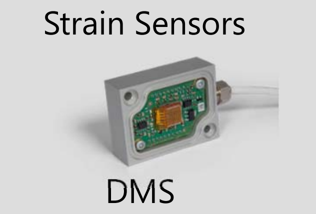
DIGITALIZATION | AUTOMATION | ELECTRIFICATION

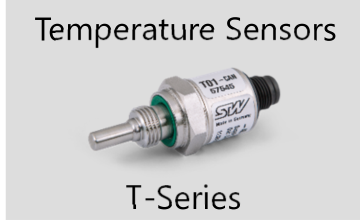
Making mobile machines perform

Sensors & Measurement Systems

Measurement Systems

Products





Technologies

Thinfilm Technology

References

AGCO

LIEBHERR

MAGIRUS

Sensors for **mobile machines and automotive applications**

M-Series **pressure**

- range up to 2000 bar
- operable from -40 to +150°C
- analog or with CAN-bus
- SENT (SAE J2716) *)
- welded, stainless steel pressure cell
- E1 approval
- high media compatibility incl. H_2

*) availability planned for Q2/2019

T-Series **temperature**

- range from -40 to +150°C
- CAN (J1939 & CANopen)

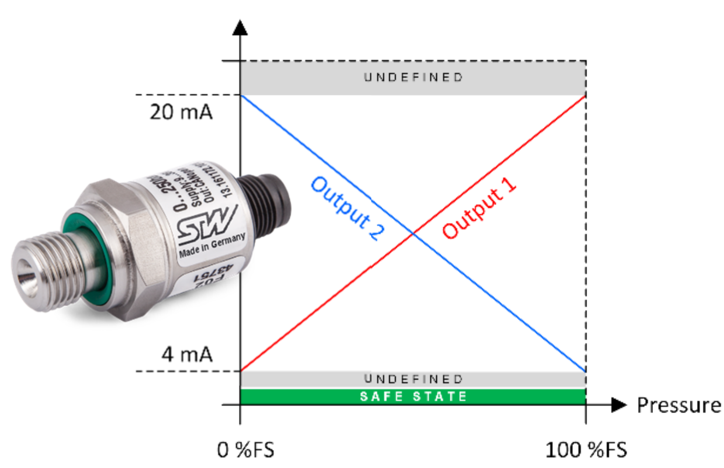
automotive **customized**

- development according to customer requirements
- qualified production processes
- custom specific bus systems
- also for applications requiring PLx, SILx and ASILx

Pressure Sensors & Switches for **safety-related applications**

F-Series **pressure switch**

- PLd (EN ISO 13849-1)
- ranges up to 1000 bar
- operable from -40 to +85°C
- two switching outputs or one switching output and one current output
- welded, stainless steel pressure cell



F-Series **pressure sensor**

- PLd (EN ISO 13849-1) | SIL 2 (IEC 61508)
- ranges up to 1200 bar
- operable from -40 to +85°C
- two analog outputs (contrary)
- welded, stainless steel pressure cell
- made-to-order

Pressure Cells (in-house product, mainly used)

Type **OEM**

- measuring range from 25 to 3000 bar
- temperature ranges from -40 to +200°C
- compensated zero
- hysteresis <0.1% FS
- integrated temperature meander
- stainless steel precision part
- suitable for wire-bonding or soldering
- long term stability <0.2% FS p.a. (ref. cond.)

Type **OPTI**

- measuring range from 25 to 2000 bar
- temperature ranges from -40 to +200°C
- hysteresis <0.2% FS
- integrated temperature meander
- stainless steel precision part
- suitable for wire-bonding
- one size up to 1.200bar
- long term stability <0.2% FS p.a. (ref. cond.)

Measurement systems for **mobile machines and automotive applications**

NGS **inclination & gyro**

- angular velocity and acceleration / inclination
- CAN interface
- custom variants available

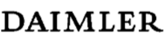
DMS **strain gauge**

- scalable range
- easy mounting
- analog electrical signal or CAN-interface
- fast exchange when service needed

FELIX **position**

- measures a linear displacement of up to 20 mm
- particularly robust
- highly resistant to contamination at the measuring point
- high linearity

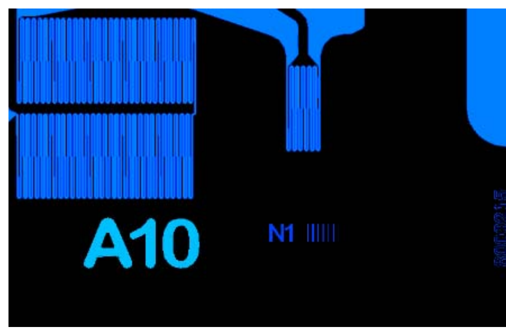
Our **Customers**

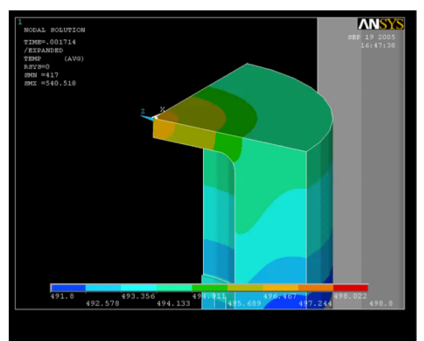


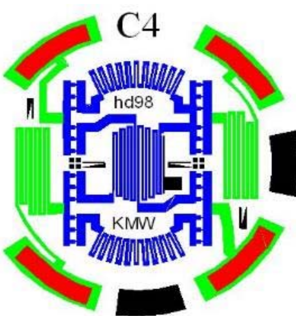
SIEMENS

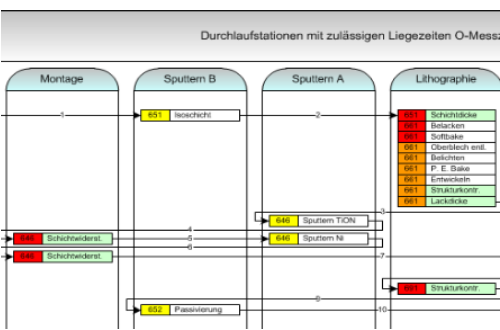
Thin Film Technology | **competence overview**

- **Design, development & production of custom Thin Film Sensors**
  - Material selection (substrate & thin film materials)
  - Application-oriented electrical and mechanical dimensioning
  - FEM-analysis
  - Multilayer mask design
  - Individual process design
  - Production in the KMW Class ISO 5 clean room





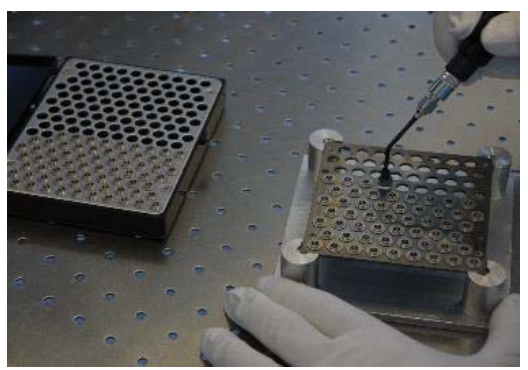




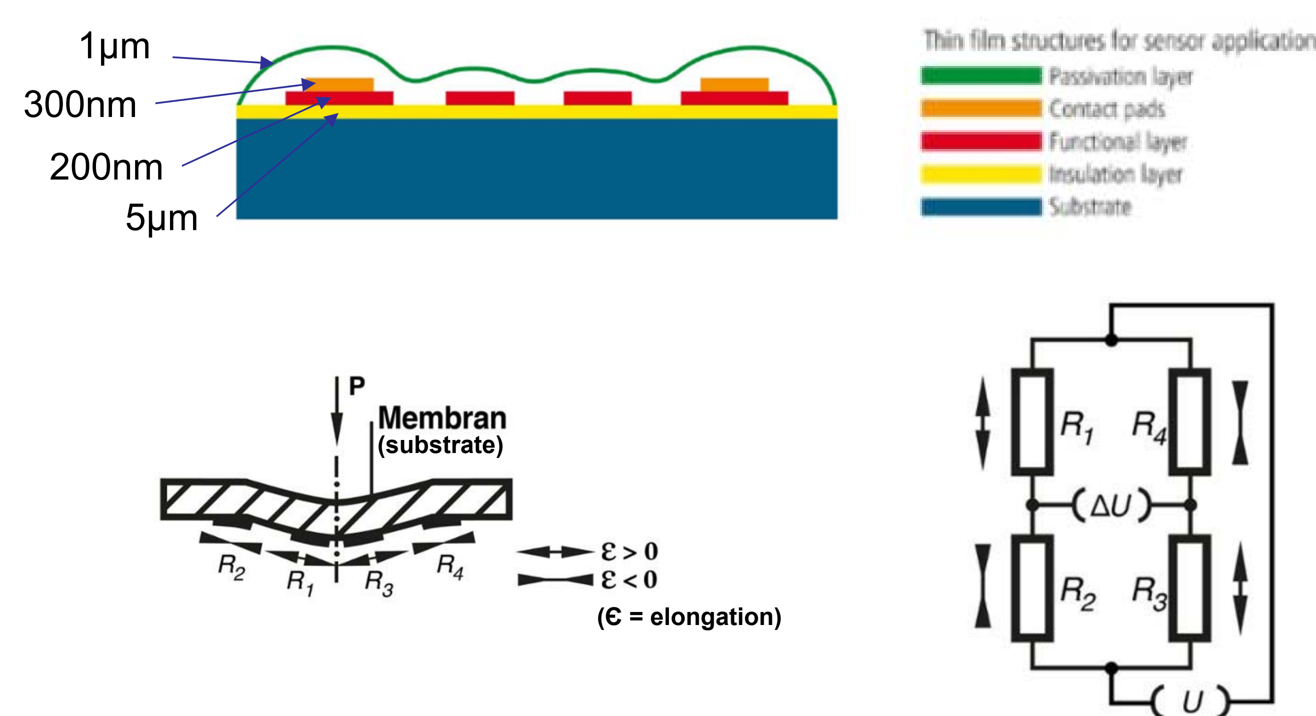
Thin Film Technology | **processes & equipment**

- Preparation – **Polishing**
  - Membrane thicknesses with an accuracy down to ±23 µm
  - Substrate heights within 30µm, allowing large numbers of single pieces in one thin film production cycle (KMW standard: 105 pcs./cycle)

- **Batch Assembly**
  - Objective: Efficient usage of the available space in our Sputtering/PECVD devices
  - Small pieces are assembled in production batches
  - Larger pieces can be coated seperately or with an individual batch design



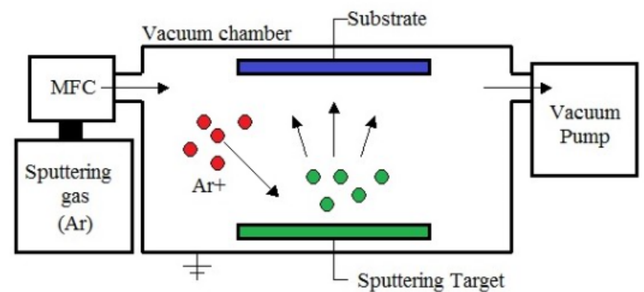
- **Package on a pressure capsule**

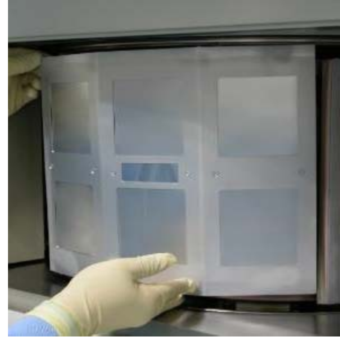


- **Isolation/Passivation Layer**
  - PECVD - process
  - Insulation materials: SiO_2,Si_3N_4, SiON
  - Polyimide for multilayer designs
  - Thickness: 0.6 up to 5 µm
  - Highly resistant (100 GΩ or higher)

Thin Film Technology | **processes & equipment**

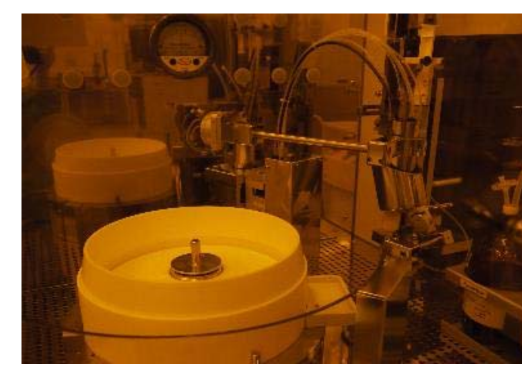
- **Functional Layers & Contact Pads (DC- and Pulsed DC-Sputtering)**
  - Multilayer-designs with vias
  - Sputter-Targets: NiCrAl, Cu, Cr, Ni, Ti, Gases: Ar, N_2, O_2
  - Functional materials (thickness: up to 1 µm)
    - Ni → high TCR, solderable
    - TiON (reactive process) or NiCrAl → high GF
    - Cu and others as interlayer or conductor if GF & TCR is not needed



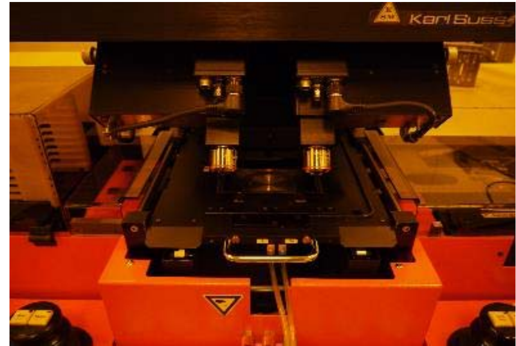


Thin Film Technology | **processes & equipment**

- **Lithography**
  - Spin- and spray-coater
    - Photoresist is applied to the substrate
    - Thickness 3..6 µm
    - Positive and negative photoresist

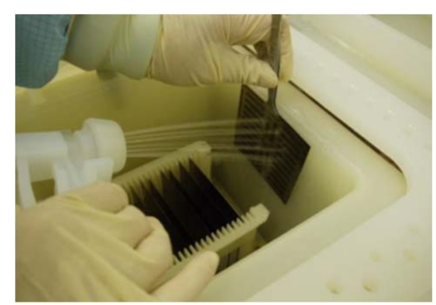


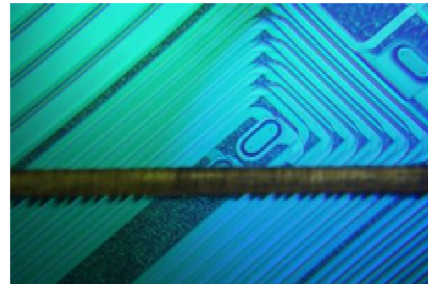
  - Exposure device / mask-aligner
    - Photomasks are aligned with the substrates
    - Structure is mapped on the photoresist
    - Hg-Lamps with 350 nm to 450 nm wavelengths



Thin Film Technology | **processes & equipment**

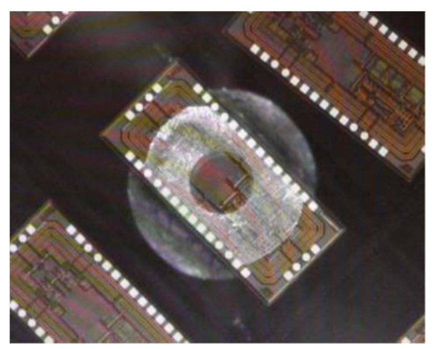
- **Structuring**
  - Wet-chemistry
    - Substrate cleaning with US-processes and QDR-sink
    - Developing of exposed photoresist with KOH
    - Metal etching with $FeCl_3$, H_2SO_4, $K_3Fe(CN)_6$
    - Lift-Off process with KOH
  - Structure scale down to 12 µm, structure distance down to 8 µm

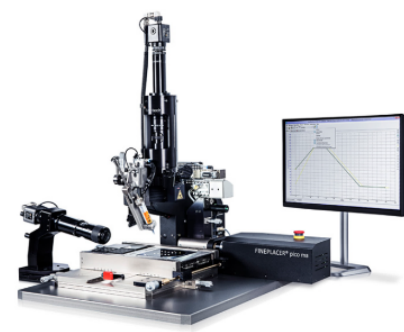


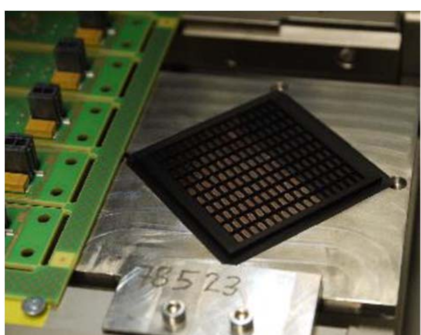


Sensor packaging | **chip bonding**

- **Chip bonding**
  - Die-bonder for chip-mounting
  - Adjustable bond force (0 N up to 30 N)
  - 5 µm placement accuracy
  - Electrical and/or thermal conductive chip connections
  - Chip molding

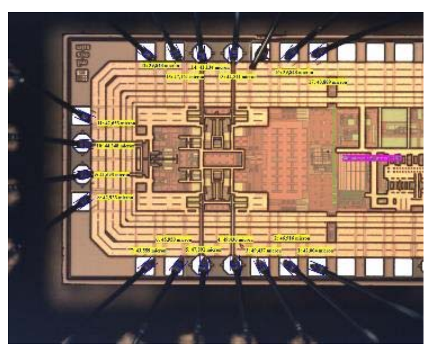


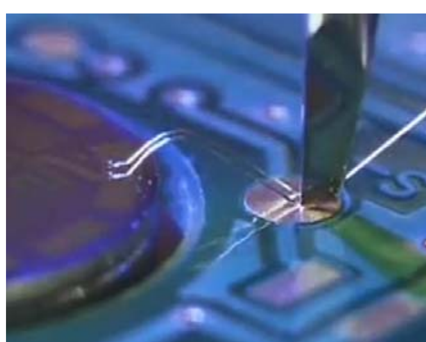


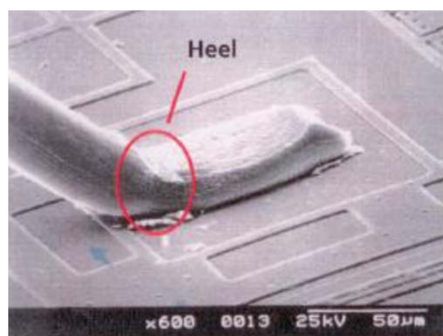


Sensor packaging | **wire bonding**

- **Wire bonding**
  - 2 fully automatic wire bonding machines
  - 2 tabletop semi-automatic wire bonding machines
  - Wedge-wedge bonding
  - Deep-access bond-head for narrow geometries
  - 25 µm / 50 µm AlSi 1% wires





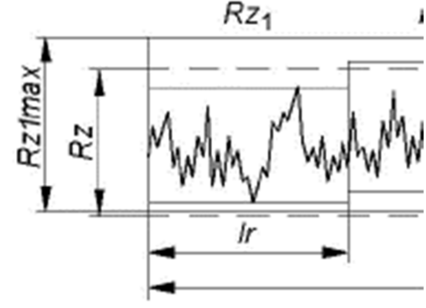


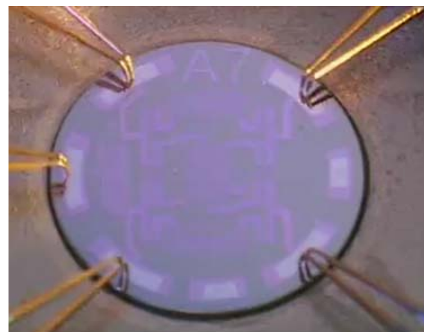
Sensor packaging | **backend packaging**

- **Laser welding**
  - NdYag pulse-laser with 7,5kW
  - Used for capsule welding and housing
  - Overlapped welding dots for hermetic connections
- **Resistance Welding**
  - Inverter with up to 36kA
  - Integrated process control for best results

Quality | **monitoring & test**

- Detailed process monitoring for thin film process steps, e.g.
  - Surface profiler and interferometer for membranes, layer thickness and roughness measurements
  - Surface resistivity measurements
  - Layer tension and adhesion tests
- Electronics: AOI, ICT, X-ray
- 100% electrical test on several production levels
- In-house EMC chamber for pre-certification measurements



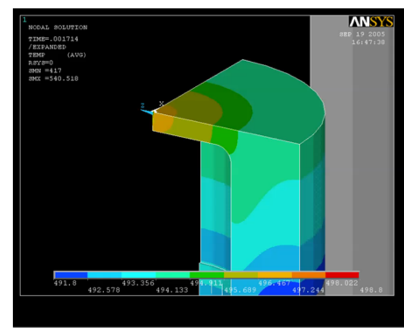


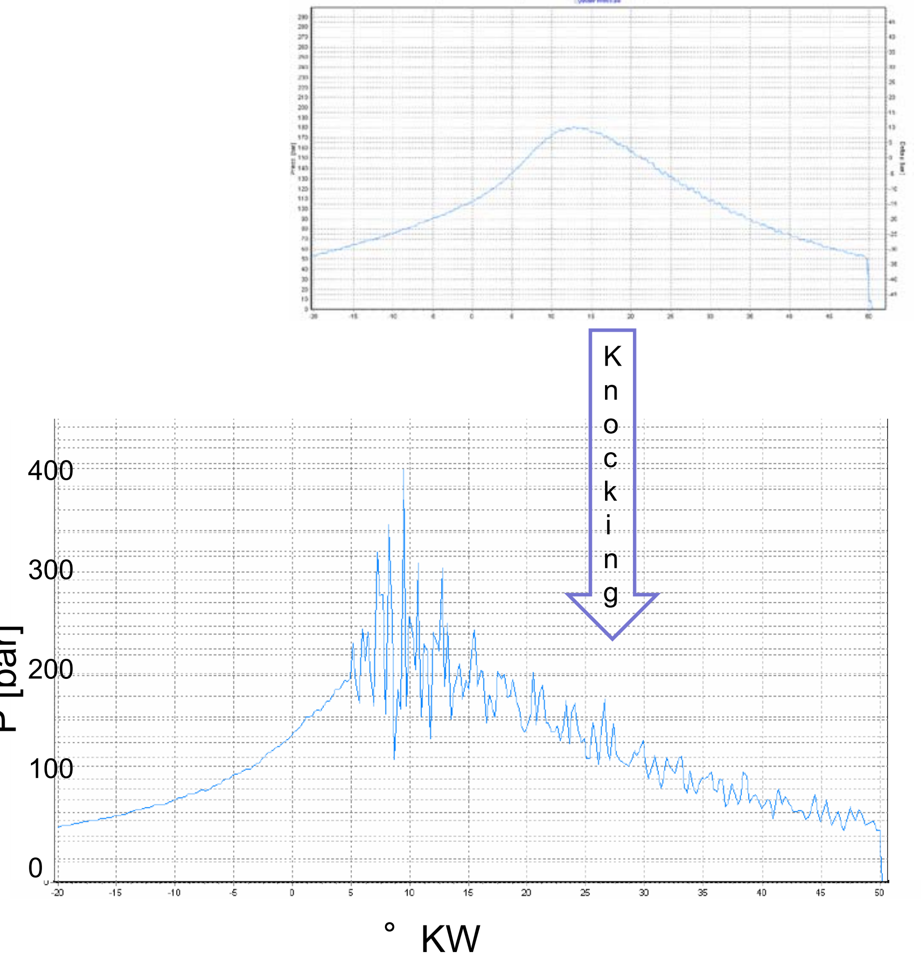
Products | **In-cylinder pressure sensors**

- Wiedemann-sensors have been used for 20 years in gas and diesel engines
- High-temperature and permanent load-resistant by using
  - own thin-film technology
  - High-strength nickel-alloy for the measuring elements
- Deviation of the span < 0,5 % after 20,000 operation hours (test in 2012)
- Vibration tests up to 50g acceleration
- Reducing of the thermo shock by patent-registered flame protection
- Standard pressure connection: M14x1.25, M10x1
- Diameter down to 8 mm possible
- Data acquisition and conditioning with a resolution up to 0.1° KW

Products | **In-cylinder pressure sensors**

- Permanent temperature > 250° C
- Peak temperature > 350° C
- High fatigue strength
- Vibration resistant
- Low measurement deviation (Thermal shock)
- Low drift in span
- Fast data acquisition
- Fast supply of control variable
- Inside existing design space





Products | **measuring elements**

- OEM Pressure capsules for hardest environments
  - Stainless steel with applied thin film structures
  - Integrated temperature meander
  - Pressure range from 10 to 3000 bar
  - Temperature range from -40 to +200 degree C

- Inductive path sensors
  - Stainless steel substrate
  - 5 metal layers
  - Microvias
  - 8 meters overall conductor length on a 30x5 mm substrate

Products | **RnD & prototypes**