Key Technologies towards New MEMS Application Fields

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After identifying silicon as a promising mechanical material, the first MEMS came up in the form of pressure and acceleration sensors. The automotive field was an early adaptor, requiring new sensors of high performance and reliability, and offering high production volumes at attractive price levels. The early technology focus was on microstructuring technologies: The invention of the “Bosch-DRIE” plasma etching technique opened a wide field of new and highly complex structures, in contrast to the simple geometries which were feasible under the tight limitations of wet-etching using alkaline solutions. High-performance accelerometers and gyroscopes entered the market, driven mainly by automotive requirements for new passenger safety systems in cars. Examples are front and side airbag, electronic stability program for anti-skidding, and overroll protection systems. Meanwhile annual inertial sensor production volumes have reached several 100’s of millions of pieces.

Today, growth in automotive sensors is slowing down. Silicon-based MEMS have reached high maturity levels, with only little technical advances added over the past few years. Sensor sizes and costs have come down significantly, making them attractive for consumer applications as well. Examples are cellular phones, PDAs, laptops, digital cameras and game consoles. The consumer area emerges as a new driver for MEMS, offering extreme volumes and growth, however at a strong price-pressure. New applications like timing devices, micromirrors, acoustic devices like microphones, and magnetic sensors for compass and navigation are coming up the line.

Beyond consumer applications, miniaturization combined with increasing performance and reliability opens opportunities in the medical field: intelligent implantable devices profit from small size, high functinonality/volume ratio and low power consumption of MEMS. MEMS is adding enhanced functions into existing and widely used implantables like the pacemaker, but is also enabling new solutions for improved quality of life and management of chronic diseases. Chips for analysis of a variety of blood-parameters at the patient’s home are examples.

Technologies of disruptive potential to the diagnostic field are lab-on-chip solutions for nucleic-acid based diagnosis. These devices take the progress in biotechnology research into practical applications by automation of complex workflows within strongly miniaturized devices. Use cases are e.g. time-critical diseases like infections where time-to-result is important. Lab-on-chip solutions are no longer silicon-based, except silicon chips serving for read-out and data-treatment. Plastic microstructuring, mounting and assembly combined with integration of bio-content and the biochemical workflows are key challenges.

An outlook on the future directions into which MEMS is proceeding will be given.