

# PowderMEMS® Technology

## 3D Microfabrication for Innovative Microsystems

*MEMS energy harvesters with integrated micromagnets*

PowderMEMS® - unique microfabrication possibilities

- Novel microfabrication technology for sensors, actuators, coils, transformers, cooling, filters etc.
- Numerous degrees of freedom, like magnetic, thermal and conductive properties, porosity and 3D-geometry
- Advantages compared to other manufacturing techniques: low process temperatures, thermally and chemically resistant structures, BEOL-compatible pre- and post-processing, wide choice of materials
- Example components:
  - Permanent micromagnets
  - Tungsten micromasses
  - Porous fluidic channels

### PowderMEMS® Technology

Fraunhofer ISIT has developed a microfabrication process for integrated 3D microstructures from a multitude of materials on wafer level. The generic technology enables the integration of numerous functions for next-generation microsystems, like micromagnets, tungsten proof masses, microfluidic channels and many other. The low process temperature allows integration in CMOS substrates and other delicate devices. Various degrees of freedom can be taken advantage of, such as the choice of powder material, custom structure geometry and the ability to pre- and post-process with established clean room techniques.

### Examples of Application

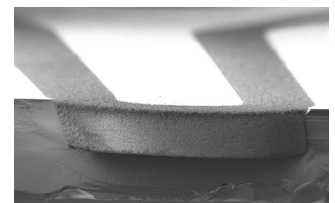
- Sensors, e.g. integrated magnetic bias for TMR and NV<sup>1</sup>-sensors, integrated back-biased<sup>2</sup> sensors
- Magnetic MEMS, e.g., energy harvesters<sup>3</sup>
- Microfluidics, e.g. packaging<sup>4</sup> and catalysis
- Microelectronics, e.g. integrated inductors for DC/DC converters<sup>5</sup>

### Technical Specifications

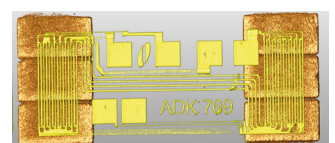
Structure lateral dimensions	30 µm to 4000 µm
Structure thickness	30 µm to 1000 µm
Applicable materials	as required: metals, ceramics, composites
Hard and soft magnetic properties	example NdFeB:
e.g. NdFeB, SmCo, Fe	$B_R \approx 550$ mT, $H_C \approx 770$ kA/m
Process temperature	75 °C to 300 °C
Clean room compatible post-processing	yes
Porous structures / microfluidics	yes



*200 mm Si Wafer with integrated NdFeB micromagnets*



*Cross section of a porous microfluidic structure*



*CT scan of an AMR sensor with substrate-integrated PowderMEMS® biasing magnets*

ISIT is a participant of

1 <https://doi.org/10.1016/j.mne.2025.100316>  
 2 <https://doi.org/10.1109/MEMS49605.2023.10052184>  
 3 <https://doi.org/10.3390/mi13060863>

4 <https://doi.org/10.1088/1361-6439/ada61e>  
 5 <https://doi.org/10.1109/APEC39645.2020.9124474>

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### MEMS R&D at Fraunhofer ISIT

#### Professional MEMS production line

- Development and production: 8" / 200 mm wafer technologies (silicon and glass)
- ISO 5 BEOL cleanroom
- Critical Dimension: 0.35 µm
- Installed capacity: 800 wafers per month
- Chemical-mechanical polishing (CMP) facility
- Wafer grinding and dicing facility

#### PowderMEMS® production line

- Dedicated atomic layer deposition (ALD) tool for 8" / 200 mm wafers
- Custom tooling for automated filling of wafers with dry powders
- Optical and magneto-optical inspection for characterization and quality control
- Custom tooling for magnetization of 8" / 200 mm wafers

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