Alkali-filled microcell production and characterization at INRIM

Chiara Gionco, Erik Cerrato, Michele Gozzelino, Giulia Aprile, Cecilia Clivati, Mario Malerba, Salvatore Micalizio, Filippo Levi, Davide Calonico

Quantum Metrology and Nanotechnologies Division, INRIM, Torino, Italy

Email: m.gozzelino@inrim.it

Micro-fabricated vapor cells are recognized as an asset to build a new generation of compact and low-power frequency standards and sensing devices[1,2,3,4].

One of the most widespread geometric configuration is based on three-layers structure: a silicon wafer is first etched in order to obtain holes of the desired diameter. The holes will constitute the inner volume of the cells. Then, glass windows are anodically bonded on the two sides of the silicon wafer to guarantee airtight confinement inside the cells and to provide optical access[5]. Before attaching the second glass window, alkali metal or alkali preform is deposited into the cavities to provide the atomic reservoir. Finally, the wafer is diced to obtain single cells.

At INRIM, thanks to the recently established clean-room facility[6], we are setting up new research lines involving the production and the characterization of MEMS-like cell filled with rubidium. Different filling methods, either with Rb dispensers or with *in-situ* reaction are being approached, as well as different cell designs.

A few batches have already been produced in-house. In parallel, a characterization setup to perform spectroscopy at the Rb wavelength has been installed, and automation is under way to characterize the serial production. Details on the wafer production, yield and evolution of the spectroscopic signals of the cells over the first few months after activation will be presented at the conference.

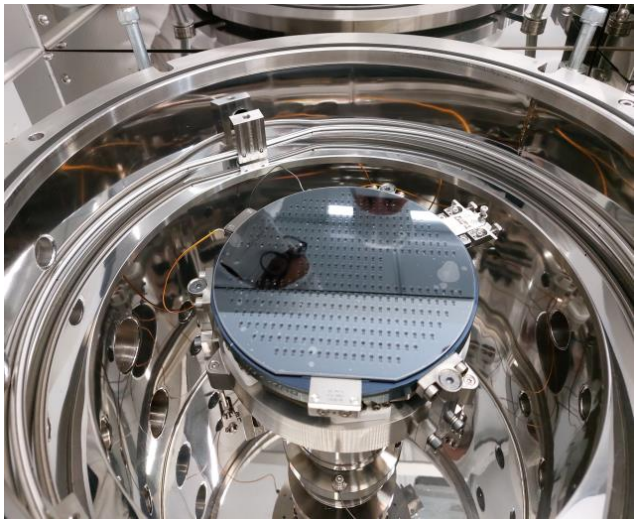

Fig. 1: Picture of a wafer produced in one of the first batches placed inside the wafer bonder. Reservoir cavities and optical cavities that are patterned into the silicon preform are visible on the wafer surface.

[1]J. Kitching, "Chip-scale atomic devices", Appl. Phys. Rev. vol 5(3), p. 031302, 2018.

[2] Z.L. Newman et al. "Architecture for the photonic integration of an optical atomic clock". Optica. vol. 6(5), p. 680, 2019.

[3]. Zhao *et al*., "Toward the Measurement of Microwave Electric Field Using Cesium Vapor MEMS Cell," in *IEEE Electron Device Lett.* vol. 44, no. 12, pp. 2031-2034, 2023.

[4]R. Jimenez-Martinez *et al*., "Sensitivity Comparison of Mx and Frequency-Modulated Bell–Bloom Cs Magnetometers in a Microfabricated Cell," *IEEE Trans Instrum Meas* , vol. 59, no. 2, pp. 372-378, 2010.

[5]G. Wallis, D. I. Pomerantz, "Field Assisted Glass-Metal Sealing". J. Appl. Phys. pp. 3946–3949, vol.40(10), 1969.

[6]https://piquetlab.it/