Miniature optical fiber cavity for a trapped atom clock

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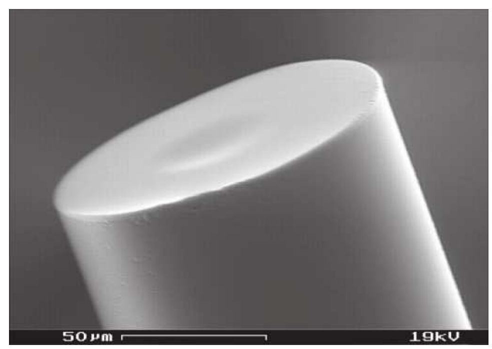
Trapped atoms have grown in importance for the development of metrology instruments. Optical clocks need the trap confinement in order to absorb the photon momentum and grant clock accuracy. Clocks for in-the-field applications benefit from the volume reduction whilst allowing long interrogation times and thus good stability. Trapped atom interferometers for acceleration and rotation sensing are under development.

Operating a microwave clock with ^{87}Rb atoms trapped on a microchip [1], we have shown that very long coherence times up to 58 s can be realised [2]. This validates the concept of atom trapping for high stability compact clocks. Another advantage arises: the atoms can be detected while remaining trapped. This reduces dead time from atom loading and improves the Dick effect [3]. Furthermore a series of multiple detection pulses on the same atomic ensemble can be used for tight steering of the local oscillator. Depending on whether the detection projects the atomic superposition state [3] or preserves the atomic phase [4] such a scheme realises a frequency lock or phase lock [5].

Here we present plans for a second-generation of our "Trapped Atom Clock on a Chip (TACC)" which will include an on-chip optical fibre cavity for non-destructive detection. Laser machining of the fibre ends creates concave depressions (photo) that, when reflection coated, can form the mirrors of a microscopic cavity [6]. Well suited for use with atom chips or ion traps, such cavities are by nature fibre coupled. Single atom detectivity [7] and quantum manipulation of atomic states have been shown [8]. We report on progress towards fabrication of cavities with few 100µm length.



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