Towards detection of individual magnetotactic bacteria using optically pumped magnetometers

T. Fremberg[1], V. Schultze[1], F. Wittkämper[1], M. Kielpinski[1], A. Ihring[1], G. Mayer[1], T. Scholtes[1] and R. Stolz[1]

[1] Leibniz Institute of Photonic Technology, P.O. Box 100239, D-07702 Jena, Germany

Magnetotactic bacteria (MTB) are aquatic bacteria that grow chains of single domain magnetic crystals inside their cell wall. These crystals are of interest for paleomagnetic measurements as well as for medical applications like drug delivery, hyperthermia cancer treatment, magnetic imaging techniques and several others [1].
A single MTB typically possesses a magnetic moment of the order of magnitude of 10^{-15}Am^2 [2], which generates a very small and localized magnetic field. For a direct measurement of this field by means of cesium vapor, it is necessary to use a very small sensing volume in close proximity to the MTB. This can be achieved by applying an optically pumped magnetometer (OPM) in a pump-probe scheme with small beam radii. In an alkali vapor cell of sufficient buffer gas pressure, the sensing volume is defined by the intersection volume of the beams.
We have designed a vapor cell based on MEMS-technology that allows both, to transport the MTB and to measure in very close proximity to the MTB (Fig.1). The cell features a microfluidic channel to guide the MTB past the sensing volume.

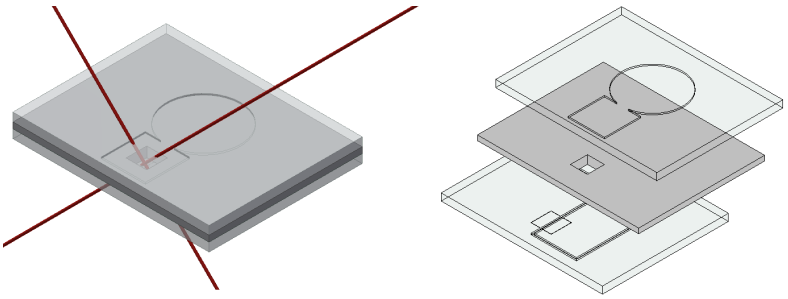

Figure 1: Schematic of the vapor cell design. An anodically bonded compound of a structured silicon wafer (dark grey) with two glass plates (light grey) forms the alkali vapor cell structure with an integrated microfluidic channel separated by a silicon nitride membrane. Laser beams for OPM detection (red) intersect in the vapor cell in close proximity to the microfluidic channel.

References

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