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Bulk absorption measurement at 1064 nm of the new Heraeus ultra pure fused silica used for the Advanced Virgo Test Mass: effect of the annealing

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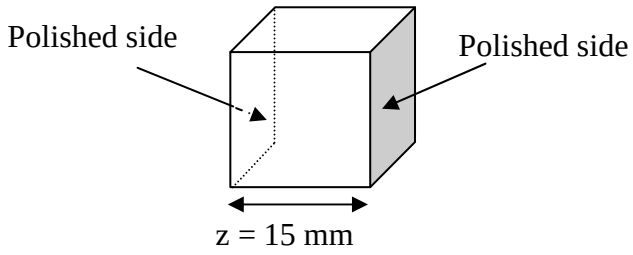
1. Introduction

This study was done in the Advanced Virgo context. It was decided (Advanced Virgo baseline) some times ago to use for the Input Mirror (IM) and the Beam Splitter (BS) the new type of fused silica developed in 2007 by Heraeus Quartzglass (Germany): Suprasil 3002 (IM), Suprasil 3001 (BS). The main interest of this new type of silica, compared to the one used in Virgo (Suprasil 312/311) is that the absorption is 3 times lower (around 0.2 ppm/cm at 1064 nm). This is a major interest to reduce the thermal lensing.
After coating, the silica substrate is annealed to improve the coating absorption level and to reduce the layers internal stress. This type of process was already used for all the Virgo mirrors installed in the interferometer.
To improve the absorption level, Heraeus has developed a new manufacturing process different from the one used for Suprasil 311/312. Because of that, people from Heraeus were afraid that the annealing procedure may induce a small increase of the bulk absorption because of the diffusion of chlorine.
We asked Heraeus to provide us two samples of Suprasil 3001 (15*15*15 mm^3, two opposite sides polished) in order to measure the bulk absorption of this new silica and to see if there is an evolution of the absorption when it is annealed.



2. Results

The absorption measurements were done on the absorption bench developed at LMA based on photothermal deflection. The minimum level measurable with this optical bench is 0.1 ppm/cm.
On the 15 mm long of these two samples (z axis), we have made, before and after annealing, an absorption measurement in depth every millimeter to see the depth homogeneity of the sample. The absorption values below are the average of these measurements.

Before annealing :
Sample 1 : **0.16 +/- 0.04 ppm/cm**
Sample 2 : **0.16 +/- 0.03 ppm/cm**

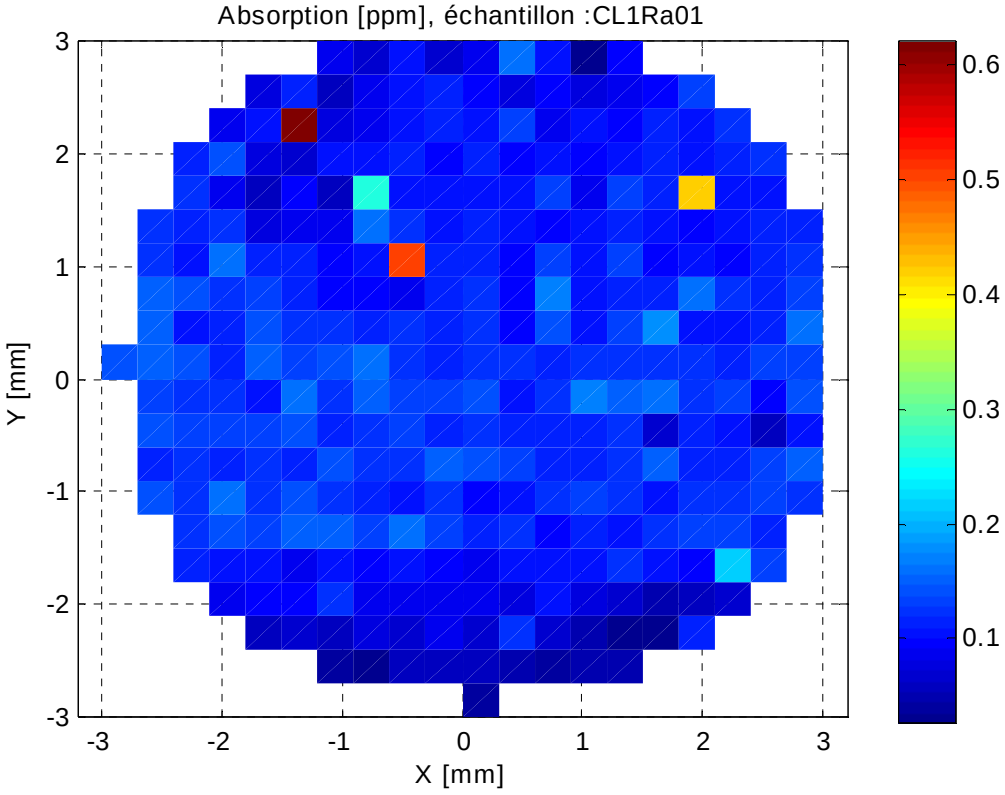
After annealing :
Sample 1 : **0.20 +/- 0.04 ppm/cm**
Sample 2 : **0.15 +/- 0.04 ppm/cm**

We have also done in the middle of the samples (z =7 mm) an absorption map to measure the

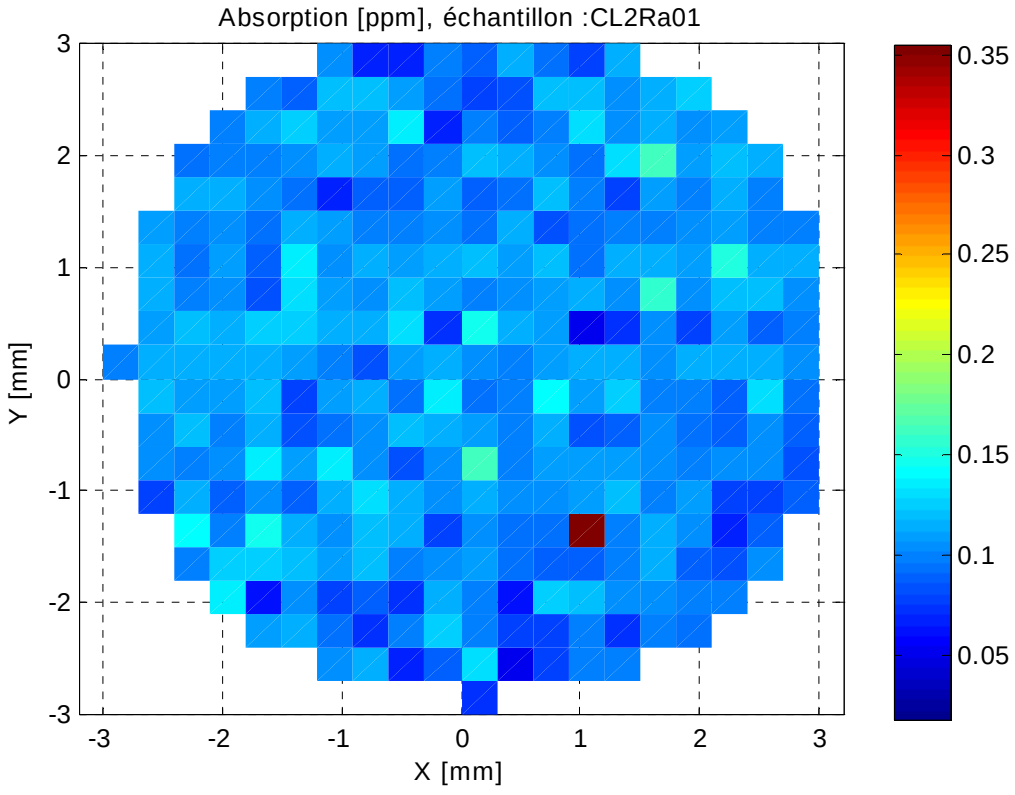
uniformity of the absorption of this material (diameter measured 6 mm). These maps are shown below. We can notice that the absorption level is perfectly uniform and the absolute values are very low :

Sample 1 : **0.11 +/- 0.05 ppm/cm**

Sample 2 : **0.11 +/- 0.02 ppm/cm**



Absorption map of sample 1 (diameter 6 mm, step 300 µm)



Absorption map of sample 2 (diameter 6 mm, step 300 µm)

3. Conclusion

- The absorption level of the new type of silica (Suprasil 3001/3002) is very low (around 0.15 ppm/cm) close to the sensitivity level of our absorption bench.
- The annealing procedure, which is used after coating, has no effect on the bulk absorption level of this fused silica.