



Raydiance Application Spotlight

Sub-Surface Ablation of Bar Codes in SiO₂ Tubes

Abstract

Precise surface and sub-surface features were created in SiO₂ (quartz) tubes. The rectangular features were ablated without introducing any collateral damage, such as edge fractures or chips, to the sample. The volume removal rate of the surface features was calculated to be 0.00625 mm³/sec. For this geometry, the linear ablation speed was 500 mm/sec.

Sample Description and Objective

The sample machined in this work was a SiO₂ (quartz) tube with an approximate outer diameter of 25.4 mm and an inner diameter of 22.0 mm. The objective was to ablate bar codes—rectangular features approximately 5 mm long, 100 μm wide and 10 μm deep—both at and below the surface of the sample.

Methods

A Raydiance Smart Light MD™ 50 ultrafast system was used to do the sub-surface ablation. The beam was moved across the sample with a ScanCube 7 scanner (no linear stage translation was required). Laser parameters were as follows:

On Target Energy: 7.6 μJ/pulse

Repetition Rate: 303 kHz

Average Power on Target: 2.3 W

Pulse Width: 750 femtoseconds

Results

Features were easily machined in the SiO₂. There were no apparent cracks, chips or other irregularities created by ablation process. The border of a machined surface feature is shown in **Figure 1**. A dark field image of a subsurface bar code is shown in **Figure 2**.

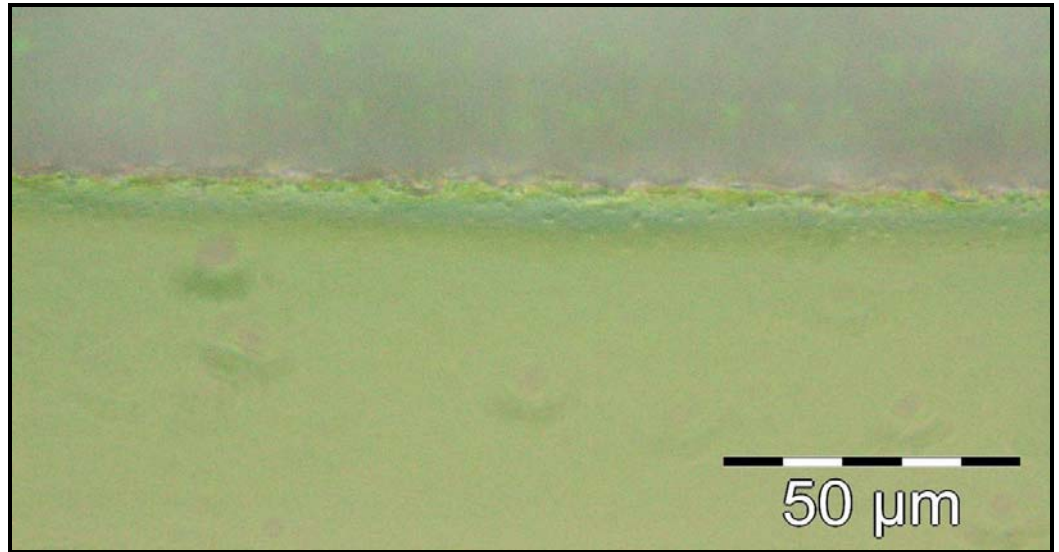


Figure 1: Pictured above is the border between the ablated region (top) and the unablated region of the tube (bottom). The microscope is focused on the edge of the feature. There are no apparent fractures or edge chips in either the feature edge or the adjoining material.

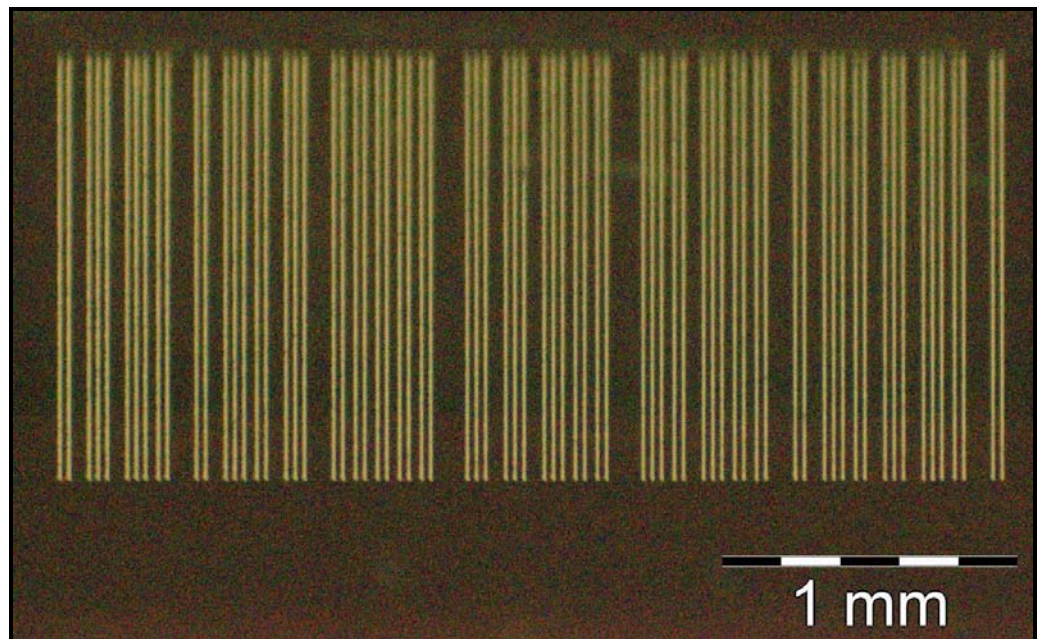


Figure 2: A dark field image of a sub-surface bar code machined in a SiO_2 tube.

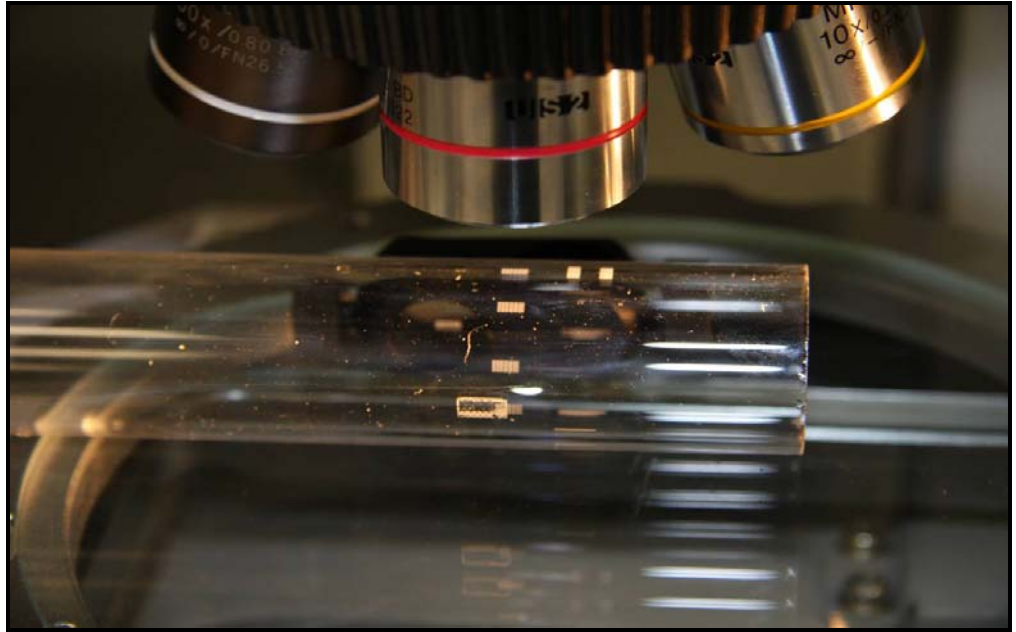


Figure 3: A macroscopic image of several bar codes machined into a quartz tube.

Typical linear speed of a single line feature was 500 mm/s. A volume 5 mm long by 100 wide and 10 μm deep was used for calculations of material removal rate. Mark time for ablating this volume was 0.8 seconds. Therefore:

Volume removal rate = 0.00625 mm^3/sec ($6.25 \times 10^6 \mu\text{m}^3/\text{sec}$).

Conclusion

Precise features can be easily machined in SiO_2 tubes without creating any collateral damage, such as edge fractures or chips, to the glass. Line features of this geometry can be ablated with a linear speed of 500 mm/s.