Optically pumped magnetometers using the potentials of micro-systems technologies

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Micro-systems technologies can be used to integrate a number of vapor cells for Optically Pumped Magnetometers (OPM) on a common substrate. With the technology established at Leibniz-IPHT, using micro-structured silicon substrates enclosed with anodically bonded glass plates [1,2], various kinds of vapor cell assemblies can been created. One example is shown in Figure 1. Due to that integration, identical working conditions throughout the whole cell assembly can be achieved. This can, for instance, favorably be used to combine the signals of such cells to improve the signal quality [3] or to create new working modes of OPM. It was shown, that shot-noise limited magnetic-field resolutions in the 10fT/√Hz range are obtained for these OPMs despite the small cells volumes of only several ten cubic millimeters [4]. Above all, the presented combinations of vapor cell assemblies and working modes offer the possibility to work outside magnetic shielding at Earth's magnetic field strength.

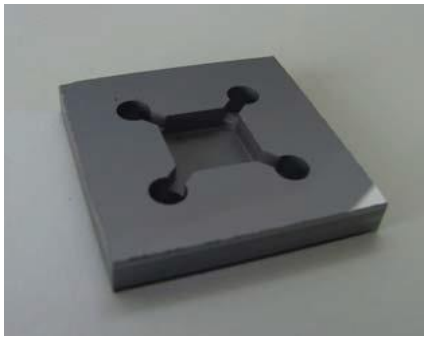

Figure 1. Integrated cesium vapor cell assembly in a 4 mm thick silicon substrate with four 4 mm wide cells, all connected via canals to a common cesium reservoir.

[1] S. Woetzel et al., Microfabricated atomic vapor cell arrays for magnetic field measurements, Rev. Sci. Instr. **82**, 033111 (2011).

[2] S. Woetzel et al., Lifetime improvement of micro-fabricated alkali vapor cells by atomic layer deposited wall coatings, Surface & Coatings Technology **221**, 158–162 (2013).

[3] T. Scholtes et al., Light-shift suppression in a miniaturized M_x optically pumped Cs magnetometer array with enhanced resonance signal using off-resonant laser pumping, Optics Express **20**, 29217 (2012).

[4] V. Schultze et al., An Optically Pumped Magnetometer Working in the Light-Shift Dispersed M_z Mode, Sensors **17**, 561 (2017).