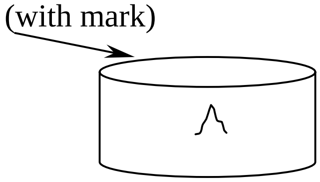
**Summary on the surface absorption study of a 1x0.25" FS substrate one surface of which was treated by Ion-Beam Figuring (IBF) technique**

01/20/2010.

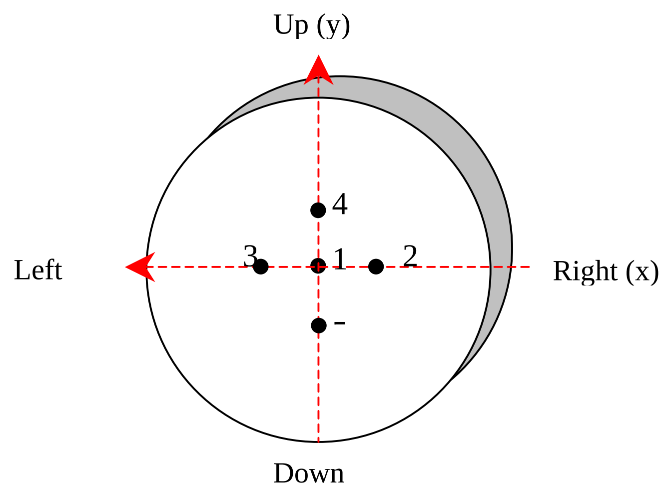
The surface absorption was investigated by a photothermal common-path interferometer (PCI) method based on the effect of thermal lensing.

The pump beam, 1.064 μm, had a power 9.00 W and waist 25 μ at the measured point. So the power density used was 4.2 kW/mm$^2$ (CW mode).
Five points were measured for averaging the data.
The positions of the points were lost after the sample was removed from the holder.

IBF treated surface (with mark)



**The "center" point has (x,y) coordinates (0,0) with an accuracy +/- 0.5 mm.**




Point names:

| | | |
|---|---|---|
| 1 | Center point | C (center) |
| 2 | 3000 μm to the right from the center point | R (right |
| 3 | 3000 μm to the left from the center point | L (left) |
| 4 | 3000  μm above the center point | U (up) |
| 5 | 3000 μm below the center point | D (down) |

The "through" measurements (z-scans) were carried out both from the **front** (IBF treated) and the **rear** (not treated) surfaces. Additionally, two in-plane (x-scans) were carried out from both surfaces (central line, 12 mm long.
The results are summarized below.

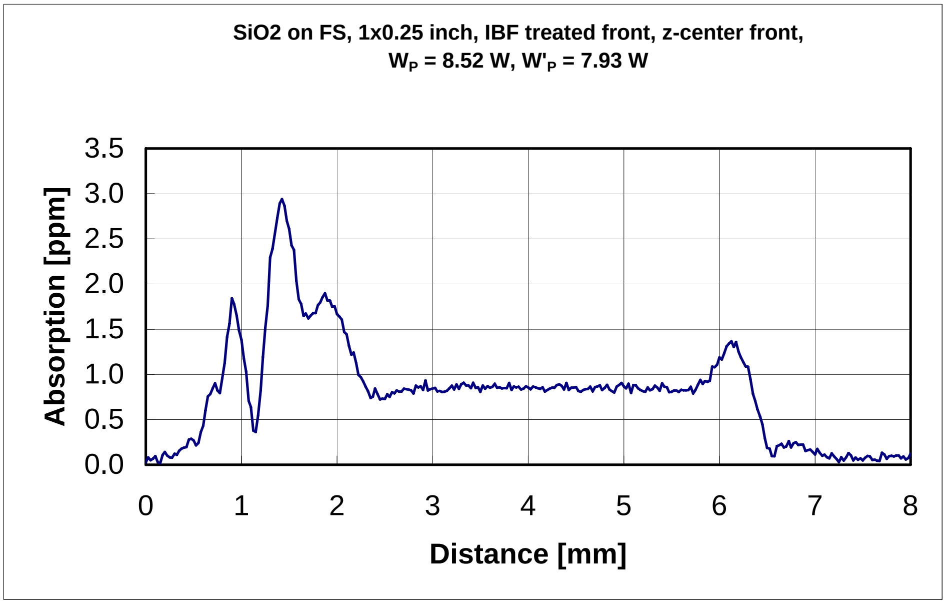



Fig.1. A z-scan through the sample. Front surface, central point. The front surface at this point has an obvious defect, while the rear surface shows a regular behavior.

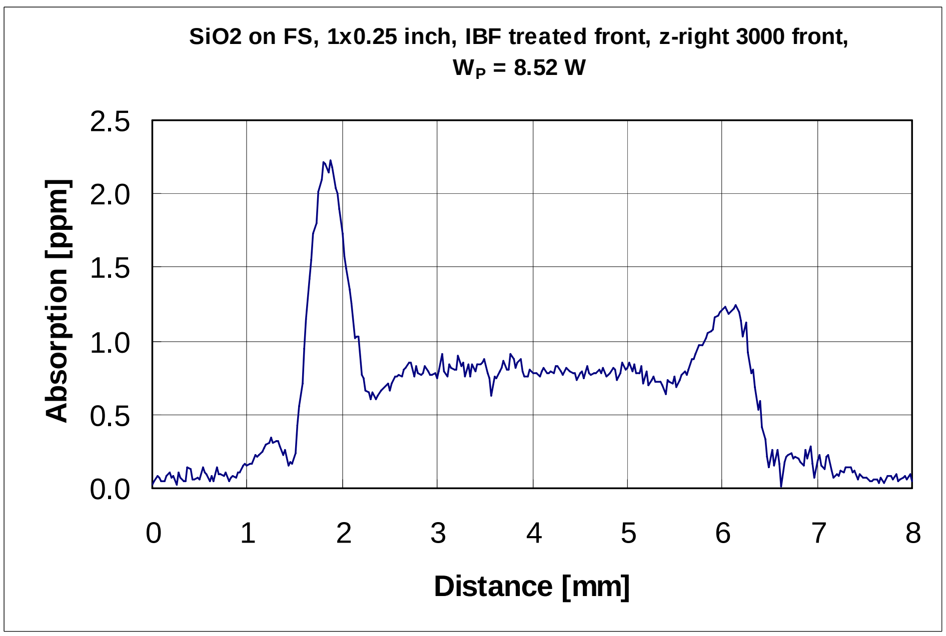



Fig.2. A z-scan through the sample. Front surface, 3 mm to the right from the central point. Both surfaces show regular behavior.

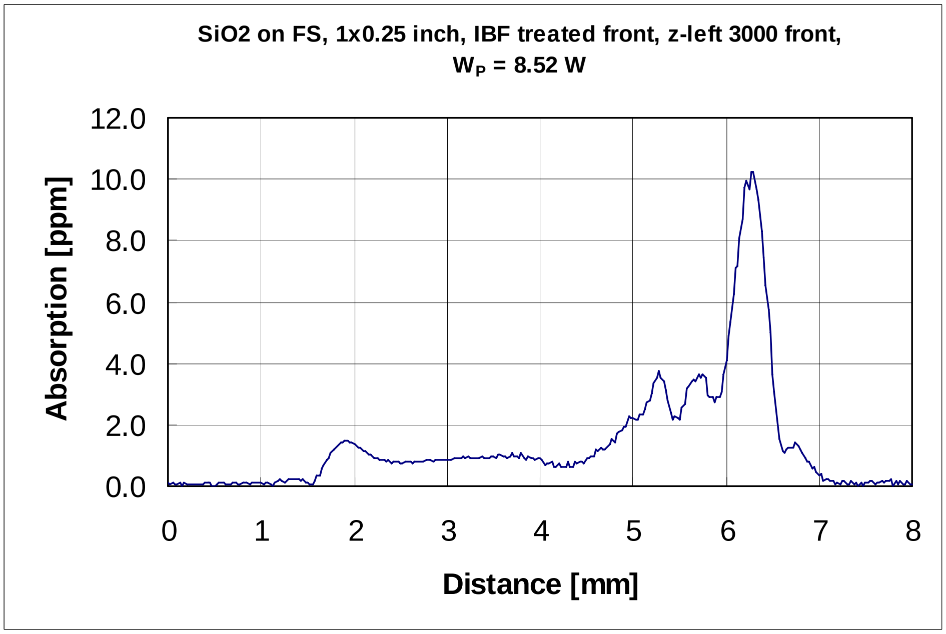



Fig.3. A z-scan through the sample. Front surface, 3 mm to the left from the central point. The signal from the rear surface shows a deviated behavior.

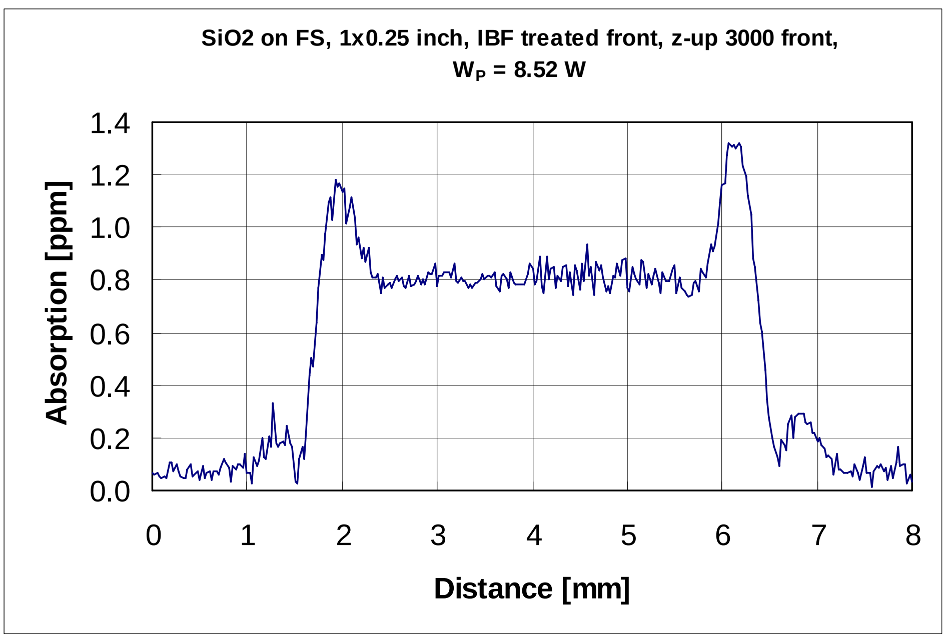



Fig.4. A z-scan through the sample. Front surface, 3 mm above the central point. Both surfaces show regular behavior.

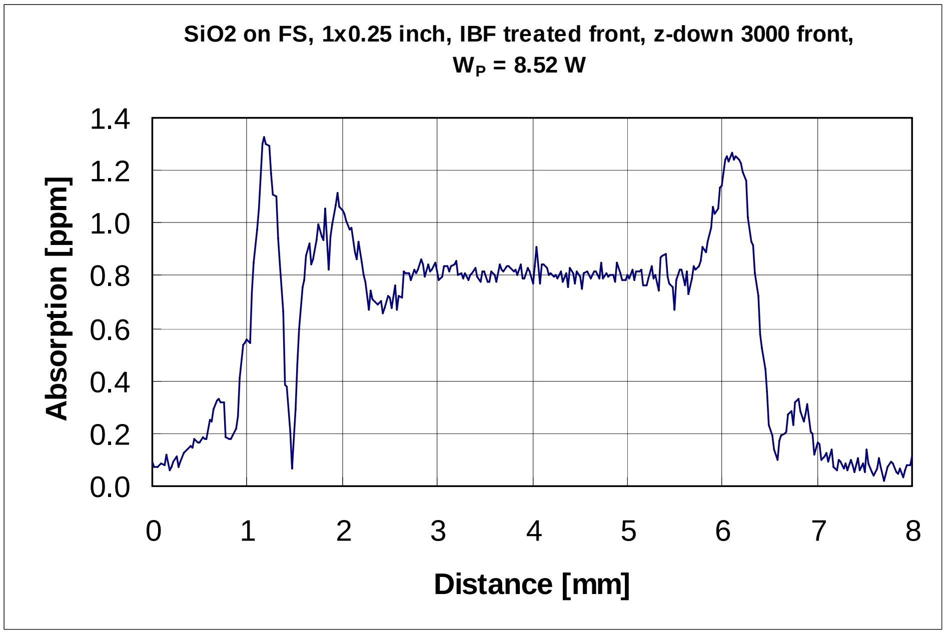



Fig.5. A z-scan through the sample. Front surface, 3 mm below the central point. The front surface at this point has an obvious defect, while the rear surface shows a regular behavior.

Five figures below are the data collected from the 2nd series of measurements with a reversed sample, when the untreated surface faced the beam.

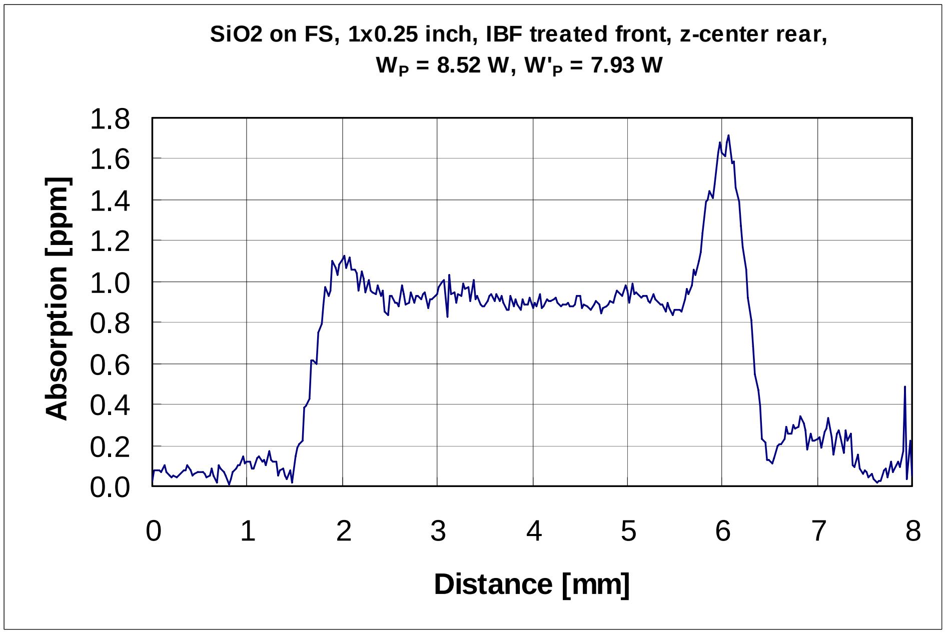



Fig.6. A z-scan, rear surface, central point.

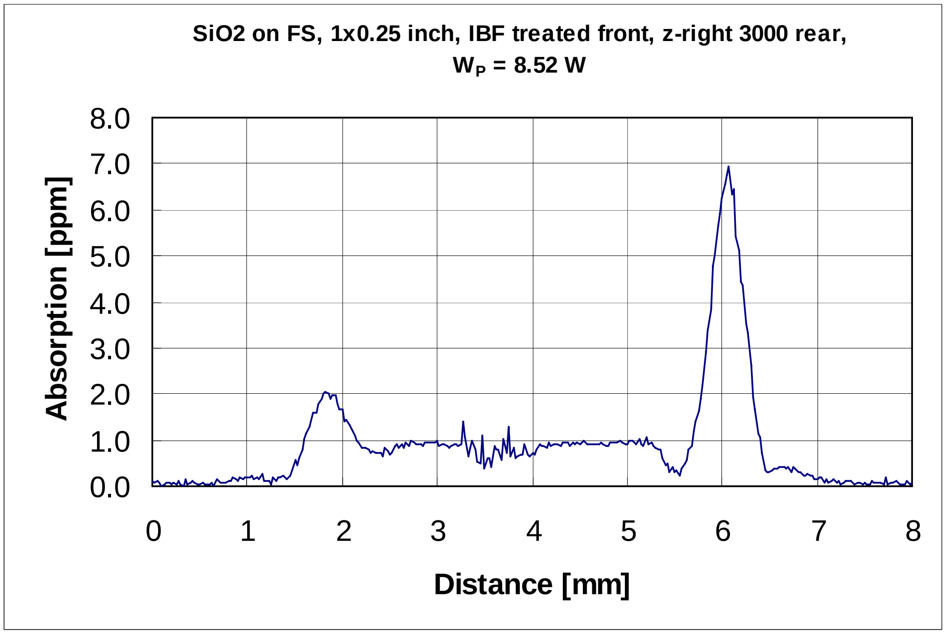



Fig.7. A z-scan, rear surface, 3 mm to the right from the central point.

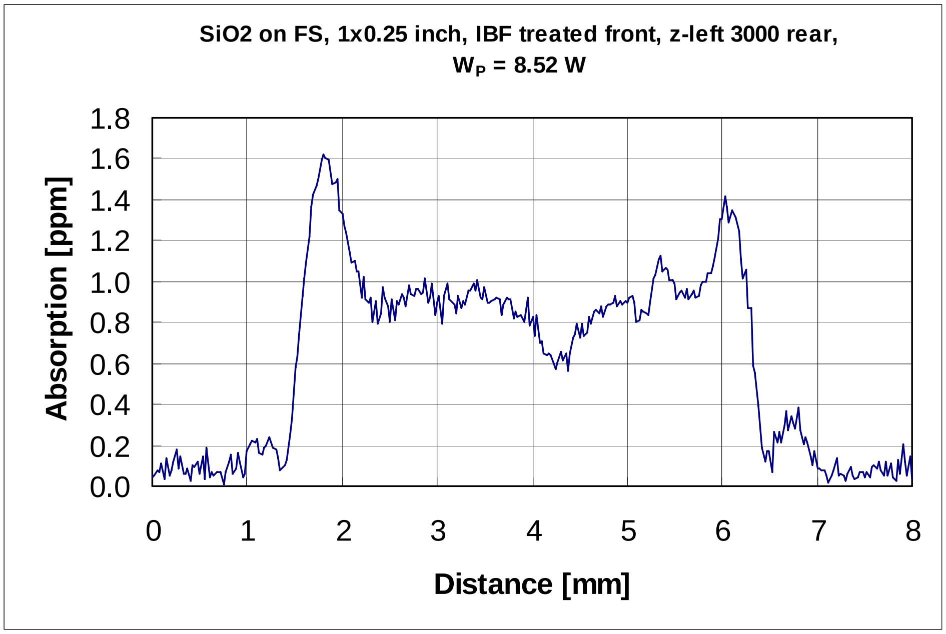



Fig.8. A z-scan, rear surface, 3 mm to the left from the central point.

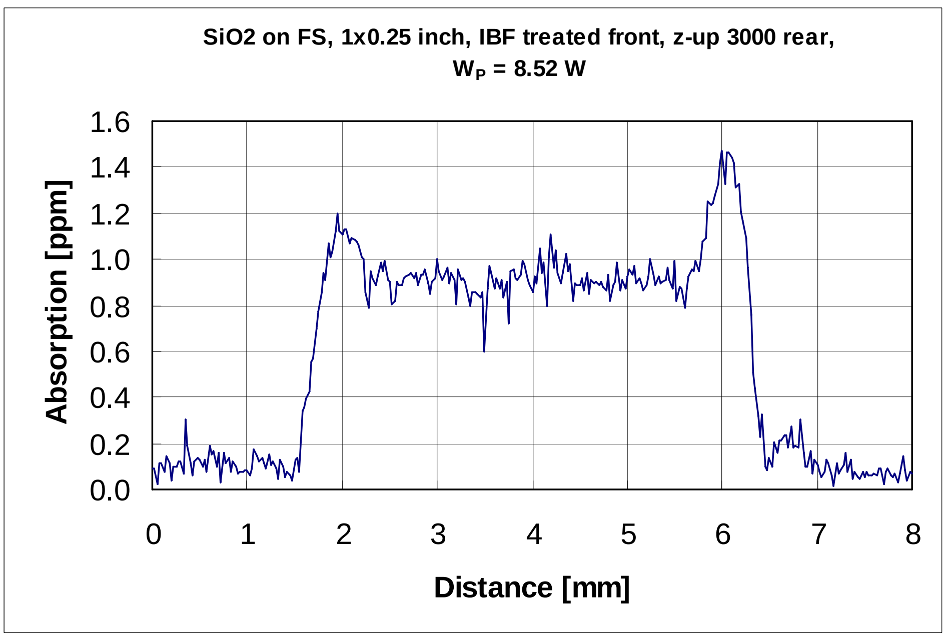



Fig.9. A z-scan, rear surface, 3 mm above the central point.

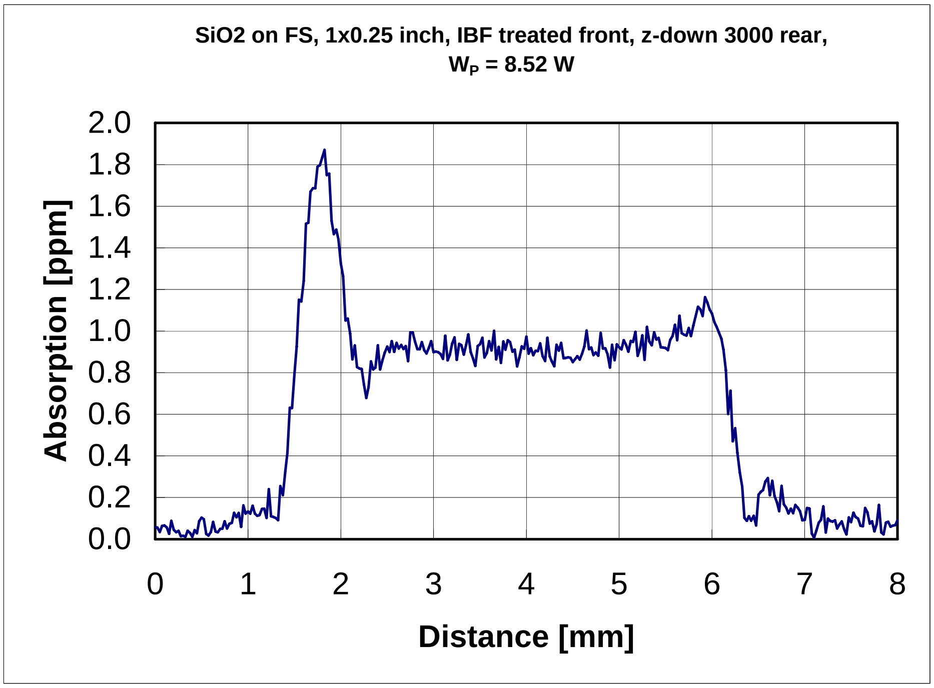



Fig.10. A z-scan, rear surface, 3 mm below the central point.

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## Numerical data

Front surface faces the beam

| Sample surface | Absorption Alpha (ppm) | | | | | Comments |
|---|---|---|---|---|---|---|
| | **C** | **R** | **L** | **U** | **D** | |
| Front (IBF treated) | **N/A** | **1.8** | **1.0** | **0.68** | **1.05** | $W_T$ = 7.93 – 8.0 W |
| Rear (untreated) | **0.9** | **0.8** | **N/A** | **0.8** | **4.2** | $W_T$ = 7.93 – 8.0 W |

Rear surface faces the beam

| Sample surface | Absorption Alpha (ppm) | | | | | Comments |
|---|---|---|---|---|---|---|
| | **C** | **R** | **L** | **U** | **D** | |
| Front (IBF treated) | **< 0.5** | **1.6** | **1.15** | **0.78** | **1.45** | $W_T$ = 7.93 – 8.0 W |
| Rear (untreated) | **1.3** | **6.5** | **0.95** | **1.05** | **< 0.5** | $W_T$ = 7.93 – 8.0 W |

The data were evaluated from the front and rear surface maximums with the half of the substrate signal subtracted.

These scans show that the surface absorption is not even from both sides. The data vary too much for a proper averaging. Therefore two in-plane scans were made from both surfaces.

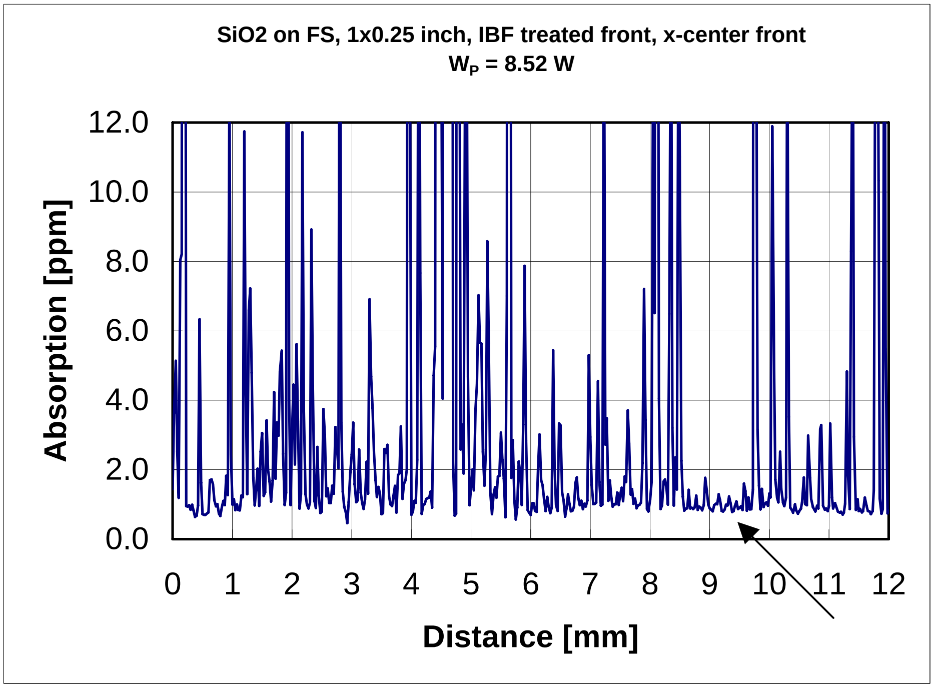


Fig.11. An in-plane x-scan along the central line of the front surface (IBF treated). The surface contains a lot of “defective” spikes, which are due to dust particles sticked to it electrostatically. A repeated on-site cleaning removes some of them but new spots arise then. Looking at a relatively perfect segment, one can see that the signal is c.a. 1 ppm. This value is equal to the signal from the bulk substrate. Therefore it can be concluded that the really clean surface is not absorptive and all the losses, when illuminating a big area, arise from dust particles and/or surface defects.

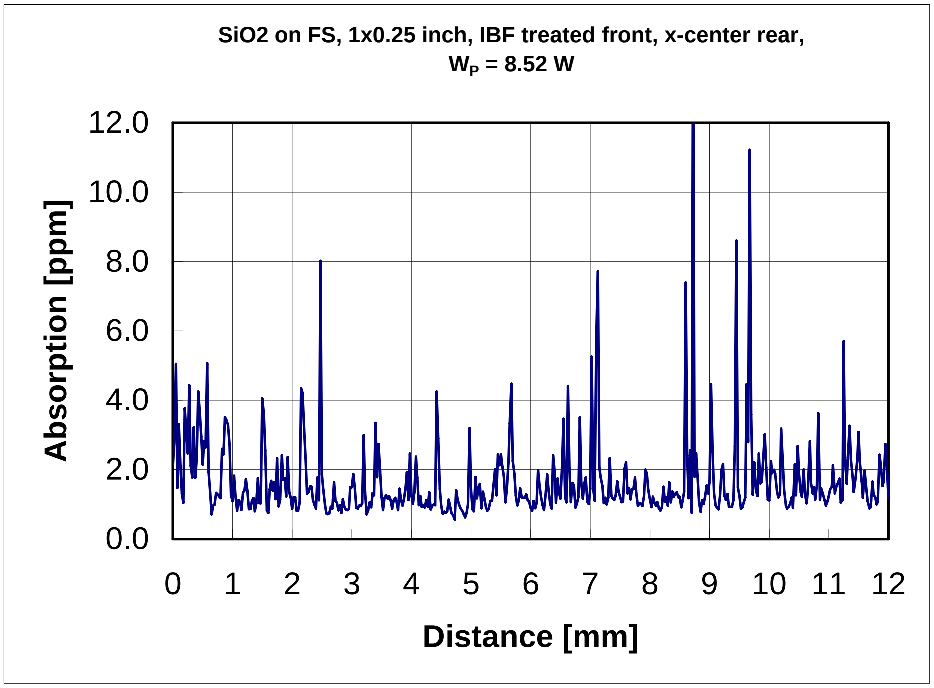


Fig.12. An in-plane x-scan along the central line of the rear surface (untreated). The surface contains substantially less "defective" spikes, which are supposed to have the same origin as those shown on fig. 11. A repeated on-site cleaning removes some of them but new spots arise then. Looking at a relatively perfect segment, one can see that the signal is c.a. 1 ppm. This value is equal to the signal from the bulk substrate. Therefore it can be concluded that a really clean surface is not absorptive and all the losses, when illuminating a big area, arise from dust particles and/or surface defects.

In conclusion. IBF treatment does not increase the surface absorption in general. However, the surface seems to become more receptive to sticking foreign particles on it.

Ashot Markosyan.