Solutions for MEMS
**Introduction**

Today, micro-electro-mechanical systems (MEMS) devices are present in almost every technology of daily life. Smartphones are a prominent example of consumer devices that incorporate multiple MEMS devices, such as accelerometers and gyroscopes for motion sensing and MEMS-based filters for wireless communication. MEMS are also a key technology for the automotive industry, ranging from pressure sensors in engine management or tire pressure monitoring systems to accelerometers in airbag release systems. In particular, MEMS devices for automotive and industrial applications must meet the highest standards of performance and reliability, which also place the highest demands on manufacturing technologies.

EVG has a long history as a leading supplier of wafer processing equipment for the MEMS market. Today, excellent process know-how, continuous innovation and a broad product portfolio in the areas of lithography and wafer bonding ensure that MEMS customers are supported in developing leading-edge solutions for their next-generation devices.

**Optical Lithography**

Most MEMS devices consist of 3D structures with high topography and small fragile moving parts. Manufacturing processes therefore require thick resist processing, conformal coating over topographies combined with excellent exposure and alignment capabilities. In addition to standard UV lithography, nanoimprint lithography (NIL) even offers nanostructuring for emerging MEMS applications. Furthermore, maskless exposure (MLE™) technology enables dynamic patterning of photoresist, including the possibility of individual die annotation - an important feature for critical automotive and industrial MEMS applications.
MEMS Devices

- Gyroscopes
- Environmental Sensors
- Ultrasonic Sensors
- Microphones
- RF MEMS
- Inkjet Printheads
- Magnetometers
- Inertial Measurement Units
- Optical MEMS

EMERGING MARKETS
- Gas Sensors
- Accelerometers
- Pressure Sensors

BIO MEMS
- Environmental Sensors
- Ultrasonic Sensors
- Microphones

AUTOMOTIVE / INDUSTRIAL
- Gyroscopes
- Ultrasonic Sensors
- Microphones

Process Results

Lithography

- MEMS Structures patterned in 20 µm thick resist
  Source: EVG

- MLE™ exposure in 50 µm thick layer JSR THB 15/N negative tone resist
  Source: EVG

- High-Q-3D solenoid inductors for RF ICs. Metal structures created using spray coating
  Courtesy of SIMIT

- 20 µm thick black resist spin-coated double layer on 8" substrate exposed on EVG®6200 NT
  Source: EVG

Bonding

- Glass-frit bond interface
  Courtesy of ST Microelectronics

- Cross section of a CuSn bonding layer
  Courtesy of Siemens

- SEM image of a MEMS device bonded to an ASIC using Al-Ge eutectic bonding system
  Courtesy of Chipworks

- Oxide-free silicon-silicon interface
  Source: EVG
Wafer Bonding

Many MEMS devices need to be protected from the external environment or operate only under controlled atmosphere or vacuum. Today’s high levels of integration with CMOS chips also require advanced wafer-level packaging solutions for MEMS devices. In addition, many MEMS are based on technical substrates such as SOI wafers. Therefore, wafer-level bonding processes play a crucial role in the manufacture of MEMS device.

Metal bonding for hermetic sealing and vacuum encapsulation (Solder, Eutectic, Transient Liquid Phase (TLP), Metal Diffusion)
- Defined pressure encapsulation
- Good mechanical strength
- High post-bond alignment accuracy
- Versatile interface properties

Anodic bonding for reliable silicon-glass interfaces
- Highly stable and strong bond
- Optical transparency
- Triple-stack bonding (Si-glass-Si)
- High post-bond temperature tolerance

Adhesive bonding for simplified integration
- Temporary bonding / debonding
- Room-temperature bonding with UV-curing adhesives
- Ultra-thin adhesive layer transfer bonding
- Compatible with a wide range of substrate materials

Fusion bonding for engineered substrates
- MEMS-SOI substrates
- Hybrid bonding
- Collective die transfer
- Heterogeneous integration for advanced semiconductor packages

Topography tolerance with glass-frit bonding
- Intermediate glass layer
- Wide process window
- Planar electrical feedthroughs
- Production proven for decades

High-end packaging with ComBond® technology
- High-vacuum handling and processing (<7E⁻⁸ mbar)
- Vacuum encapsulation without getters
- Low-temperature Al-Al bonding
- Wafer surface activation

Process Services and Competence Center

With state-of-the-art application labs and cleanrooms at its headquarters in Austria, as well as in the U.S. and Japan, EVG is focused on delivering superior process expertise to our global R&D and production customer and partner base. Services range from equipment demonstrations and feasibility studies to small-to-medium-scale pilot-line production to shorten time to market. EVG has also established the Heterogeneous Integration Competence Center™, which is designed to assist customers in leveraging EVG’s process solutions and expertise to enable new and enhanced products and applications driven by advances in system integration and packaging.
MEMS Devices

Product Range Excerpt

Lithography

EVG®610
Mask Alignment System
up to 200 mm

EVG®610 Automated Resist Processing System
up to 300 mm

EVG®7200 Automated SmartNIL® UV-NIL System
up to 200 mm

HERCULES®
Lithography Track System
up to 300 mm

Bonding

EVG®501 / EVG®510
Wafer Bonding System
up to 200 mm

GEMINI® Automated Production Wafer Bonding System
up to 300 mm

ComBond® Automated High-Vacuum Wafer Bonding System
up to 200 mm

EVG®850 TB Automated Temporary Bonding System
up to 300 mm