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Heterogeneous Technology Alliance

The SOI MEMS Platform: HTA one-stop-shop for microsystems processing

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Added value of HTA MEMS Platform to customers

Faster — because optimized use of existing process modules

Lower cost — because utilizing existing equipment base

Less risky — because wide base of expertise and solutions

More innovative solutions — because access to wider technology portfolio

AND effective **industrialization and production capability**

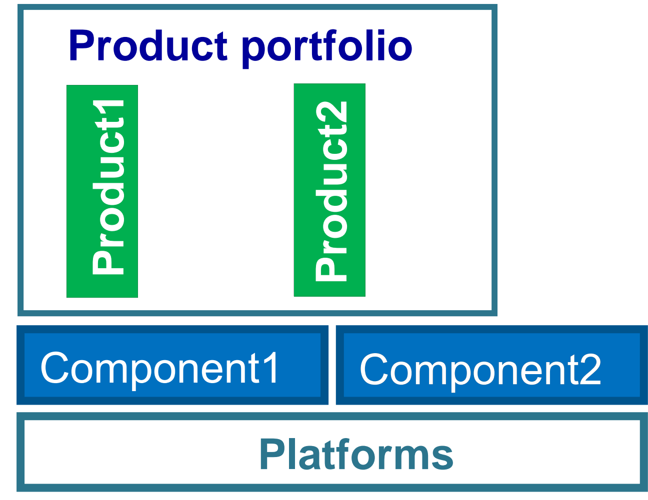
One-stop shop

Attractive offering of HTA MEMS Platform One-stop shop

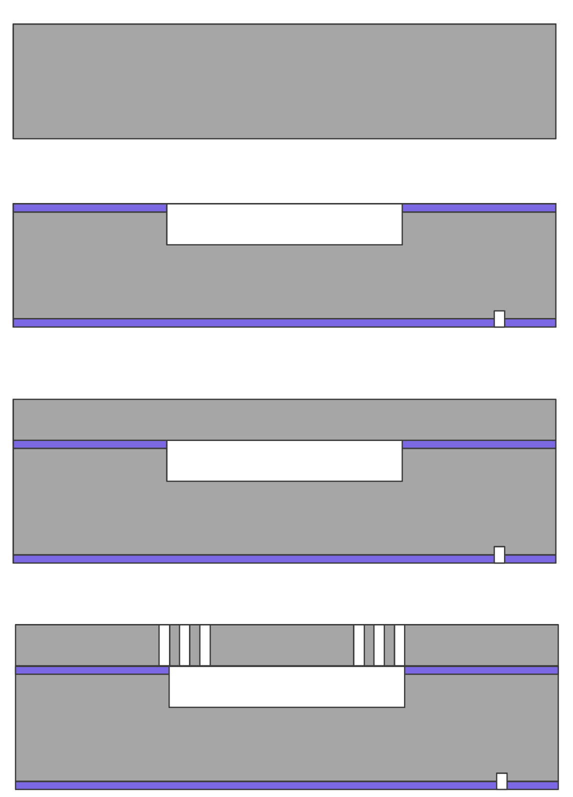
1. Very extensive R&D resources, **900 researchers**
2. Can provide **prototyping and process development**
3. **Industrialization** — bridging the gap between prototyping and production
4. Large set of **process modules**
5. Large set of **SOI MEMS devices** in offering
6. Large set of **processing equipment with back-up/second source options**

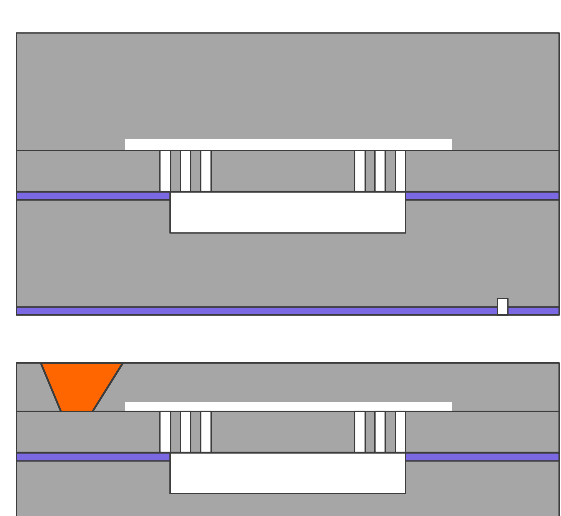
Platform purpose and definition

- **Platform purpose**
  - To **create flexibility in designing and manufacturing** new components
  - **Customer needs can be better met** through joining our arsenal of capabilities
  - Open up our arsenal to all HTA partners
- **Definition**
  - Platform composes **of process equipment, steps, modules and needed personnel** of HTA partners
  - Platform **forms a basis for research** and product development
  - Platform **enables flexible processing** capability and prototyping



Example of SOI MEMS fabrication cycle





HTA SOI MEMS Platform

Market
- Special needs
- Small scale products (SME)

Market
- Mass products
- Consumer products

External foundry

HTA production services

Prod.

HTA SOI MEMS PLAT FORM

Resulting technology

R&D

Tech1 | Tech3 | Tech5 | Tech7

TRL files

CSEM Neuchâtel (100 and 150 mm)

CEA LETI Grenoble (200 mm)

VTT Espoo (150 mm)

Fraunhofer (100, 150 and 200 mm)

Customer needs

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HTA Complete Offer

Integrated solutions

MEMS Platform	• Design • IC • RF • MEMS • 3D • System • System building • Testing & reliability	Other Processing • CMOS • Roll-to-roll • Laser machining • Polymer electronics	Packaging & 3D-Integration • Wafer-level • Chip-level • LTCC • Flexible substrates • Polymers

- HTA complete offer covers all key competencies to create solutions for our customers
- Key mission of HTA is to enable flexible integration and combination of different micro- and nanotechnologies
- SOI MEMS Platform managers offer a communication channel between the partners

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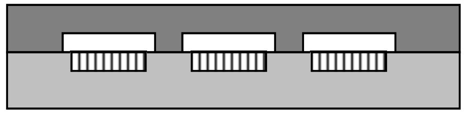
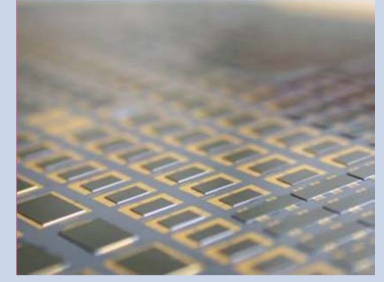
MEMS Packaging

Wafer Level Packaging



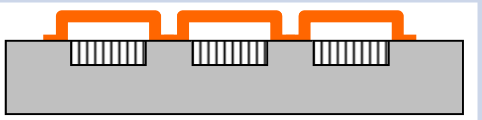
Accelerometer with hermetic cap (Anodic bonding)

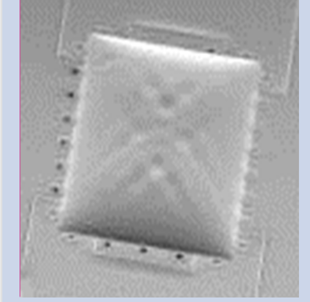


RF Mems with 50 µm silicon cap (polymer bonding)

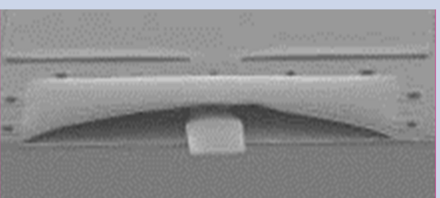
- Polymer Bonding
- Silicon direct bonding
- Anodic Bonding
- AuSi eutectic bonding
- AuSn eutectic bonding

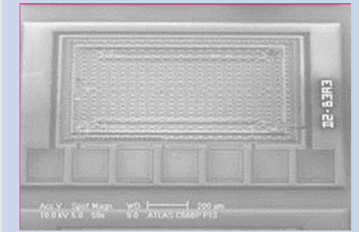
Thin Film Packaging



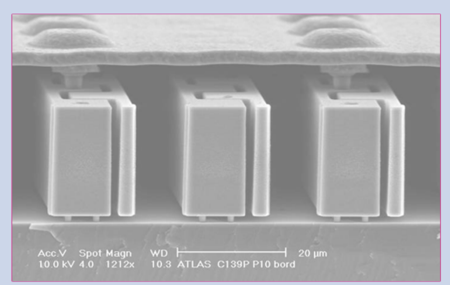


RF Mems with thin film protection (polymer sacrificial layer)





Accelerometer with hermetic TFP (oxide sacrificial layer)



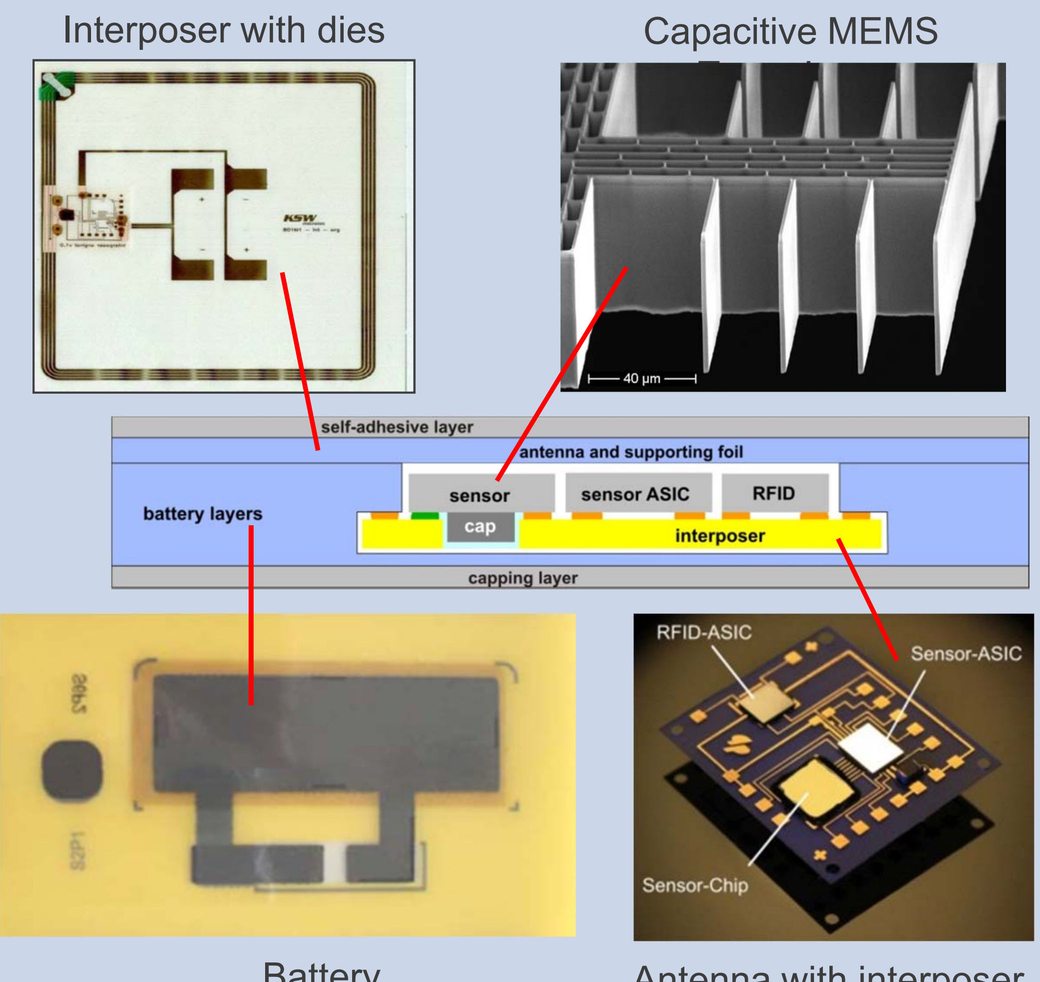
Packaging and Assembly - label for transport monitoring

The label components:

- RF-chip with antenna
- battery for energy supply
- sensor system consisting of the micromechanical transducer and the signal processing electronic

The system has to detect and record inclination and mechanical shock

Transport label



Battery

Antenna with interposer

MEMS processing

200 mm

150 mm

Packaging

Wafer-level, 100~200 mm

Plastic

CMOS processing

Itzehoe

Duisburg

Dresden

Chemnitz

Erlangen

Munich

Grenoble

Helsinki

300 mm

200 mm

150 mm

Processing on specific substrates

Organics

Compound semicond.

LTCC

Process steps and equipment list

Name of institute:
Responsible person:
Contact:
Special feature:

- Example page of process step and equipment list to facilitate quick and efficient response
- Access available through each partner

Applicable materials in MEMS fabrication facility	Chip-Level	100 mm Wafer-Level	150 mm Wafer-Level
Silicon	x	x	x
Glass	x	x	x
Ceramics (i.e. PZT, LTCC,...)	x	x	
Lithium Niobate / Lithium Tantalate	x	x	
others	Saphire, SiC, Ge	2" wafer Saphire, SiC, Ge	

Availability for different substrates and nar

Front-End-of-Line	Chip-Level		100 mm Wafer-Level		150 mm Wafer-Level	
	©/x/n	name of equipment	©/x/n	name of equipment	©/x/n	name of equipment
RCA clean 1 & 2	x	beaker	x	Arias	x	Arias
Piranha clean	x	beaker	x	beaker	x	beaker
DI-H_2O flushing	x	beaker	x	Arias	x	Arias
Thermal Oxidation	o					
dry			x	CentroTherm	x	CentroTherm
wet			x	CentroTherm	x	CentroTherm
RTA			x	Heatpulse 610	x	Heatpulse 610
<u>C</u>hemical <u>V</u>apour <u>D</u>eposition - CVD						
SiO_2 - low pressure			x	LPT	x	LPT
SiO_2 - plasma enhanced			x	P5000 / Oxford	x	P5000 / Oxford
Si_3N_4			x	LPT	x	LPT
Si_3N_4 - plasma enhanced			x	P5000 / Oxford	x	P5000 / Oxford
poly-Si			x	LPT	x	LPT
SiON - plasma enhanced						
TEOS - plamsa enhanced						
alpha-Si - plasma enhanced						

MEMS Device examples from the Platform

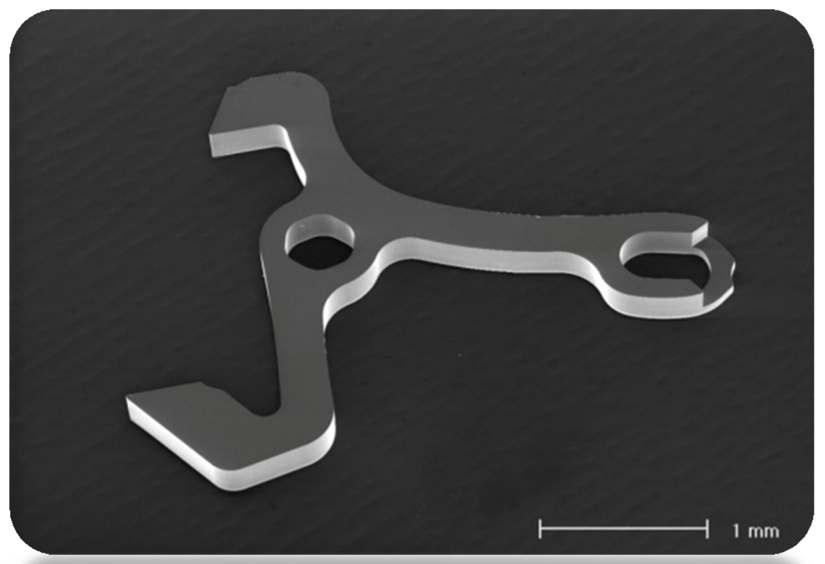
Si active

Si basic

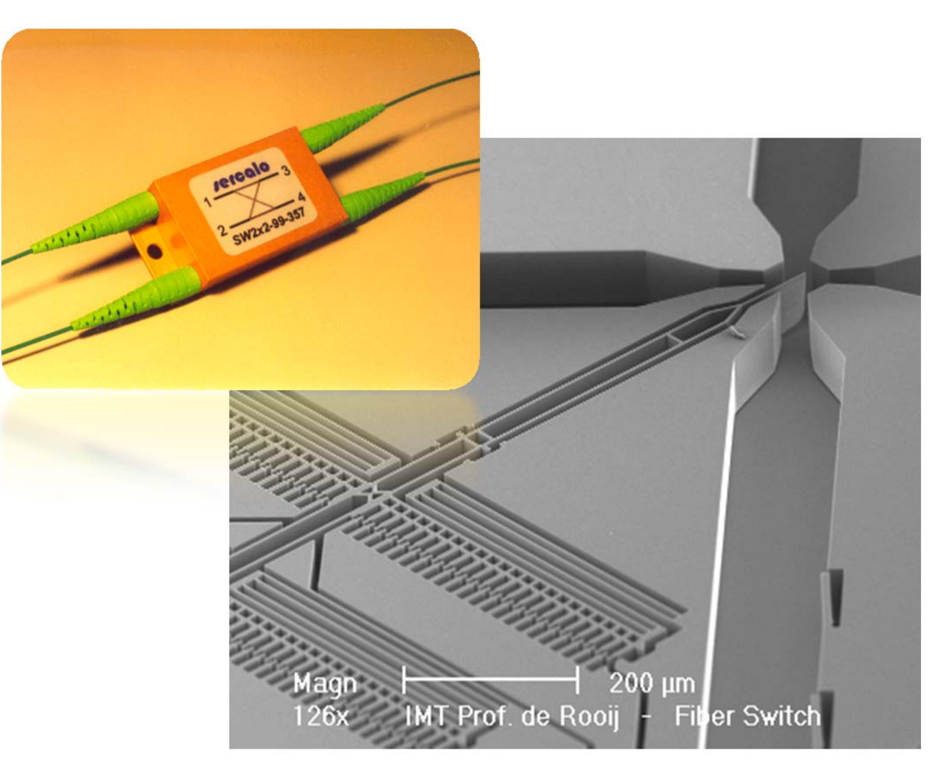
Step-by-step switch-gear
(FhG ENAS Chemnitz)

SOI processing of 2D MEMS
scanner (FhG IPMS Dresden)

MEMS Device examples from the Platform



- Precision micromechanical parts
- Production for several watchmakers

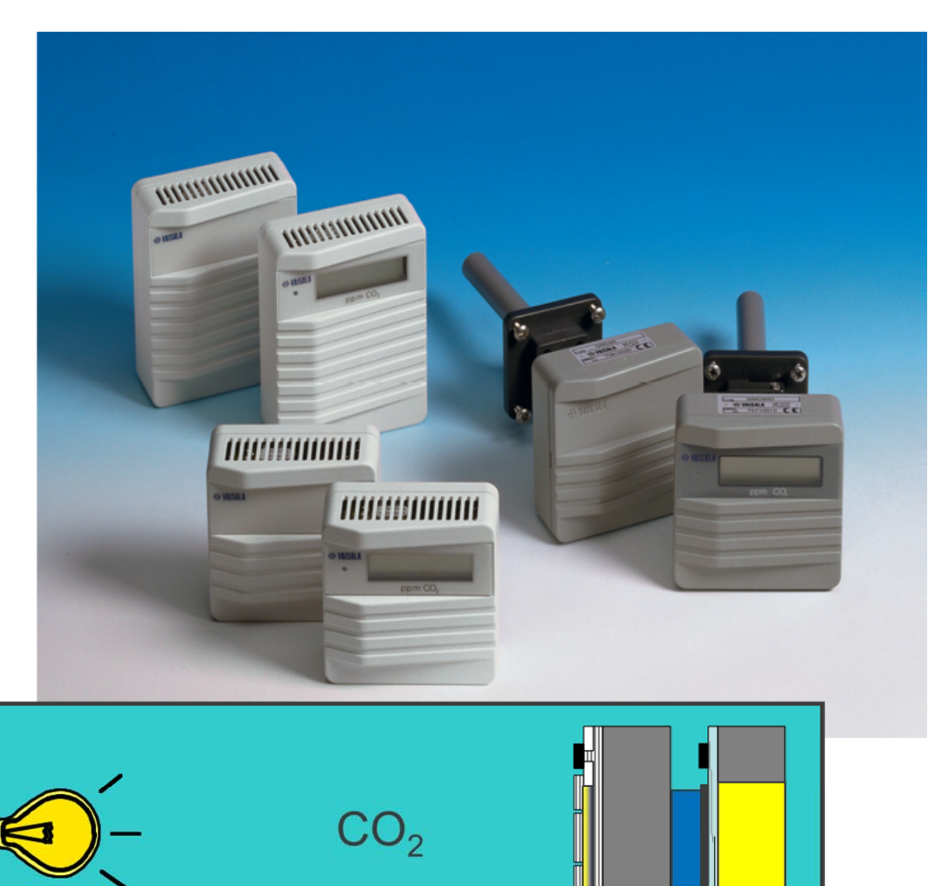


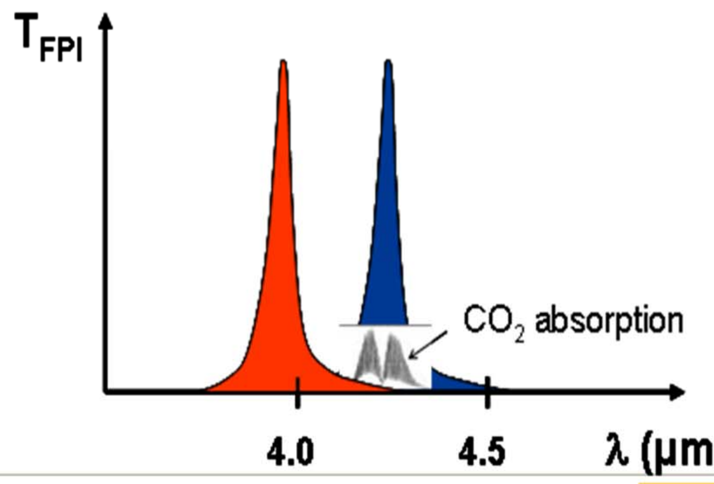
- Micromirror
- Commercialized by Sercalo

MEMS Device examples from the Platform

Example: CO_2 sensor of Vaisala's CABOCAP

- CARBOCAP® sensor for carbon dioxide measurement
- MEMS-chips have been manufactured at VTT's facilities since 1997





MEMS Device examples from the Platform

Fuel quality sensor technology

- MEMS is heart of the sensor, including e.g.:
  - Fabry-Perot interferometer
  - Thermopile detector
- The outcome of the VTT's subproject is a mini spectrometer for near infrared wavelength region
  - Optical resolution 5…10 nm
  - Tuning range: 25% of the selected center wavelength

EUREKA/Euripides project IQFUEL, Industrial and research partners:
Continental, PSA Peugeot-Citroen, VTI Technoogies, Selmic, Aboard Engineering Ensiatec, CEA LETI, IFP

MEMS Device examples from the Platform

Multi gas sensor based on NEMS resonators

- GC column provides selectivity by separating in time and space the gas mixture components
- NEMS detectors sequentially detect the elution peaks at the GC output

Injection

Gas mixture

GC Separation

Capillary column

PDMS as stationary phase

Detection

NEMS detector chip

Functionalized and packaged

Capillary

5 mm

3 mm

Glass cap with microfluidic channel

Gas chromatogram

Toluene (29ng)

Octane (23ng)

Ethylbenzene (29ng)

Xylene (29ng)

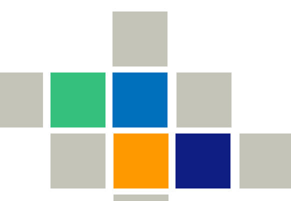
Resonance frequency shift (Hz, neg)

Time (s)

Both GC column and NEMS detectors can be miniaturized and fabricated with VLSI silicon micro- and nanofabrication techniques.

kni CALTECH

cea leti



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Summary

- MEMS platform focused on SOI wafer technology was presented
- This service oriented and open one-stop shop for SOI MEMS processing, prototyping and small scale production has been established by the HTA Alliance.
- Platform composes of process equipment, steps, modules and needed personnel to run the facilities. Platform forms a basis for research and product development
- Benefits of the platform are:
  - Faster – because optimized use of existing process modules
  - Lower cost – because utilizing existing equipment base
  - Less risky – because wide base of expertise and solutions
  - More innovative solutions – because access to wider technology portfolio
  - Effective industrialization and production capability