Final Report Summary - XMEMS (Towards Cost-Efficient Flexible Heterogeneous Integration for Micro- and Nanosystem Fabrication)

In this project we aimed for a new micro- and nanosystem-specific integration and manufacturing paradigm, in which the technologies and tools are adapted to the production volumes and device variations of micro- and nanosystem solutions. We therefore addressed frontier research on flexible and cost-efficient heterogeneous integration schemes for combining best-of-class materials, components and manufacturing methods into economically viable micro- and nanosystem solutions. We focused, on one hand, on the use of unconventional technologies and tools for integrating innovative materials with MEMS and on the other hand we developed novel wafer-level heterogeneous integration technologies that provided the material and design freedom required in MEMS and NEMS solutions. The research activities were implemented within the following research areas that are relevant to a large variety of micro- and nanosystem components:

- **Heterogeneous Material Integration**, where we incorporated high-performance materials into MEMS using unconventional and innovative technologies and tools, including serial integration, wafer-level integration and free-form fabrication of MEMS; Key achievements included the use of high-speed wire bonding tools for implementing very high aspect ratio and hermetic through silicon vias (TSVs), as well stud bumps for sealing liquid and vacuum cavities.

- **Heterogeneous System Integration**, where we developed new wafer level schemes to combine, process and interconnect components fabricated with different technologies such as MEMS, NEMS, ICs or photonics, made of materials in the solid state. Key achievements included a new heterogeneous integration platform for integrating nano-electromechanical (NEMS) devices with integrated circuits, a new fabrication approach for realizing tunneling junctions with sub 2 nm electrode gaps, first micromachined millimeter-wave waveguide switch with excellent on/off ratio and the development of a new integration method of microchips into millimeter-wave waveguide systems.

- **Lab-on-Chip Integration**, in which transducers, mass transport solutions, surface biochemistry and liquids were combined at the wafer level into high-performance systems. Key achievements included the demonstration of a new microfluidic packaging method for photonic biosensor arrays, compatible with surface biofunctionalization and wafer level processing, a process for batch-integration of liquids for MEMS and Lab-on-Chip applications.

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Subjects

Construction Technology - Industrial Manufacture - Materials Technology - Physical sciences and engineering