

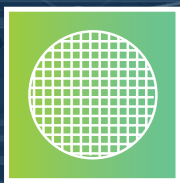
# Cleanroom and Process Solutions



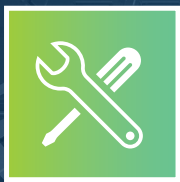
13 Fraunhofer and  
Leibniz Institutes



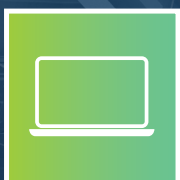
2.000 Scientists  
3.500 Employees in total



13 Cleanrooms  
11.000 m<sup>2</sup> Space



2.000 Tools and  
Instruments



1 Common Manufacturing  
Execution System (MES)

## Processing Capabilities within FMD

Frontend	Wafer Diameter			Process Types and Materials*
	<200 mm	200 mm	300 mm	
Deposition				
ALD (thermal, PE Batch)	x	x	x	Al <sub>2</sub> O <sub>3</sub> , HfO <sub>2</sub> , ZrO <sub>2</sub> , AlN, SiO <sub>2</sub> , SiN, Ta <sub>2</sub> O <sub>5</sub> , In <sub>2</sub> O <sub>3</sub> , ZnO, LaOx, TiN, TaN, Cu, Co, Ni, Ru, MoS <sub>2</sub> , WS <sub>2</sub> , BN, MoN
CVD (LP-, PE-, SA-)		x	x	SiO <sub>2</sub> , SiN, SiON, BPSG, Poly Si/a-Si (doped/undoped), Ge, SiGe, SiC, W, Co, TiN, graphene
PVD	x	x	x	Al, Ti/TiN, Co, Ta/TaN, Cu(Mn), AlSiTi, AlSiCu, Ta <sub>2</sub> O <sub>5</sub> , Al <sub>2</sub> O <sub>3</sub> , AlN, AlScN, PZT, MgO, TiAl
Evaporation	x	x		Al, SiO <sub>x</sub> , TiO <sub>x</sub>
Epitaxy (RP-, MOVPE, MBE)	x	x		Si, SiGe (doped/undoped), SiC, GaN/AlGaIn, group III-arsenides (e.g. InGaAs), group III-phosphides (e.g. InP), Ga <sub>2</sub> O <sub>3</sub> , AlN
Patterning-Etch	x	x	x	Si (Deep Si), poly, metals, oxides, nitrides, GaN, SiC, high k, hardmask (TiN)
Furnace				
Batch Deposition	x	x	x	poly Si, a-Si (undoped/doped), Ge, SiGe, SiO <sub>2</sub> , SiN,
Anneal	x	x	x	forming gas, Cu Anneal, H <sub>2</sub> Anneal, H <sub>2</sub> /O <sub>2</sub> Anneal
Diffusion	x	x		wet/dry oxidation, POCl <sub>3</sub>
RTP	x	x	x	Si, GaN, SiC
Implant	x	x		high current, medium current, high energy, (B, As, P)
Patterning-Litho				
Stepper/Scanner	x	x		e.g. Nikon, Canon
e-Beam	x	x	x	
Coater/Developer	x	x	x	e.g. TEL Track, Süss ACS300, spin on resists and polymers, spray coating, resist lamination
Electroplating	x	x	x	Cu, Au, Ni, Sn, Ag/Sn, Cu/SnAg, In, post plating thermal treatment and clean
Planarization-CMP	x	x	x	metals (Cu,W), dielectrics (oxides), InP, Post CMP cleans
WET & Cleans	x	x	x	megasonic, spray, scrubber, Si wafer frontside/backside/bevel, RCA, hotPhos, piranha, BOE (HF), AIIIIV wet
Metrology	x	x	x	stress, resistance, thickness, step height, ph-value, wafer geometry, hardness, porosity, Hall, contact angle
Defect Density	x	x	x	darkfield, brightfield, optical, automated Litho inspection, oblique light control

\*Other materials and/or processes might be available upon request.

Wafer Diameter				
Backend	<200 mm	200 mm	300 mm	Process Types / Materials
Wafer Passivation	x	x	x	CVD SiO/SiN, polymer passivation (PI, PBO, BCB, low temperature cure polymers i.e. below 200 °C)
PVD				Ti, TiW, Cu, Au, Pt, NiCr, Cr, Ta, Ge, Al, AlSi, AlSiCu, AlSc, W, Si
Wafer Bumping	x	x	x	size depending on process (between 1 µm and 500 µm): CuNiAu, SnAg, CuSn, Cu-Pillar, Au, AuSn, In, InSn, nanoporous Au
WLP	x	x	x	redistribution using Cu/Polymer or Cu/inorganic
Fan-Out Wafer & Panel Packaging	x	x	x	chip-first and RDL-first, wafer and panel molding
Permanent Wafer Bonding	x	x	x	die & wafer, adhesive, anodic, eutectic, fusion and glass frit bonding, wire bonder, bond aligner
Temporary Wafer Bonding	x	x	x	polymer, debonding using laser or mechanically
Chip to Wafer Bonding or chip to substrate	x	x	x	flip-chip bonding, thermocompression bonding, hybrid bonding
Wire Bonding				wedge/wedge (15 µm - 75 µm), ball/wedge (Au, Cu, Ag, Pt), heavy wires (125 µm - 500 µm), ribbons up to 2 mm
SiP	x	x	x	interposer: Si, glass, and organic including molding, Si-stacking using TSV
Thinning & Singularization	x	x	x	wafer saw, dicer (stealth dicer), laser grooving, grinder, polisher, Taiko-wafer grinding, flycut, baker (oven), scribe, breaker, fine placer, wafer mounter, chip positioning systems

#### Analytics (Destructive & Non-Destructive)

optical microscopes, SEM (with FIB), TEM, EDX, SIMS, TOF-SIMS, XPS, TXRF, XRD, X-Ray tomography, XRR, scanning acoustic microscope (SAM), confocal laser scanning microscope (LSM), film stress characterization (-100°C to + 400°C), AFM, raman, shear testing, ICPMS (combined with VPD analysis), membrane thickness measurements, gas analysis, liquids analysis, titration, temperature measurements for wafer chucks, oblique light control, indenter, reliability test and analysis, electrical test (e.g. C-V)

#### Test

lifetime, HV, DC, wafer prober (4 points-, RF-), fully automated test system, reliability (harsh condition test, electromigration), high temperature ovens, vibration test combined with temperature cycling, electro-optical testing, mixed signal test systems

#### Print

jet printer for paste with low and high viscosity, screen printer, 3D printer for metals, plastics, ceramics

200 mm MEMS  
200 mm GaN-on-Si

Itzehoe

## FMD Cleanroom Facilities all over Germany

200 mm MEMS  
200 mm CMOS/Si

Duisburg

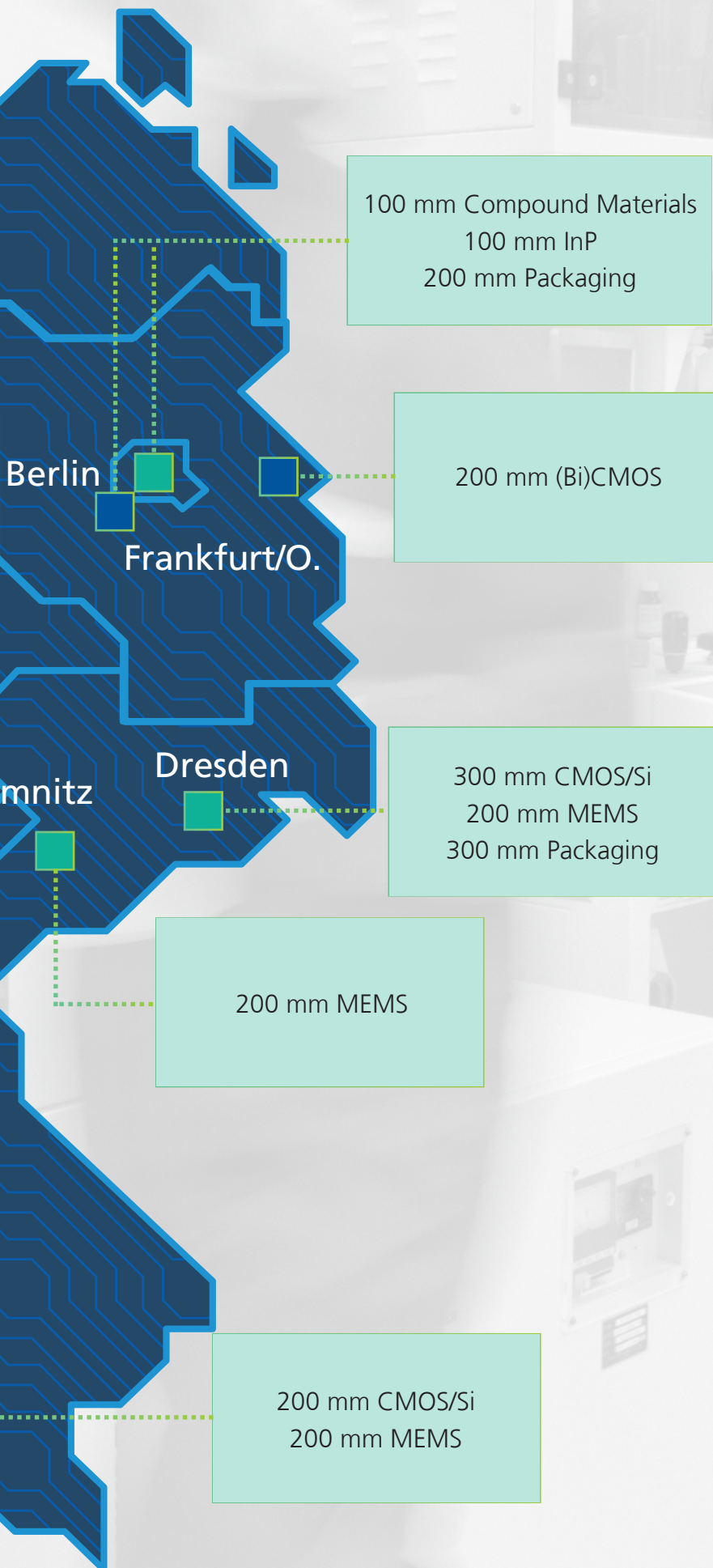
150 mm SiC  
200 mm CMOS/Si

Erlangen

100 mm Compound Materials  
200 mm GaN-on-Si

Freiburg

Munich



## Facts and Technical Highlights

- 13 cleanrooms all over Germany
- up to class 1 cleanroom facilities
- overall size: 11.000 m<sup>2</sup>
- over 2.000 advanced instrument and tools
- more than 10 million moves per year
- wafer diameters from 2" up to 300 mm

## State-of-the-Art Cleanrooms

- 200 mm and 300 mm CMOS lines
- 200 mm MEMS & Sensor lines
- 100-150 mm SiC line
- 200 mm GaN-on-Si line
- 200 mm and 300 mm 3D integration, assembly and packaging
- in-line and off-line characterization and metrology

## Commitment to Quality

- ISO 9001 qualified and partially automotive certification
- MES and contamination protocols established
- use of statistical process control
- protection of customer's intellectual property and compliance of confidentiality

## About Research Fab Microelectronics Germany

Research Fab Microelectronics Germany (FMD) is a technology research group consisting of eleven Fraunhofer institutes and two institutes of the Leibniz Association. The FMD offers advanced technologies along the microelectronic value chain from design to materials and processes, from heterointegration to characterization and test. FMD delivers micro as well as nano technologies for CMOS, MEMS, compound materials and assembly/packaging. Four types of cleanrooms (CMOS, Compound, MEMS, Packaging) are available to realize customer specific developments and product needs.

FMD offers a unique range of expertise and infrastructure: fast access, flexible, good escalation routes combined with strategic developments and comprehensive knowledge. Other materials and/or processes might be available upon request.

### Interested in our technology portfolio?

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