CPT spectroscopy on low-temperature sealed MEMS rubidium vapour cells

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**Experimental setup**

**Parameters of the Atomic Resonator:**
- The micro-fabricated cell is placed inside a cylindrical double layer mu-metal shield.
- The outer shield has a length and diameter of 20 cm. The cell is heated with a twisted wire to temperatures in the range 80-95°C.
- Furthermore a magnetic field of 3uT is applied to isolate the clock transition between the m_1=0 Zeeman levels.

**Experimental Results**

**MEMS Cell fabrication and sealing at low temperature**

1) Preform fabrication
2) Rb and buffer gas filling
3) low temperature sealing
4) Pref-amplifier
5) Atomic resonator
6) VCSEL MEMS Cell
7) Photodiode
8) Lock-in
9) Preform fabrication
10) Pref-amplifier

**Signal-to-Noise:**
- We have measured the signal-to-noise of the LTF/Samlab cell #2 (2mm thick, 30 mbar N_2). **Top:** CPT signal with contrast of 1.81% and linewidth 1.55kHz. The corresponding Q-factor is 2.10^10. **Bottom:** Noise Power spectral density measured with an FFT spectrum analyzer. The noise on the clock signal (red curve) is ~3uV/Hz at 500Hz. **Table:** short-term clock stability based on the measured signal-to-noise ratio.

**Conclusion:**
- We have developed a low temperature (~150°C) and short process time (~minutes) sealing technique for MEMS rubidium vapour cells. Here we present the first spectroscopic results obtained with this new type of cells. Cells fabricated at LTF/Samlab show good reproducibility between different samples. For 2mm thick cells with (nominal) 30mbar nitrogen buffer gas we measure a CPT contrast and linewidth of 1.8% and 1.35kHz, respectively. Noise-measurements with this cell predict a short-term Allan deviation of 2-10^-11 using the present laboratory setup. We have also observed a CPT signal from cells fabricated by LMTS/LPM. However, for these cells we measure a low contrast which may be due to a layer of amorphous silicon reducing the rubidium density inside the cell. In the future we will record the long term stability of low temperature bonded cells with particular attention to applications in vapour cell microwave frequency standards.

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