Functionalized mm-scale vapor cells for alkali-metal magnetometry

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Miniaturized high-sensitivity OPMs require – simultaneously – small volumes, temperature control, magnetic field control, and low magnetic noise. This presents interlinked challenges when designing vapor cells for OPMs. We report a dual-chamber (4 x 4 x 1.5 mm^3) low-noise functionalized vapor cell (FVC) and its use in a single-beam SERF OPM [1]. The FVC, made at wafer scale by MEMS techniques, incorporates surface metallization for both heating and thermal monitoring, while also maintaining a low thermal magnetic noise. We discuss also the zero-field operation of the OPM, in which we observe a magnetic sensitivity of about 18 $fT/\sqrt{Hz}$. This FVC design is a step toward mass producible OPMs for applications in sectors including medical imaging, space and geophysical.

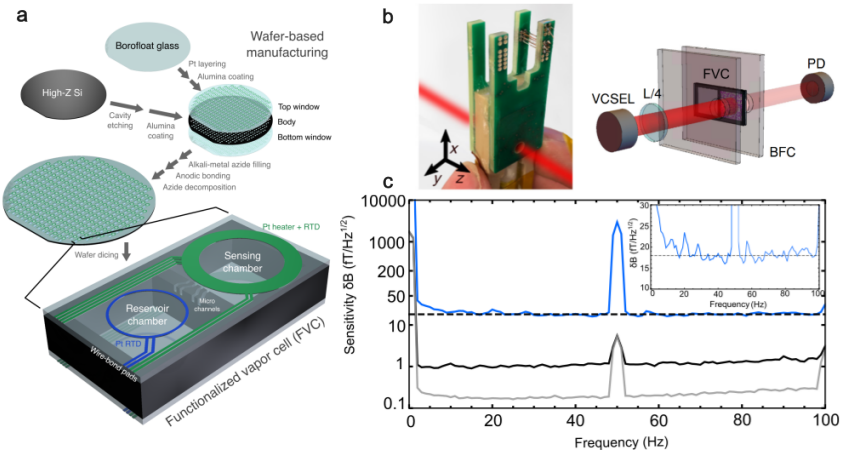

Figure 1. (a) Schematic view of a functionalized vapor cell (FVC) for miniature alkali-metal sensors, indicating some of the key design elements and stages of the manufacturing process. (b) Zero-field-resonance magnetometry with the FVC. [2] (c) The sensitivity spectrum is given by the blue curve and the dashed black line indicates the 18 $fT/\sqrt{Hz}$ sensitivity level.

[1] H. Raghavan et al., Functionalized mm-scale vapor cells for alkali-metal spectroscopy and magnetometry, **arXiv:2405.10715**, (2024).
[2] M.C.D. Tayler et al., Miniature Biplanar Coils for Alkali-Metal-Vapor Magnetometry, Phys. Rev. Applied 18, **014036**, (2022).