



WESTERN MICHIGAN UNIVERSITY

The Effect of Laser Heating on the Ductile to Brittle Transition of Si

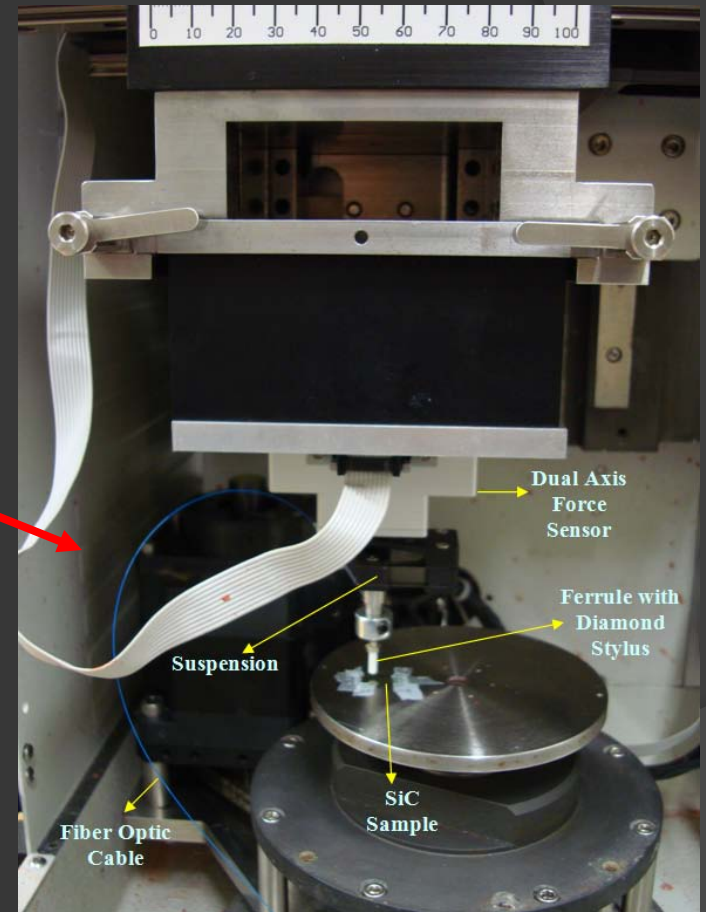
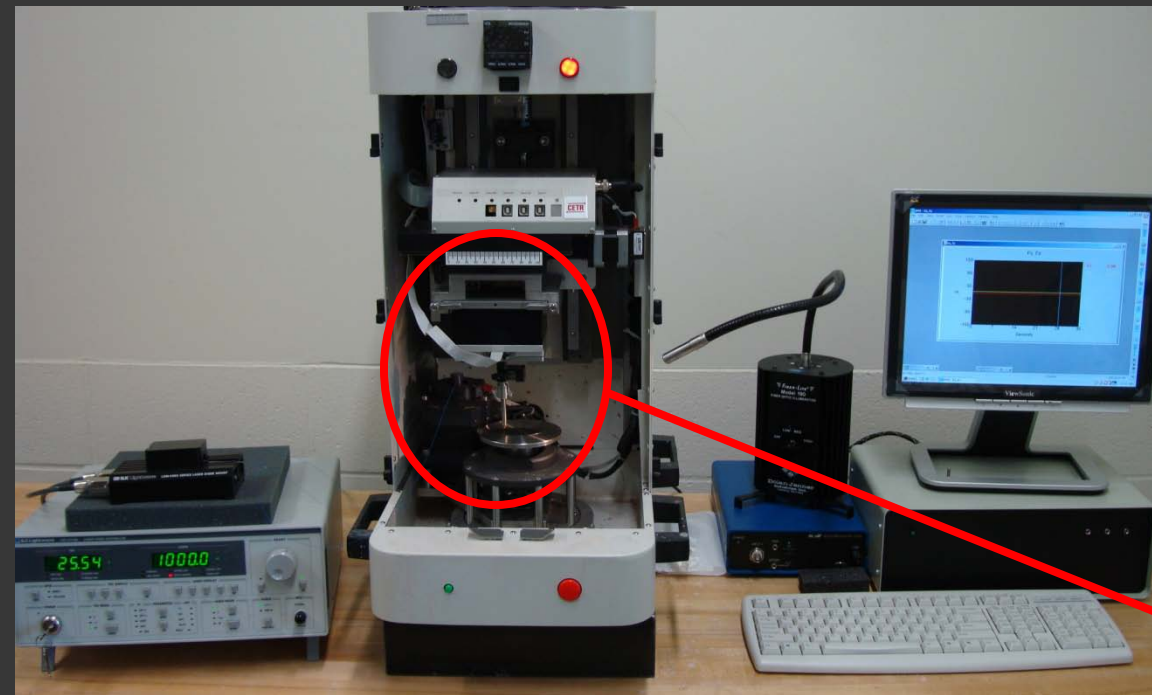
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Experimental Setup

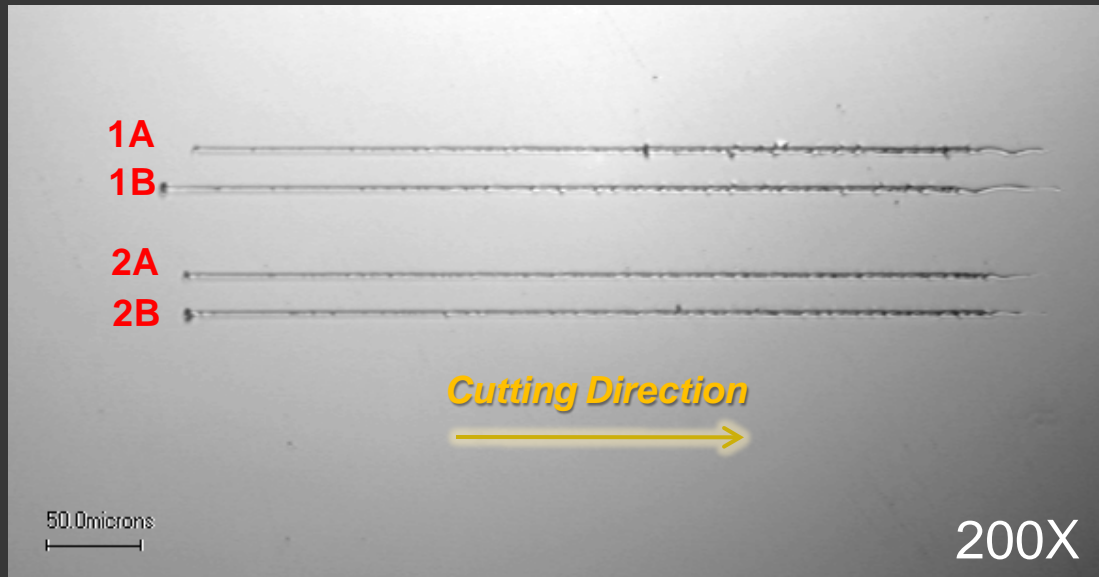


Testing Parameters

- ❖ # of scratches : 4
- ❖ cutting speed : 1 $\mu\text{m}/\text{sec}$
- ❖ scratch length : 500 μm
- ❖ cutting tool : 90° conical single crystal diamond tip with 5 μm radius spherical end
- ❖ laser wavelength : 1480 nm (*only applicable for the scratches w/ laser heating*)
- ❖ laser power : 350 mW (*only applicable for the scratches w/ laser heating*)
- ❖ Work piece : Si wafer
- ❖ Crystal plane : (100)
- ❖ Cutting direction: [110]



Scratch Matrix



1 A : No Laser

1 B : With 350mW Laser

} 20-90 mN (2-9 g load)

2 A : No Laser

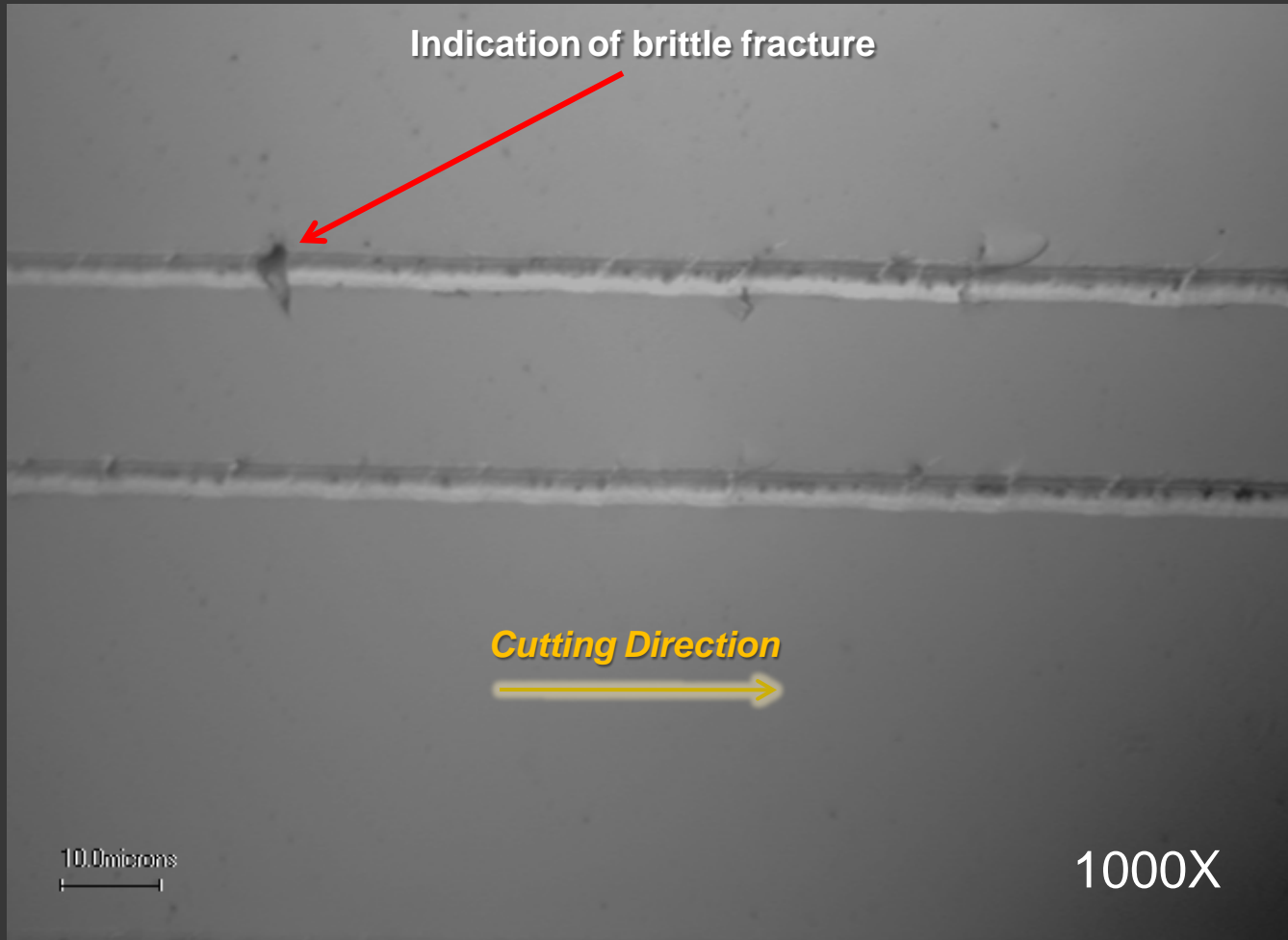
2 B : With 350mW Laser

} 20-70 mN (2-7 g load)

** Results comparing scratches 2A and 2B were used for analysis.*



Experimental Setup

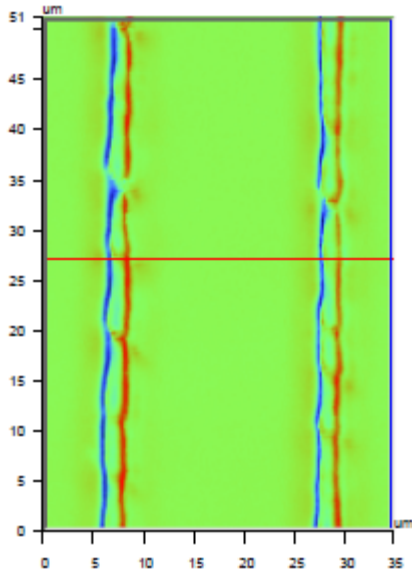


No Laser

With Laser



Depth of Cut Comparison



X Profile



Title: Lsr(L) vs No Lsr(R)

Note: 700nm (Duct) vs 480nm (DBT)

Fz ~ 3.2 g or 32 mN



Depth of Cut 3D Comparison

Measurement Info:

Magnification: 39.84

Measurement Mode: VSI

Sampling: 210.82 nm

Array Size: 369 X 440

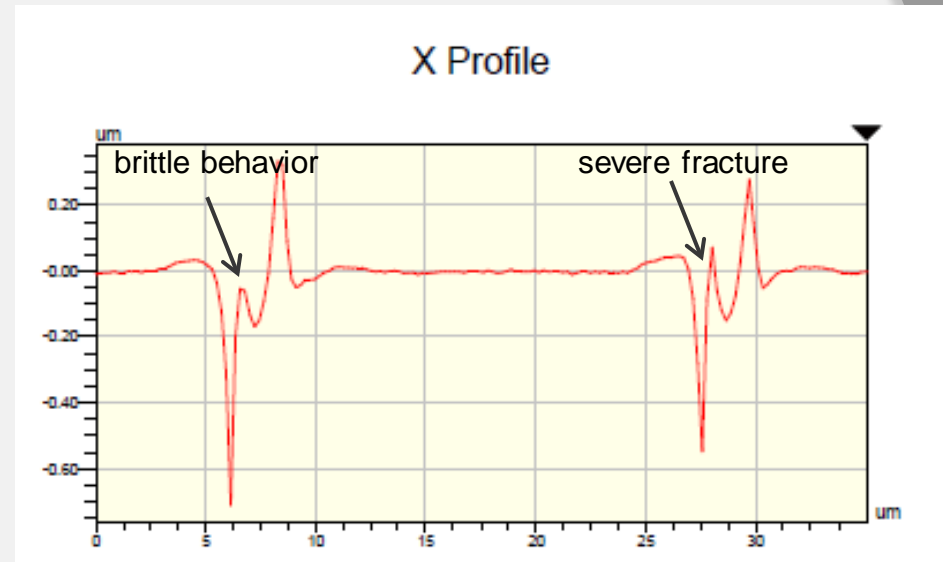
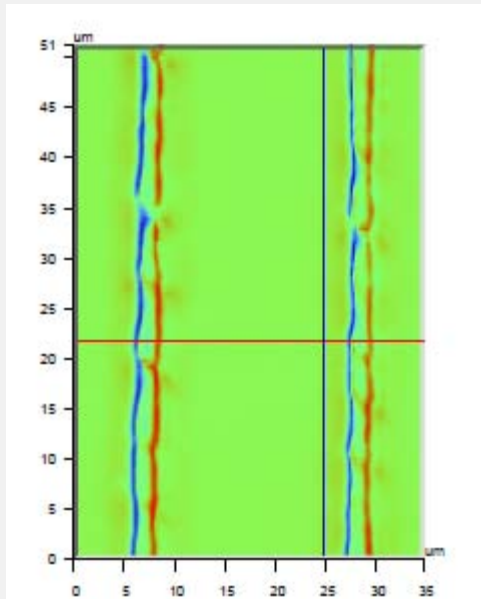


Title: Laser effect on Si

Note: With (left) & Without Laser (right)



Depth of Cut Comparison



Title: Lsr(L) vs No Lsr(R)

Note: 710nm (DBT) vs 540nm (Brittle)

Fz ~ 4.2 g or 42 mN

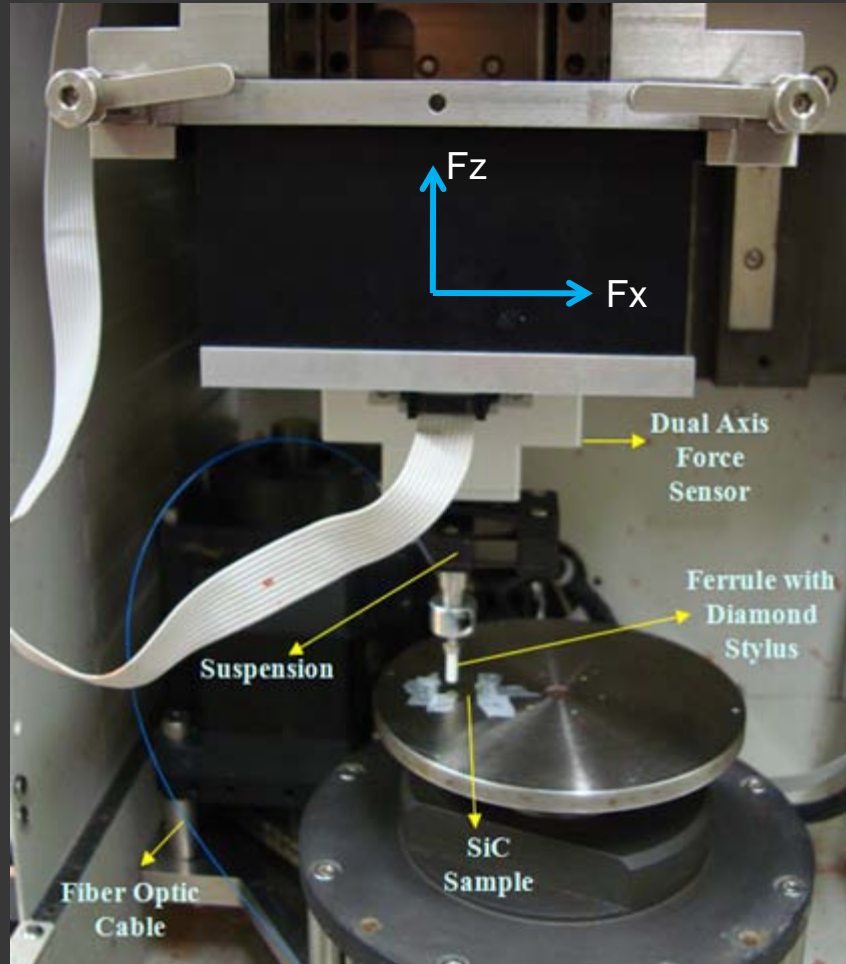


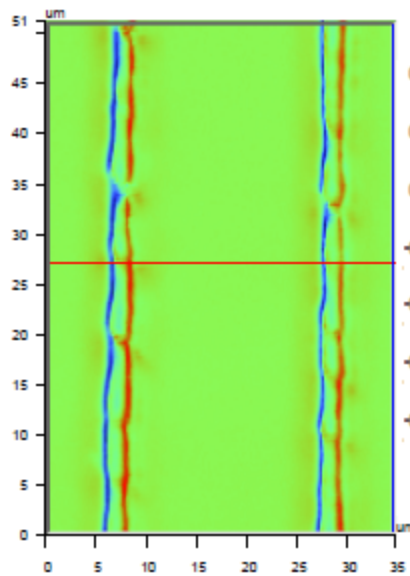
Summary

Machining Condition	Fz (mN)	Fx (mN)	DoC (nm)	Scratch Nature
no laser	20	5.8	280	Ductile
with laser	20	5.3	400	Ductile
no laser	32	9.0*	480	DBT
with laser	42	11.0*	710	DBT

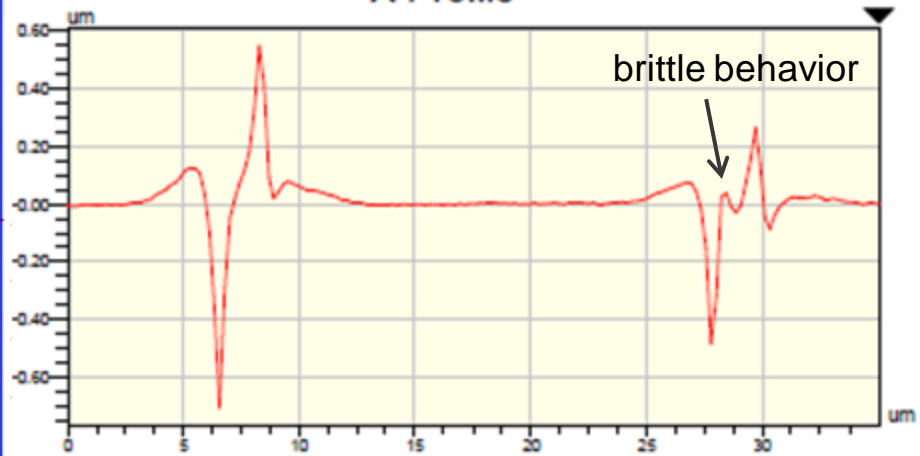
**Just before DBT occurs.*







X Profile



Title: Lsr(L) vs No Lsr(R)

Note: 700nm (Duct) vs 480nm (DBT)

THANK YOU

QUESTIONS

