Rb microfabricated cells for a two-photon optical frequency reference

M. Callejo,[1,*] R. Vicarini,[1] A. Mursa,[1] P. Abbé,[1] E. Klinger,[1] N. Passilly,[1] and R. Boudot[1]

[1] *FEMTO-ST, CNRS, UBC, ENSMM, Besançon, France*

Miniaturized vapor cell optical clocks based on the use of the two photon absorption transition (TPT) of the Rb atom at 778 nm have recently demonstrated remarkable stability results [1].

In such experiments, the presence of impurities in the vapor cell induces collisional broadening (several MHz/Torr) of the probed optical transition [2]. Thus, achieving a cell inner atmosphere with high-purity is of crucial importance to fully explore the potential of the TPT natural linewidth (~ 300 kHz).

In this work, we report on characterization studies of pill dispenser-based Rb micro-fabricated cells. These microcells are fabricated similarly to Cs microcells [3], but use Rb dispenser pills.

We have implemented a table-top setup for TPT spectroscopy at 778 nm, using an external cavity diode laser (ECDL). Resonances detected in MEMS cells can be compared to those obtained in a reference glass-blown vapor cell.

We assess the Rb cell purity by measuring the Lorentzian broadening of the TPT resonance linewidth. The reference cell resonance was measured to be broadened by 250 kHz, attributed to helium permeation from the surrounding air. The microcell showed a Lorentzian broadening equal to 2 MHz, revealing the presence of impurities, other than helium. These observations confirm that the measurement of the TPT resonance is a useful non-destructive method to test the level of purity of vapor microcells.

We also demonstrate preliminary stability results of an optical frequency reference at 778 nm based on such a MEMS Rb cell. The Allan deviation is below 10^{-12} at 1 s and reaches 2.5×10^{-13} at 100 s. Cells with integrated non-evaporable getters [4] might be tested in the near future. Latest results will be presented at the conference.

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* martin.callejo@femto-st.fr