Chip-size-packaged silicon microphones [for hearing instruments]
The first results of silicon microphones that are completely batch-packaged and integrated with signal conditioning circuitry in a chip stack are discussed. The chip stack is designed to be directly mounted into a system, such as a hearing instrument, without further single-chip handling or wire bonding. The devices are fully encapsulated and provided with a well-determined interface to the environment. The integrated microphones operate at a bias of 1.5 V and are expected to reach a sensitivity of 5 mV/Pa, an A-weighted equivalent input noise of 24 dB sound pressure level, and a power consumption of about 50 μW in the near future, thereby living up to the tight specifications of microphones for hearing instruments. Other potential applications include mobile phones, headsets, and wearable computers, in which space is constrained.

Solid state silicon based condenser microphone for hearing aid, has transducer chip and IC chip between intermediate chip and openings on both sides of intermediate chip, to allow sound towards diaphragm
NOVELTY - A silicon transducer chip (1) has parallel backplate and movable diaphragm (12) and forms an electrical capacitor. The chip and electronic circuit chip (3) are provided on either sides of intermediate chip (2). The chip (2) has openings (4, 10) between two sides of the chip, to allow sound towards diaphragm. Surface of the chip (2) has electrical conductors (14) to connect chip with IC chip (3). USE - For use in miniature electroacoustic devices such as hearing aid. ADVANTAGE - Since sound inlet is covered by filter, dust, moisture and other impurities do not obstruct interior and sound inlet of microphone. External electrical connection can be made economically reliable and the thermal stress is avoided with the small size solid state silicon based condenser microphone.

Silicon microphones - a Danish perspective
Two application areas of microphones are discussed, those for precision measurement and those for hearing instruments. Silicon microphones are under investigation for both areas, and Danish industry plays a key role in both. The opportunities
of silicon, as well as the challenges and expectations, are discussed. For precision measurement the challenge for silicon is large, while for hearing instruments silicon seems to be very promising.

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**Fabrication and characterization of truly 3-D diffuser/nozzle microstructures in silicon**
We present microfabrication and characterization of truly three-dimensional (3-D) diffuser/nozzle structures in silicon. Chemical vapor deposition (CVD), reactive ion etching (RIE), and laser-assisted etching are used to etch flow chambers and diffuser/nozzle elements. The flow behavior of the fabricated elements and the dependence of diffuser/nozzle efficiency on structure geometry has been investigated. The large freedom of 3-D micromachining combined with rapid prototyping allows one to characterize and optimize diffuser/nozzle structures.

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**Oxidation of hydrogen-passivated silicon surfaces by scanning near-field optical lithography using uncoated and aluminum-coated fiber probes**
Optically induced oxidation of hydrogen-passivated silicon surfaces using a scanning near-field optical microscope was achieved with both uncoated and aluminum-coated fiber probes. Line scans on amorphous silicon using uncoated fiber probes display a three-peak profile after etching in potassium hydroxide. Numerical simulations of the electromagnetic field around the probe-sample interaction region are used to explain the experimental observations. With an aluminum-coated fiber probe, lines of 35 nm in width were transferred into the amorphous silicon layer. (C) 1997 American Institute of Physics.
Fabrication and characterization of truly three-dimensional diffuser/nozzle microstructures in silicon

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Fast three-dimensional laser micromachining of silicon for microsystems

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Laser direct etching of silicon on oxide for rapid prototyping

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Laser direct writing of oxide structures on hydrogen-passivated silicon surfaces

A focused laser beam has been used to induce oxidation of hydrogen-passivated silicon. The scanning laser beam removes the hydrogen passivation locally from the silicon surface, which immediately oxidizes in air. The process has been studied as a function of power density and excitation wavelength on amorphous and crystalline silicon surfaces in order to determine the depassivation mechanism. The minimum linewidth achieved is about 450 nm using writing speeds of up to 100 mm/s. The process is fully compatible with local oxidation of silicon by scanning probe lithography. Wafer-scale patterns can be generated by laser direct oxidation and complemented with nanometer resolution by scanning probe techniques. The combined micro- and nanoscale pattern can be transferred to the silicon in a single etching step by either wet or dry etching techniques. (C) 1996 American Institute of Physics.

Nanoscale structures by laser direct writing in silicon

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Nanoscale structures by laser direct writing in silicon
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On the flow behavior of diffuser/nozzle elements microfabricated in silicon

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Optical near-field lithography on hydrogen-passivated silicon surfaces

We report on a novel lithography technique for patterning of hydrogen-passivated amorphous silicon surfaces. A reflection mode scanning near-field optical microscope with uncoated fiber probes has been used to locally oxidize a thin amorphous silicon layer. Lines of 110 nm in width, induced by the optical near field, were observed after etching in potassium hydroxide. The uncoated fibers can also induce oxidation without light exposure, in a manner similar to an atomic force microscope, and linewidths of 50 nm have been achieved this way. (C) 1996 American Institute of Physics.

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Silicon nanostructures produced by laser direct etching

A laser direct-write process has been applied to structure silicon on a nanometer scale. In this process, a silicon substrate, placed in a chlorine ambience, is locally heated above its melting point by a continuous-wave laser and translated by high-resolution direct-current motor stages. Only the molten silicon reacts spontaneously with the molecular chlorine, resulting in trenches with the width of the laser-generated melt. Trenches have been etched with a width of less than 70 nm. To explain the functional dependence of the melt size on absorbed power, the calculations based on a two-phase steady state heat model are presented, taking the temperature-dependent thermal conductivities and optical parameters into account. ©1995 American Institute of Physics.

Sub-band-gap laser micromachining of lithium niobate

Laser processing of insulators and semiconductors is usually realized using photon energies exceeding the band-gap energy. This makes laser processing of insulators difficult since high photon energies typically require either a pulsed laser or a frequency-doubled continuous-wave laser. A new method is reported which enables us to do laser processing of lithium niobate using sub-band-gap photons. Using high scan speeds, moderate power densities, and sub-band-gap photon energies results in volume removal rates in excess of 10^6 µm^3/s. This enables fast micromachining of small piezoelectric structures, or simple etching of grooves for precision positioning of optical fibers. ©1995 American Institute of Physics.