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Manufacturing the first generation micro-cell with spin protecting coating and measurement of spin

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D2.1. Manufacturing the first generation micro-cell with spin protecting coating and measurement of spin

The first generation of microcells was fabricated and lifetimes were tested for cells with different parameters and where different production methods were applied. The first part of the production procedure was carried through in the facilities of DANCHIP by etching and bonding procedures. The resulting layer-structured chip can be seen in Figure 1. The microcell itself consists of a 200x200µm^2 channel which was cut into a glass wafer and smoothed by HF etching. This wafer was bonded to silicon wafers on each side. A funnel through one of the silicon layers and an additional glass layer was included to permit a connection to the atomic reservoir (Figure 2). Cells with different hole sizes were produced. This is due to the fact that, on the one hand, the access needs to be big enough for the filling and coating of the cells as described below. On the other hand, big holes limit the life-time of the atomic spin state as atoms from the ensemble can escape through the holes.

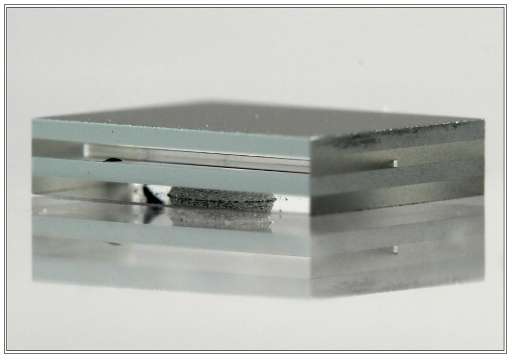

Figure 1: The chips are made of layers of glass and silicon. Their size is (10x8x2)mm (length, width, height). The hole that leads into the channel is 200 by 200µm and can be seen at the end facet of the chip.

In the second production step, windows were attached to seal the atomic cell. All walls were coated with an Alcene coating and a glass tube including the Cesium reservoir was attached above the funnel (see Figure 3). Different approaches were used to attach the windows. First, a gluing procedure was optimized with the goal to minimize the glue penetrating into the cell. However, in lifetime measurements evidence arose that the glued cells display a deteriorating performance despite earlier tests that indicated that the glue would be suitable to our purpose. Therefore, other approaches to attach the windows needed to be found. Fusing of the windows was attempted. The microcells produced this way display much better stability.

Figure 2: Chip viewed from below. The hole in the picture is the funnel that will connect the channel with the Cesium reservoir.

Due to the high temperatures necessary, this indicates that difficulties might arise when AR coated windows are used. Further investigation needs therefore to be made to find the optimal bounding procedure.

A setup to test the microcells was build. The life time of the longitudinal spin T1 was measured by monitoring the polarization rotation of a probe beam which was detuned by 850MHz from the D2 line sent through an oriented ensemble. Orientation was created by means of optical pumping. T1 times up to 1.5ms were measured. The transversal decay T2 was measured with magneto optical resonance signal (MORS) techniques. For cells possessing holes with diameters of 45/90µm, decay rates of the spin were measured to be T2=1.6/0.9ms, respectively.

Figure 3: Chip with glass windows and tube attached. The windows seal the channel from each side. The tube contains the Cesium atoms that will enter the channel through the funnel.