MEMS atomic vapor cells at CSEM and their applications

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CSEM started the development of MEMS atomic vapor cell fabrication for miniature atomic clock (MAC) applications about 10 years ago. Right from the beginning, the selection of the fabrication process has been made such that it remains compatible with low-cost wafer level production, while still meeting the clock performance requirements.

CSEMs baseline approach for the fabrication of MEMS atomic vapor cells was thus defined to rely on anodic bonding and alkali azide based filling, as patented in [1]. The fabrication process was continuously improved, in terms of reliability and long-term frequency stability performances [2], and also by adding functionalities like integrated heating and temperature sensing. The cells are currently very close to the ultimate commercial clock requirements, in terms of size, costs and long-term performances.

CSEMs MEMS atomic vapor cells (4 x 4 x 1.6 mm) were already successfully integrated in a novel flat form factor miniature atomic clock physics packages having a height of less than 5 mm (Figure 1). The performances are in line with the expectations [3].

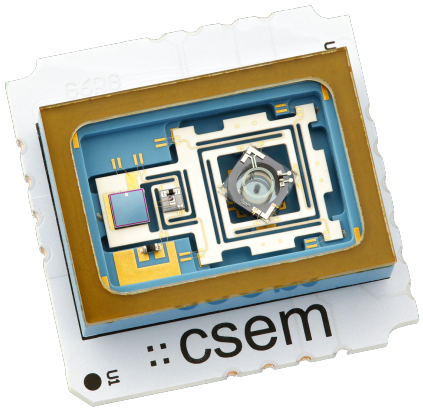

Figure 1: Ceramic-based miniature atomic clock physics package developed by CSEM and VTT in the frame of the C-MAC project (funded by ESA).

Modified MEMS atomic vapor cells have also been fabricated for miniature atomic NMR gyroscope applications. Such cells differentiate from the cells developed for MACs in terms of size (8 x 8 x 1.6 mm) and content (Rb + Xe). Characterization of the spin-polarized pumping efficiency and of the relaxation times of the Xe nuclear spins as a function of cell size and temperature is described in [4].

[1] US patent US 8,906,470 B2 (2011) and EP application 3 244 269 A1 (2016)
[2] S. Karlen, PhD Thesis (2018) http://doc.rero.ch/record/308907
[3] J. Haesler et al., Proceedings of the 6th international colloquium on scientific and fundamental aspects of GNSS / Galileo, Valencia (2017)
[4] S. Karlen et al., Proceedings of the Frequency and Time Forum EFTF, Besanon (2017)