

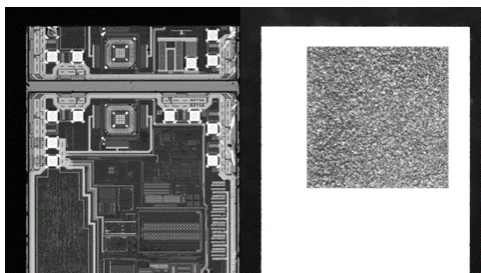
# The World's Smallest Monolithic Back-Biased 3D Hall Sensor

8" / 200 mm CMOS wafer  
with integrated  
PowderMEMS®  
micromagnets

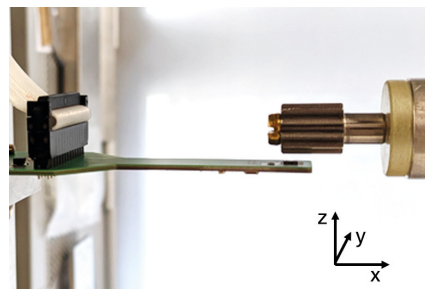
Fraunhofer ISIT and IIS introduce the world's smallest back-biased 3D Hall-effect sensor: By combining market-proven HallInOne® sensor technology with PowderMEMS® micromagnets, the bias magnets are integrated into the bulk-Si underneath the CMOS layers on wafer-level. This approach eliminates the need for individual assembly of external bias magnets and allows for application-dependent shaping of the biasing field.

## Applications

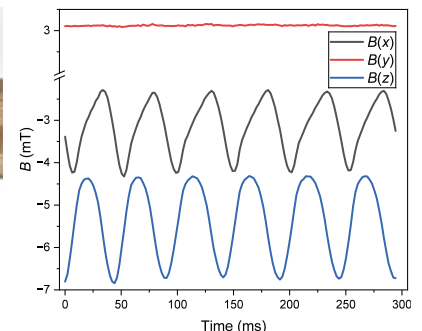
- Gear speed/direction and vibration/runout measurement
- xD position detection
- Condition sensing - e.g. open/closed without counter magnet
- Tamper/intrusion detection
- Keystroke detection
- Process monitoring for deep drawing of sheet metal



Left: Top-view of HallInOne® sensor die  
Right: Bottom-view of PowderMEMS® back-biasing magnet. The chip dimensions are 4 x 2.5 x 1 mm



Demonstration of gear speed/direction and vibration/runout measurement.



## PowderMEMS® technology

PowderMEMS® is a unique process for the integration of NdFeB micromagnets and other ferrous and non-ferrous materials on wafer level. Dry loose powder is filled into microcavities in silicon or glass substrates. The powder is then fixed in place by atomic layer deposition (ALD) of a ceramic nanolayer that mechanically interconnects individual particles. Due to the low process temperature, PowderMEMS® is ideally suited for the modification of pre-processed CMOS wafers. PowderMEMS® wafers are safe to handle in clean-room environments and are compatible with most MEMS processes.

Available materials	NdFeB, Ferrite, etc.
Process temperature	Below 100°C
Typ. Lateral magnet dimensions	30µm ... 4000µm
Typ. Vertical magnet dimensions	30µm ... 1000µm
Typ. remanence $B_r$ (NdFeB)	Up to 550mT
Magnetization (3T) out-of-plane / in-plane	Complete 200mm wafer / Individual chips
Typ. Upper Temperature limit (NdFeB)	130°C
Typ. Lower Temperature limit (NdFeB)	Cryogenic conditions (~10K)

Properties of PowderMEMS® micromagnets

## Our services:

- Customer-driven development of monolithic back-biased Hall sensors
- Concept design, manufacturing, and characterization
- Pilot production in 8" / 200 mm MEMS fab and dedicated PowderMEMS® facility

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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  $\mu\text{m}$
- Installed capacity: 800 wafers per month
- Chemical-mechanical polishing (CMP) facility
- Wafer grinding and dicing facility

### PowderMEMS<sup>®</sup> 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

## Contact

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