniaturized MEMS Ultrasonic Transducers

MEMS chip with ultrasonic transducer array

Motivation

New innovative ultrasound applications and the constant trend toward miniaturization result in great demand for small high-performance ultrasonic transducers.

Based on microelectromechanical systems (MEMS) technology, the Fraunhofer ISIT develops highly miniaturized piezoelectric micromachined ultrasonic transducers (PMUTs), suitable for a large variety of technical applications, such as distance measurements, gesture recognition, or medical imaging. The concept is based on piezoelectrically actuated cantilevers or membranes, which are manufactured using semiconductor technologies, enabling high miniaturization as well as cost-efficient production in high volumes.

Our MEMS ultrasonic transducers are characterized by extraordinarily small footprints, high area-normalized sound pressure levels (SPLs), and low driving voltages. By varying the transducer design and combining multiple transducers on a chip, the operating frequencies, SPLs, and radiation characteristics are highly customizable.

Ongoing research focuses on further miniaturization, design upgrades, and the integration of new materials, such as aluminum scandium nitride, to further improve the performance of our ultrasonic transducers and allow for a fully CMOS-compatible process.

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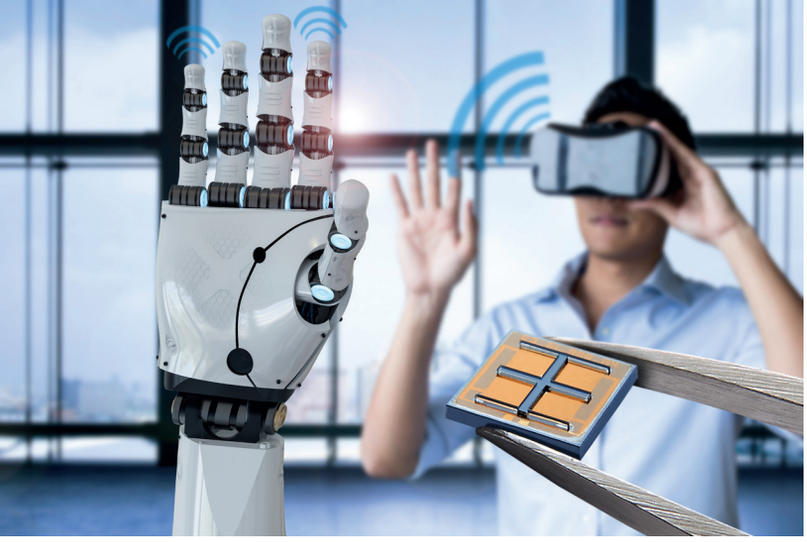
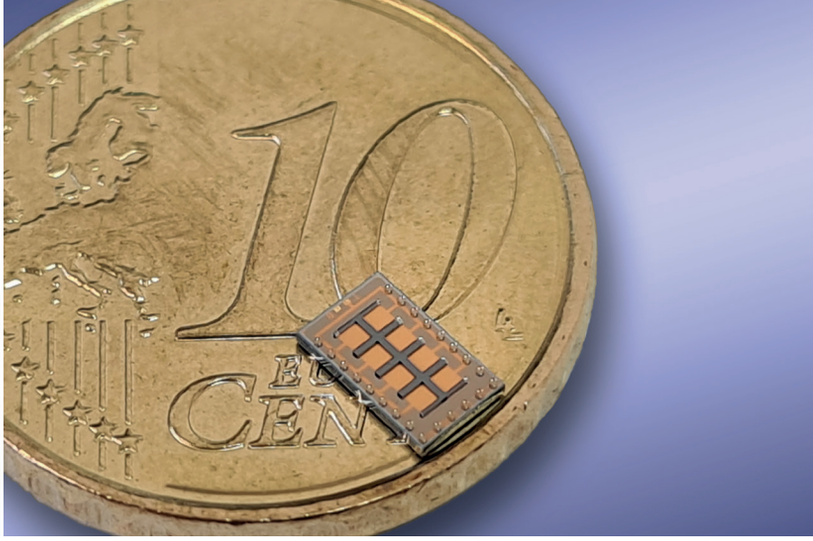


Ultrasonic transducer for human machine interfaces (application example)



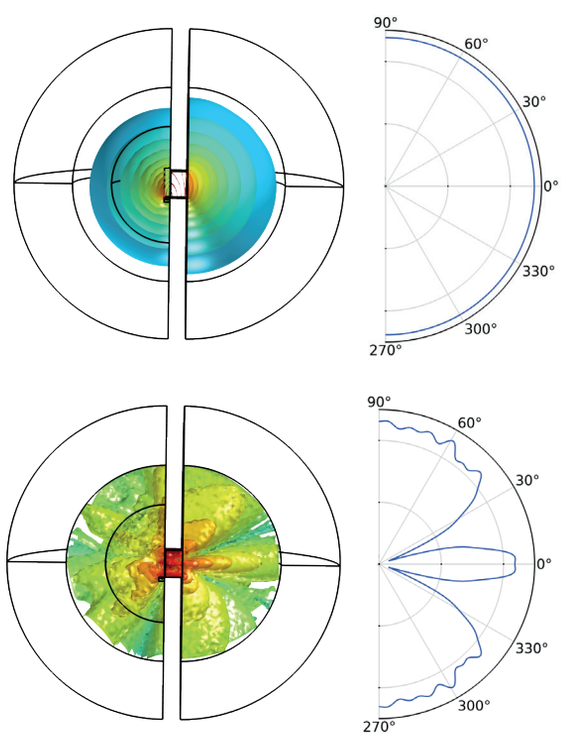
MEMS ultrasonic transducer array on a coin

Technology

Our MEMS ultrasonic transducers are based on piezoelectric unimorph actuators. Utilizing the inverse piezoelectric effect, an alternating electric field causes the device to vibrate and create ultrasonic waves. For frequencies below 100 kHz, rectangular bending actuators are used, which are surrounded by a narrow gap and an acoustic shield. Making use of thermo-viscous effects, the cantilevers acoustically behave like a closed membrane while being mechanically decoupled at the same time. For higher frequencies up to several MHz, a closed design is used, mimicking a classical, circumferentially clamped membrane.

Our service

- Patent-protected technologies
- Comprehensive development of MEMS ultrasonic transducers: concept, design, manufacturing and characterization
- Pilot fabrication of MEMS ultrasonic transducers
- Expertise for innovative applications
- Partnership for future developments in the field of MEMS acoustics



Simulation of transducer radiation pattern (examples)

Technical data

Our MEMS ultrasonic transducers offer

- High miniaturization and small footprints
- High SPL per device area and high scalability
- Low driving voltages
- High adaptability to customer requirements, e.g., regarding frequency range, bandwidth, and radiation characteristics
- Low cost in mass production due to semiconductor technology
- A broad portfolio of piezoelectric thin-film materials: AlN, PZT, AlScN

Applications

Our MEMS ultrasonic transducers are suitable for a wide range of technical or medical applications, such as

- Distance or fluid level measurements
- Object or gesture recognition
- Haptic feedback
- Medical imaging
- Material testing