Leibniz Ferdinand Braun Institut

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Miniaturized optically pumped magnetometer enabled by additively manufactured technical ceramics

The FBH develops miniaturized physics packages towards portable and robust quantum sensing devices, ready to be used outside the lab. By integrating optical and electrical components as well as atomic systems into compact and stable platforms, field-deployable quantum technologies are enabled for a wide range of applications – from precision sensing and timekeeping to quantum control and fundamental research.

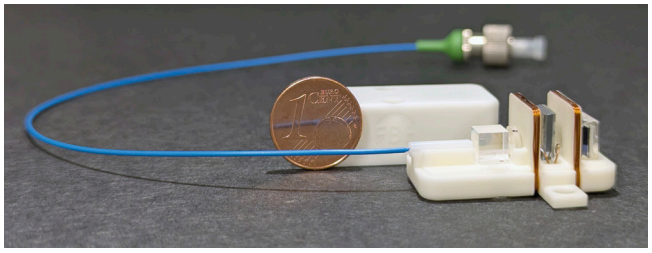
Compact, stable and ready for harsh environments

FBH's Mx-type optically pumped magnetometer (OPM) is developed for non-invasive biomagentic field measurements and combines a compact form factor with high measurement performance. The core sensing unit is a MEMS-based alkali vapor cell, integrated into a miniaturized sensor head (total volume 7 ml). Fiber coupling separates light source and detection electronics from the sensing area – ideal for operation in moderately shielded settings requiring strict magnetic cleanliness and target sensitivities below 1 pT/√Hz.

All components are bonded onto an additively manufactured ceramic micro-optical bench, ensuring mechanical rigidity, thermal stability, and a low magnetic footprint – essential for long-term use in space-borne biomagnetic diagnostics (e.g., magnetomyography).

3D printed technical ceramics for quantum technology

- lithography-based ceramic manufacturing (LCM)
- complex, miniaturized structures with high mechanical and thermal dimensional stability, as well as tight tolerances
- rapid prototyping with scalable manufacturing
- integrated, robust systems for field applications



Miniaturized, fiber-coupled OPM. The core sensing elements are alkali atoms inside a heated MEMS vapor cell.

Exemplary 3D-printed Al_2O_3 components: micro-optical benches, structural lids, iso-grids, elctro-optical mounts, ...

Key specifications of the ceramic printing system

Print system	Lithoz CeraFab S65
Materials	Al_2O_3, ZrO_2, AlN, SiAlON, ...
Build volume	102 x 64 x 320 mm^3
Lateral resolution	40 µm
Layer thickness	10 - 200 µm

Profile

The Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) researches electronic and optical components, modules and systems based on compound semiconductors. In the field of III-V electronics, it manufactures high-frequency devices and circuits for communications, power electronics, and sensor technology. Moreover, FBH develops light sources from the visible to the UV spectral range: high-power diode lasers, UV light sources, and hybrid laser systems. Applications range from medical technology, materials processing and sensors to optical communications in space and integrated quantum technology. In close cooperation with industry, its research results lead to cutting-edge products.

The institute is a member of the Leibniz Association and part of Research Fab Microelectronics Germany (FMD).