Water Erosion Resistance Surface Treatment Using Low Plasticity Burnishing(LPB)

Madina

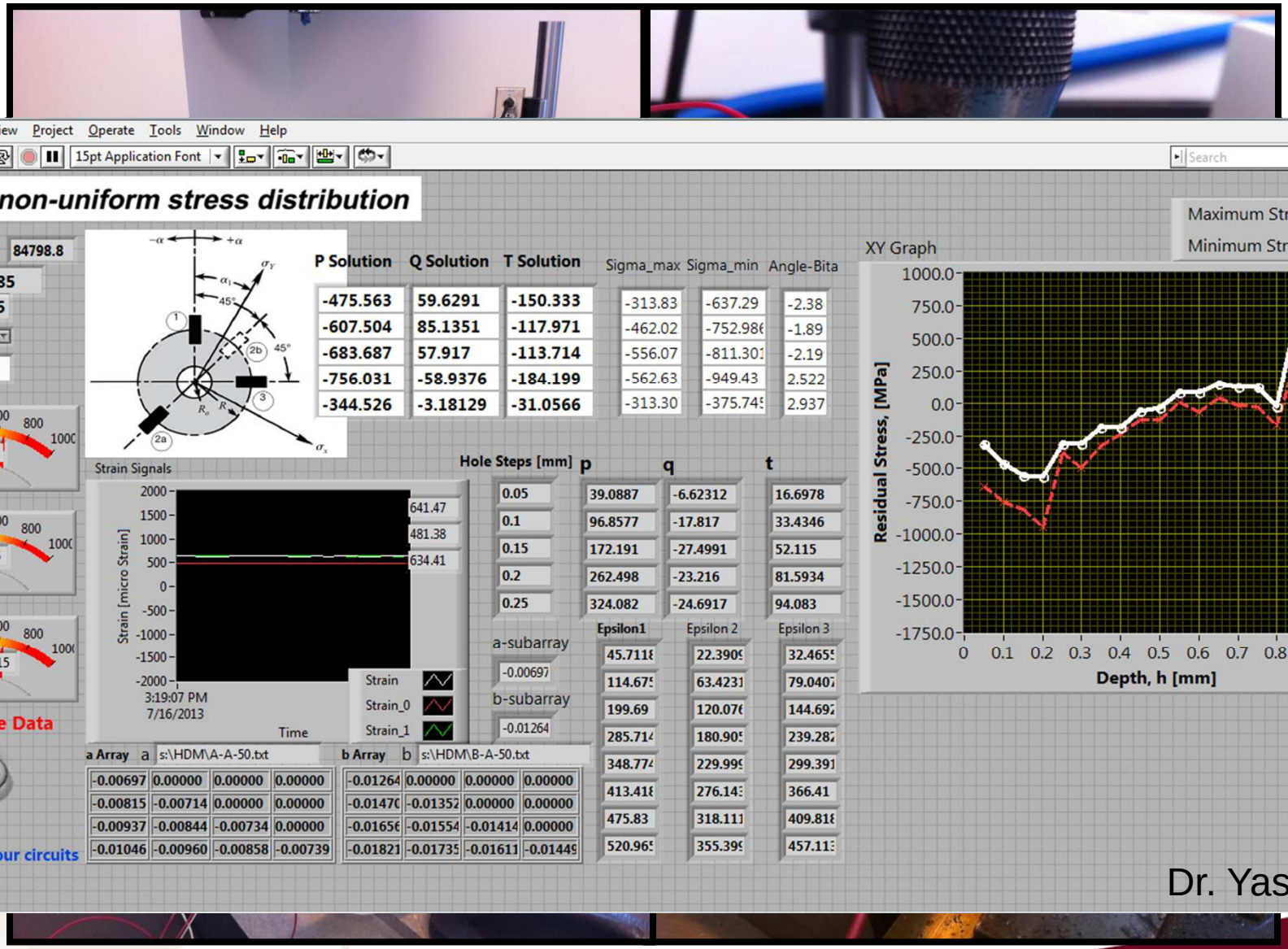
Supervisor: Professor Medraj

Date: 2013/10/03

Outline

- Residual stress distribution
- Water erosion rig test
- Effect of surface roughness on incubation period
- Status of the work for the project

Incremental Hole-drilling Residual Stress Measurement



Dr. Yasser

Residual stress distribution

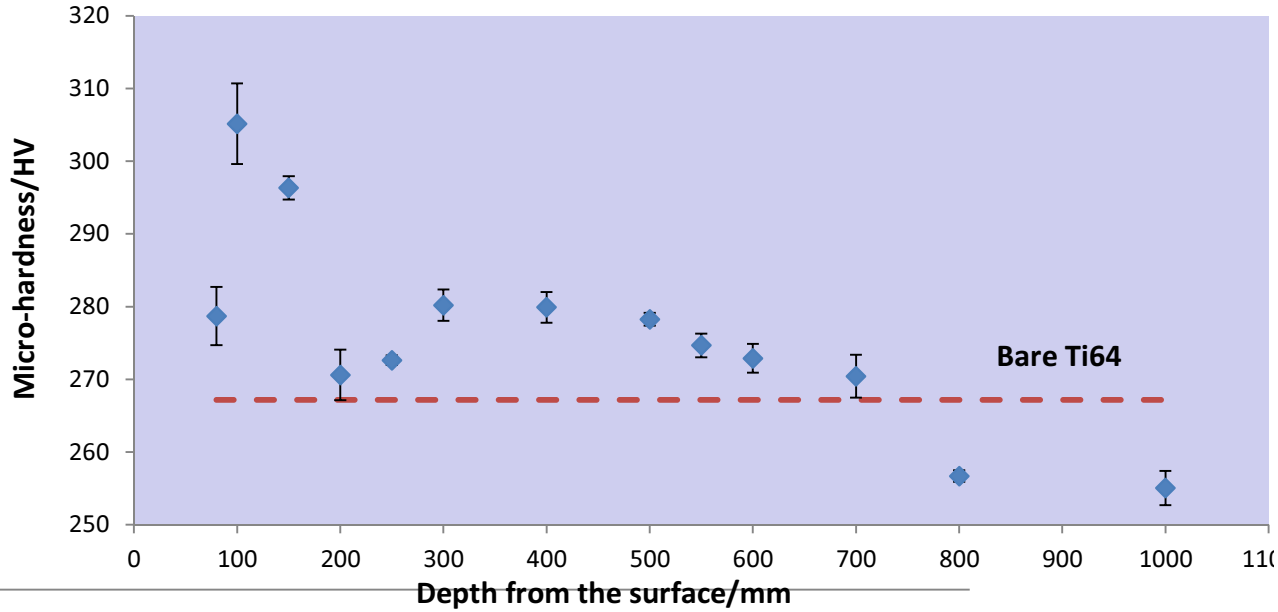
- LPB sample #6 (+ - - +)

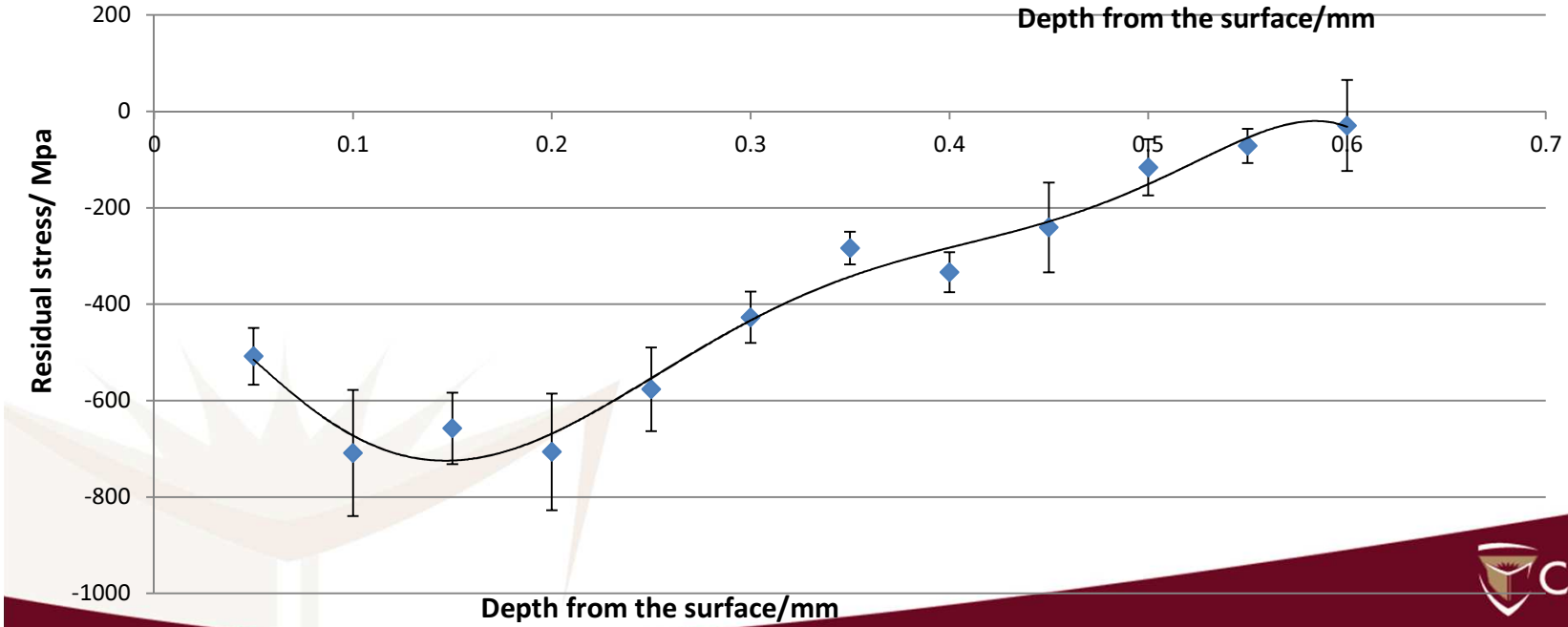
Spindle velocity: 150rpm

Feed: 0.06mm/rev

#Passes: 1

Pressure: 200 bar





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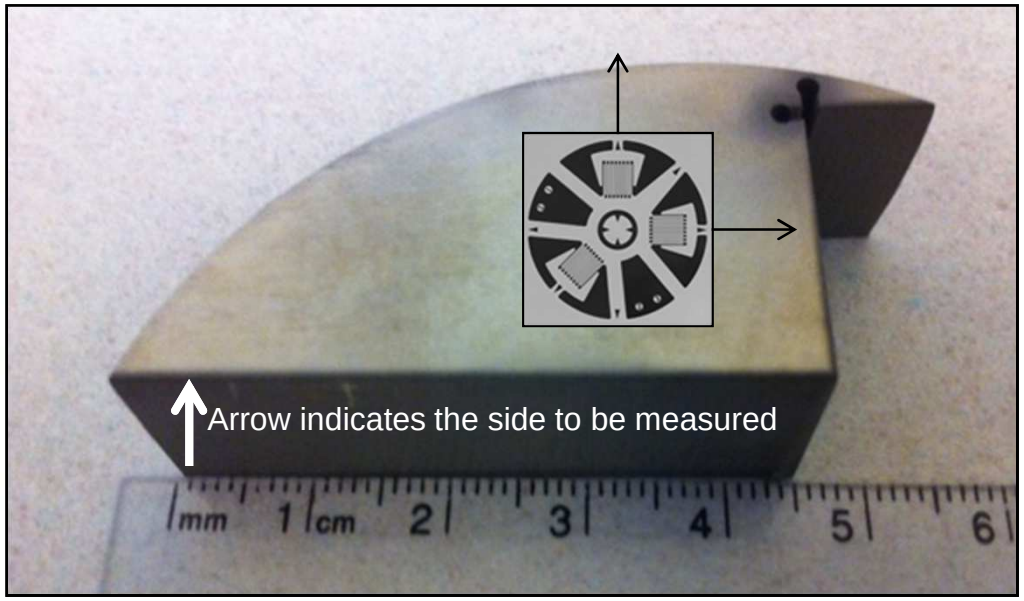
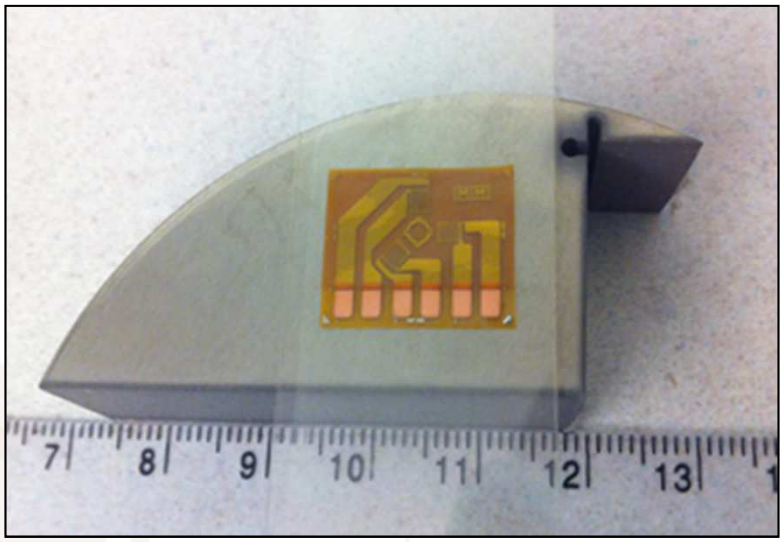
Residual Stress Measurement

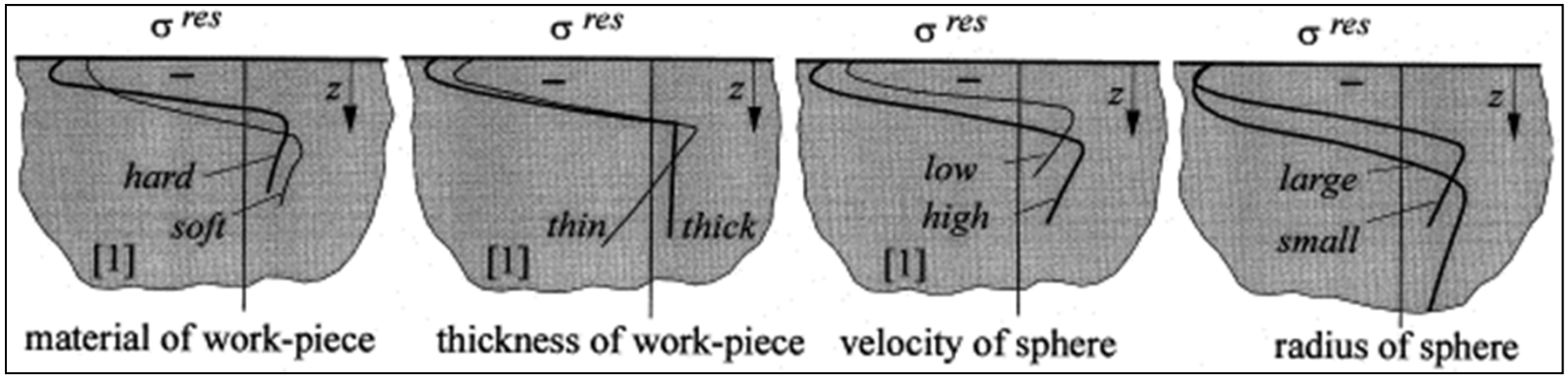




Stresscraft Ltd.(UK)

062RE/UL/UM gauges: drilling increment depths are set at 4 x 32 μm + 4 x 64 μm + 8 x 128 μm to give a completed hole depth of 1408 μm for residual stress data to depth 1024 μm

Residual Stress Distribution



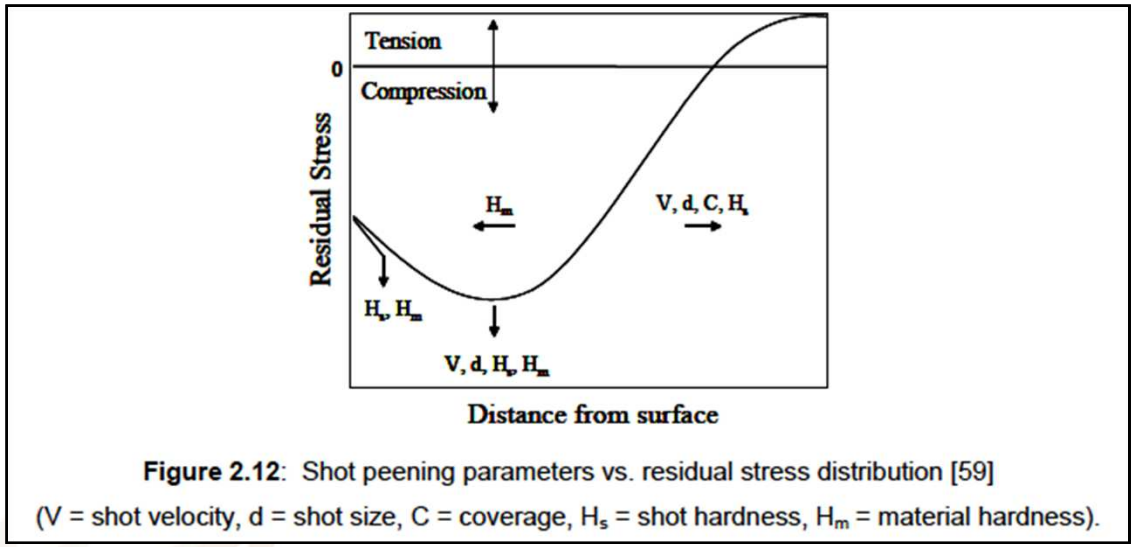


Figure 2.12: Shot peening parameters vs. residual stress distribution [59]
(V = shot velocity, d = shot size, C = coverage, H_s = shot hardness, H_m = material hardness).

K Schiffner, 1999;
Baskaran Bhuvaraghana, 2010.

LPB Parameters:
Spindle Velocity; Feed; #Passes; Pressure.

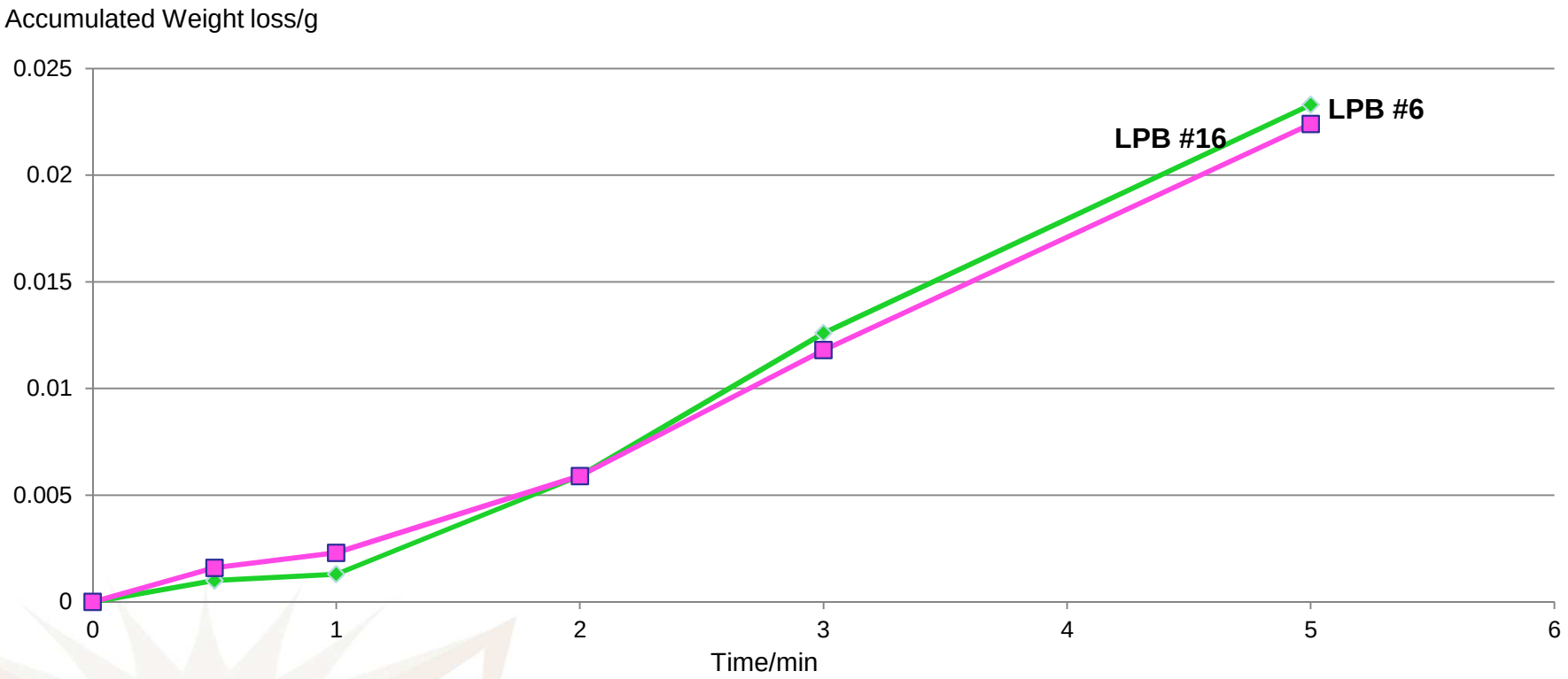
Water Erosion Rig Test

Droplet size : 600 microns
Impact Velocity : 350 m/s (14000 rpm)

Water Erosion Rig Test

Parameters of LPB sample #6	
Spindle Velocity: 150rev/min	Feed: 0.06mm/rev
#Passes: 1	Pressure: 200 Bar

Parameters of LPB sample #16	
Spindle Velocity: 150rev/min	Feed: 0.20mm/rev
#Passes: 1	Pressure: 100 Bar

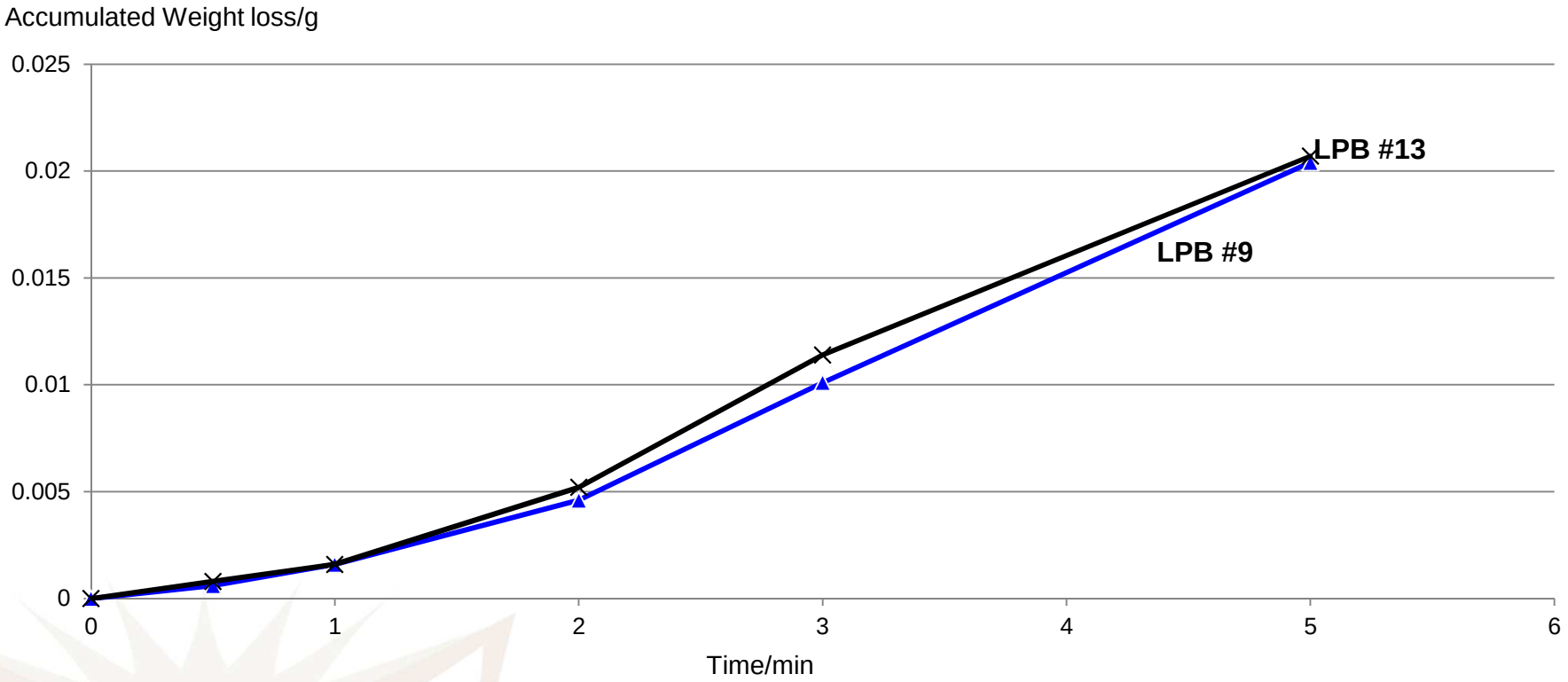


Droplet size: 600 microns
Speed: 350 m/s

Water Erosion Rig Test

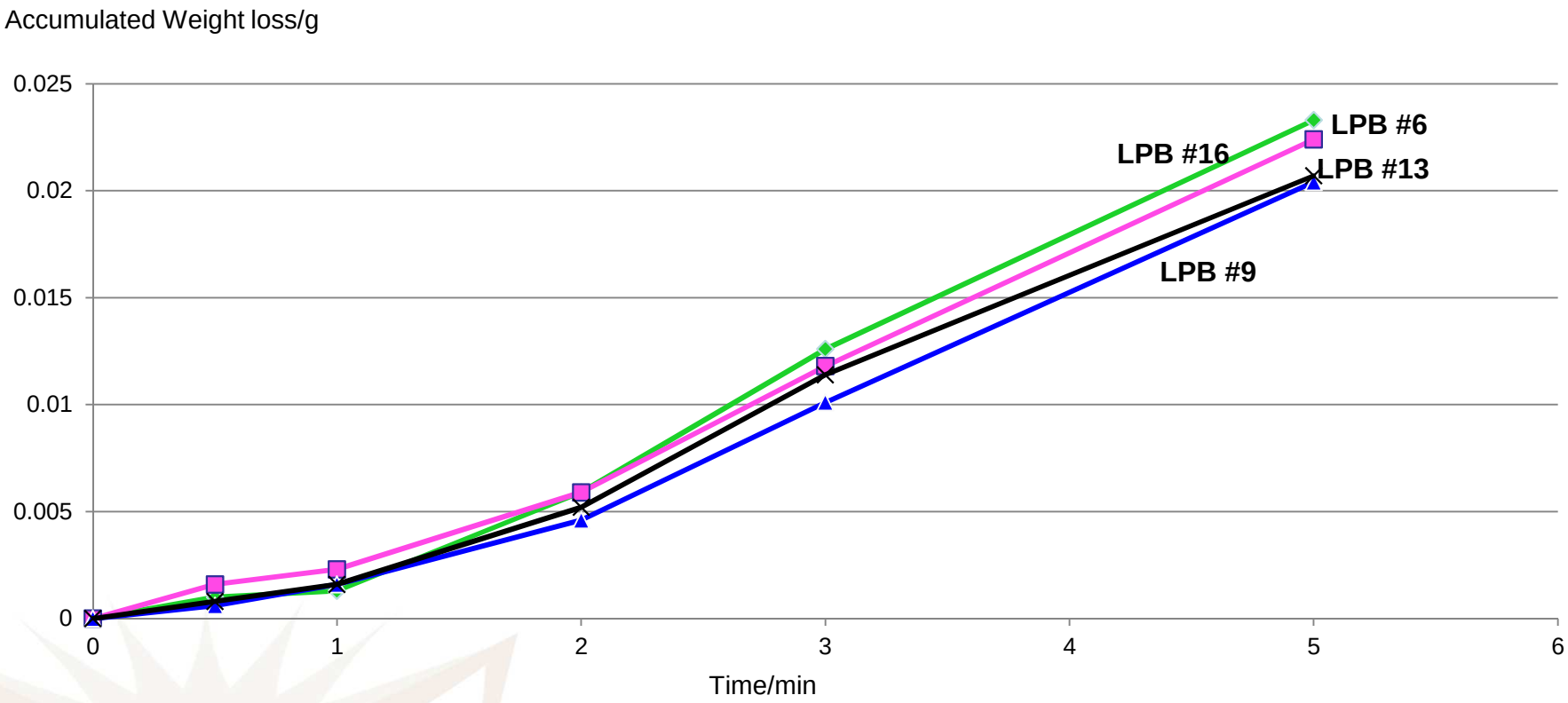
Parameters of LPB sample #9	
Spindle Velocity: 75rev/min	Feed: 0.20mm/rev
#Passes: 3	Pressure: 200 Bar

Parameters of LPB sample #13	
Spindle Velocity: 150rev/min	Feed: 0.20mm/rev
#Passes: 3	Pressure: 100 Bar



Droplet size: 600 microns
Speed: 350 m/s

Water Erosion Rig Test



Droplet size: 600 microns
Speed: 350 m/s

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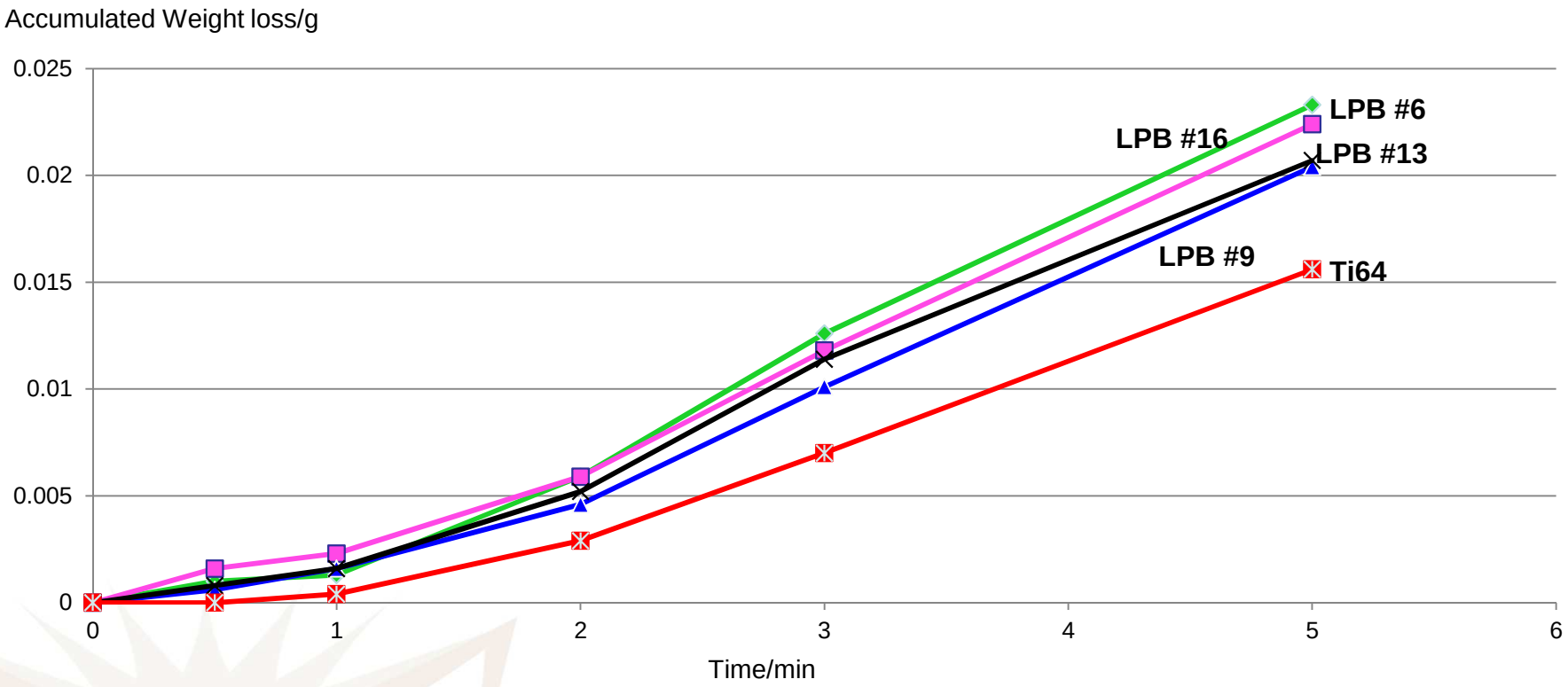
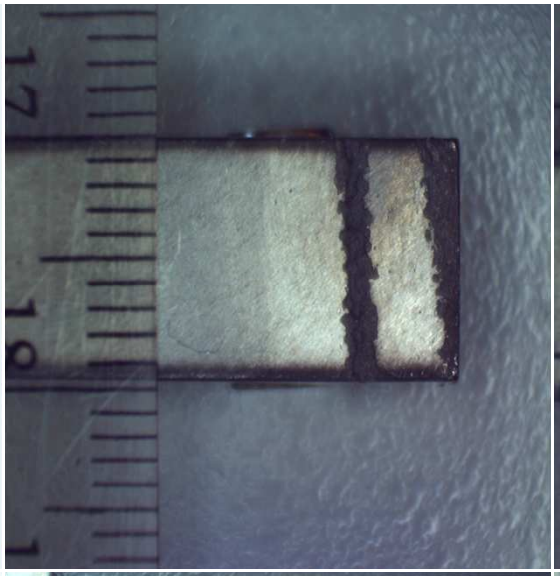
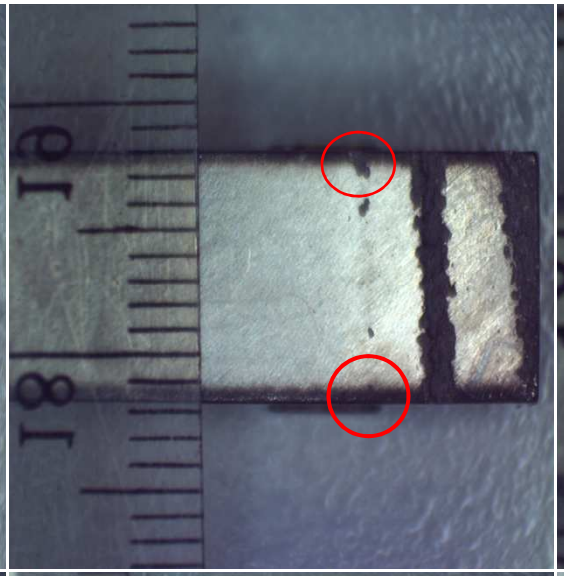
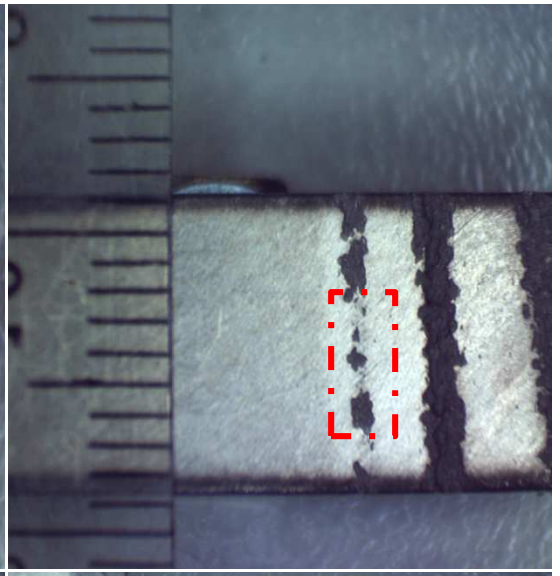
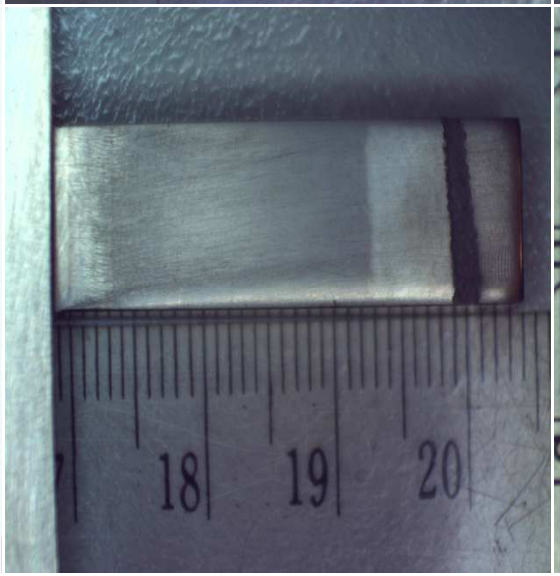
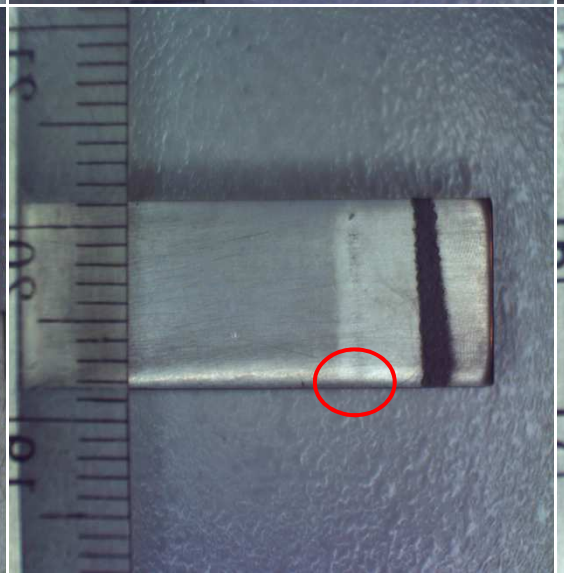
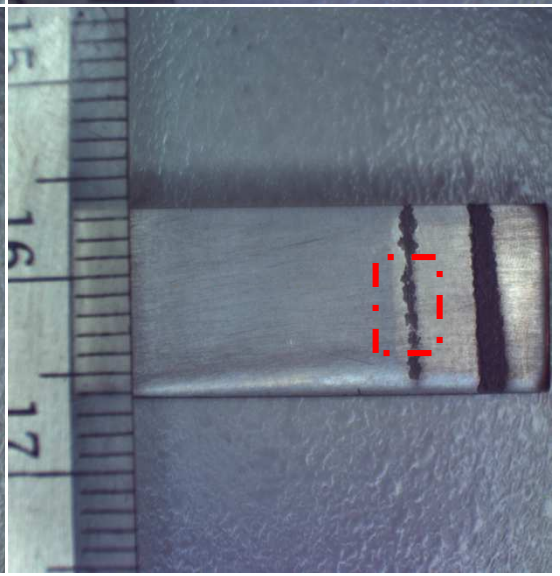
Water Erosion Rig Test

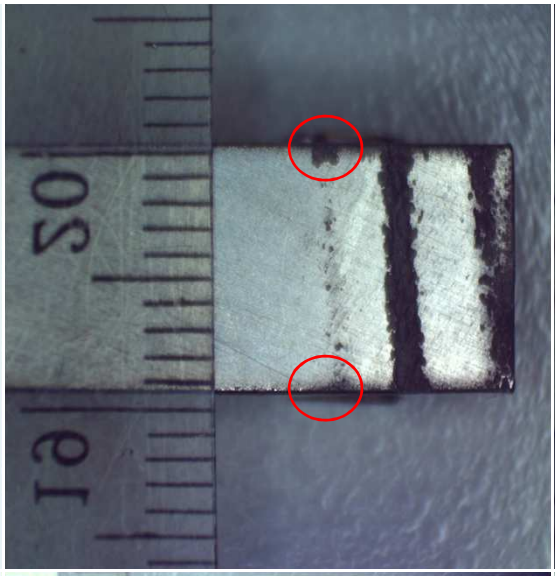
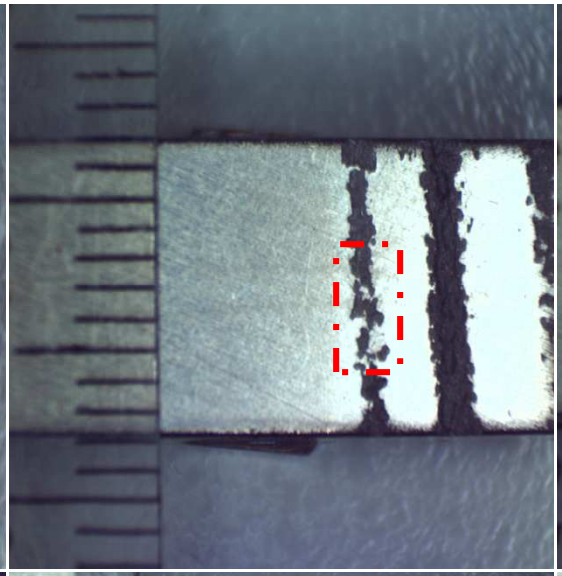
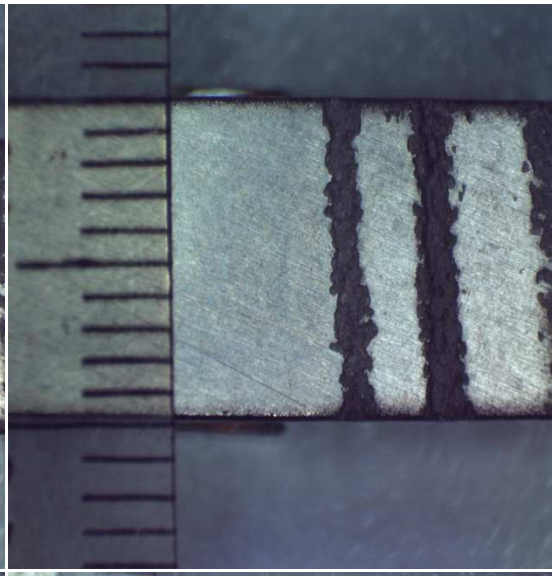
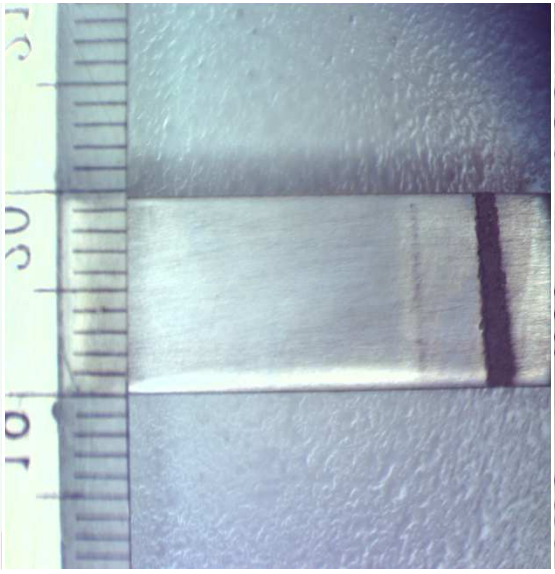
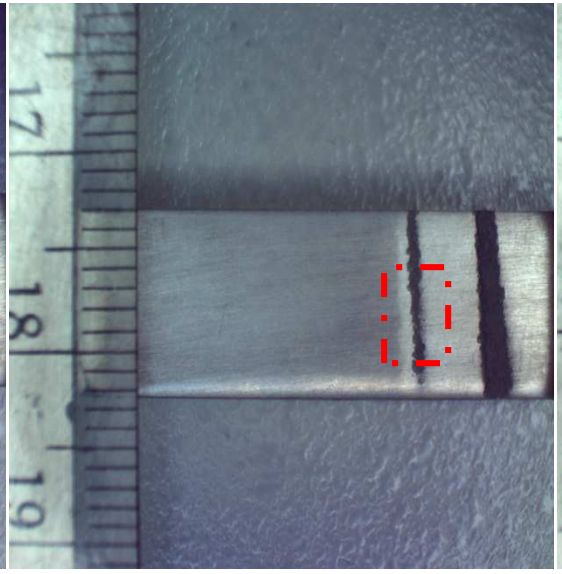
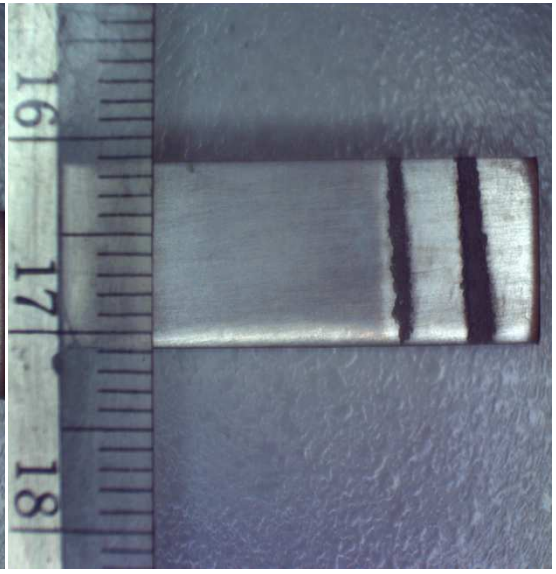


Droplet size: 600 microns
Speed: 350 m/s

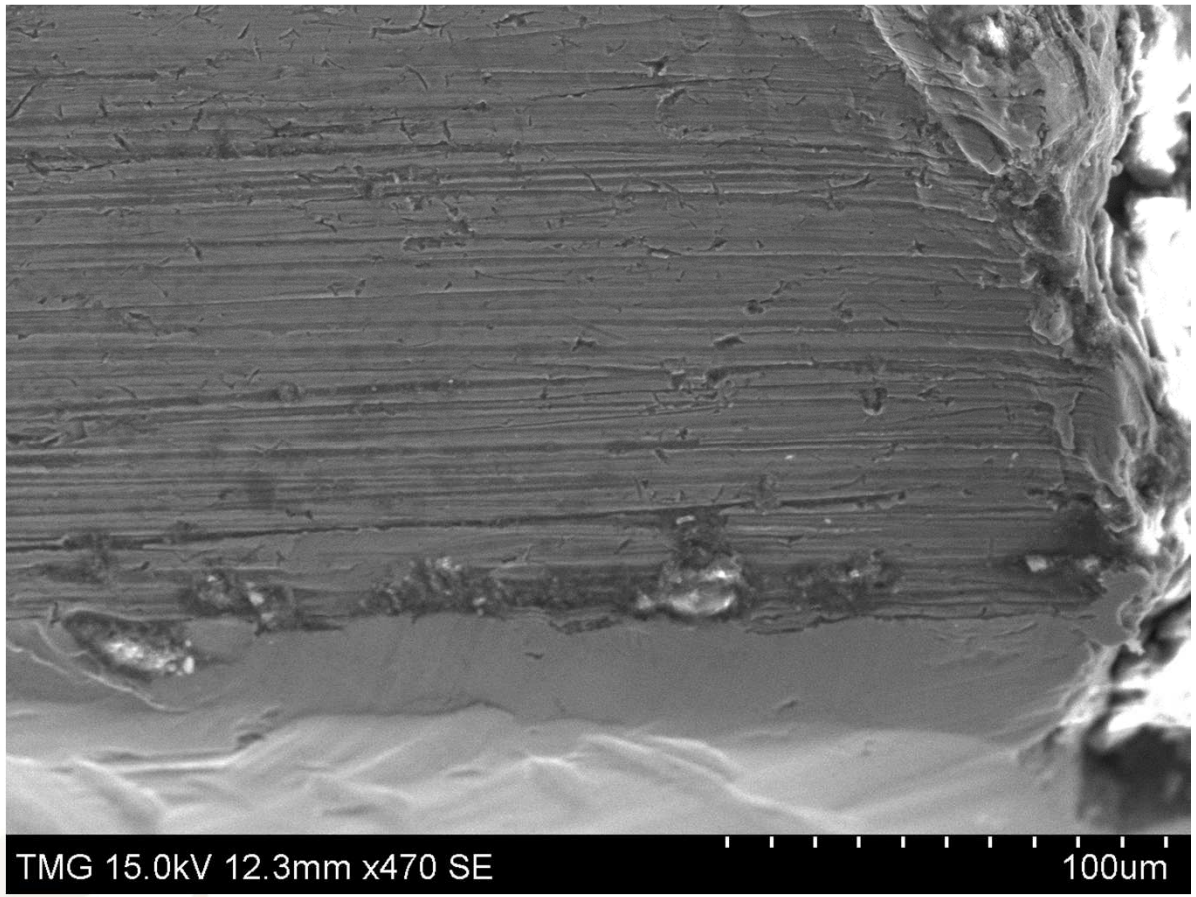
Erosion Surface of Test 1

Time	0.5 min	1 min	2 mins
LPB #13			
Ti64 #13			

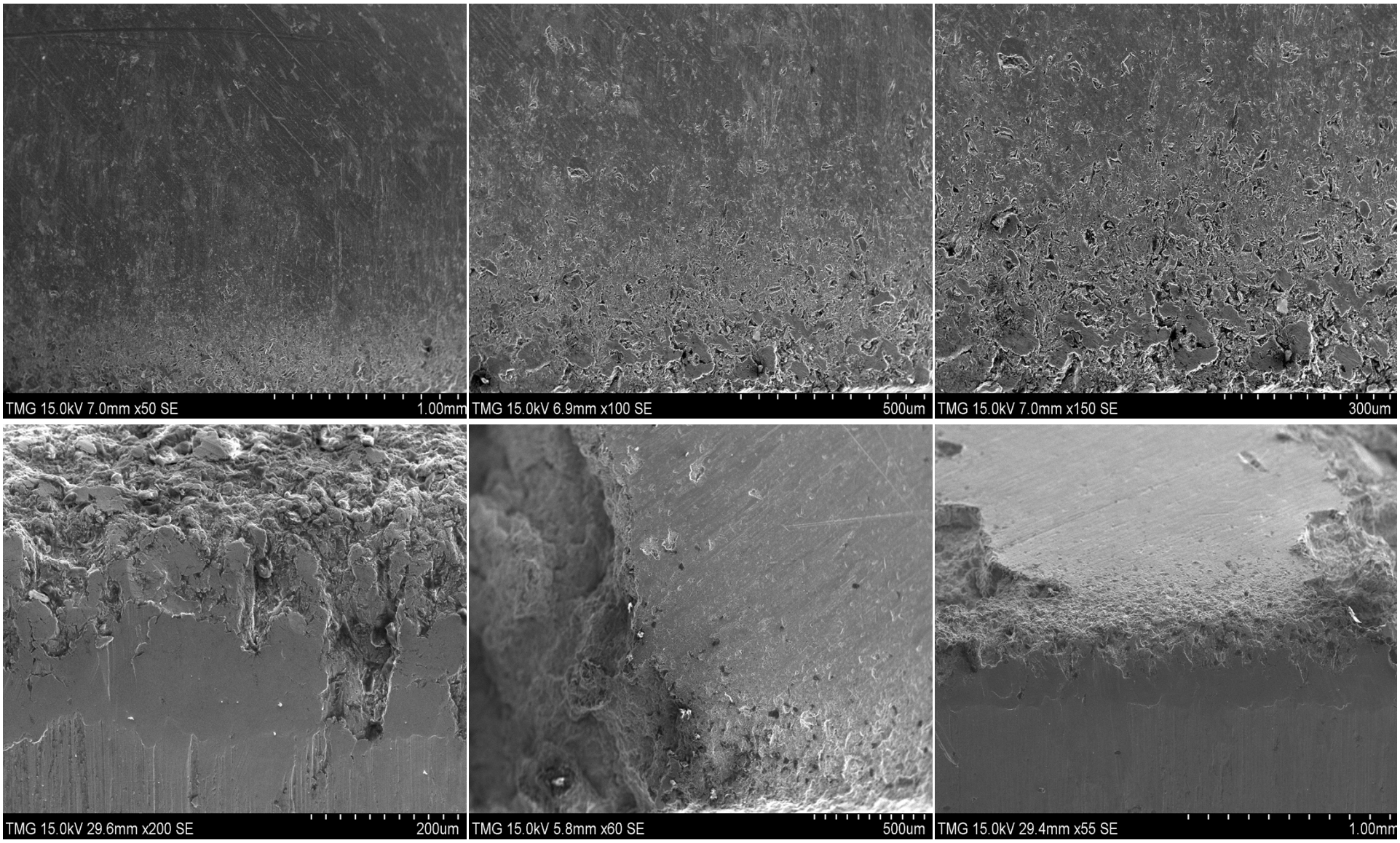
Erosion Surface of Test 2

Time	1 min	2 mins	3 mins
LPB #9			
Ti64 #9			

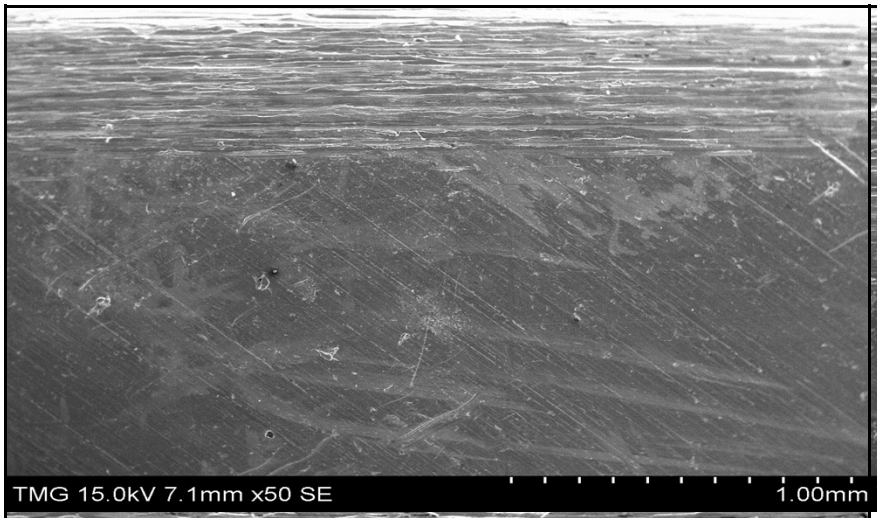
SEM image of Ti64 edge

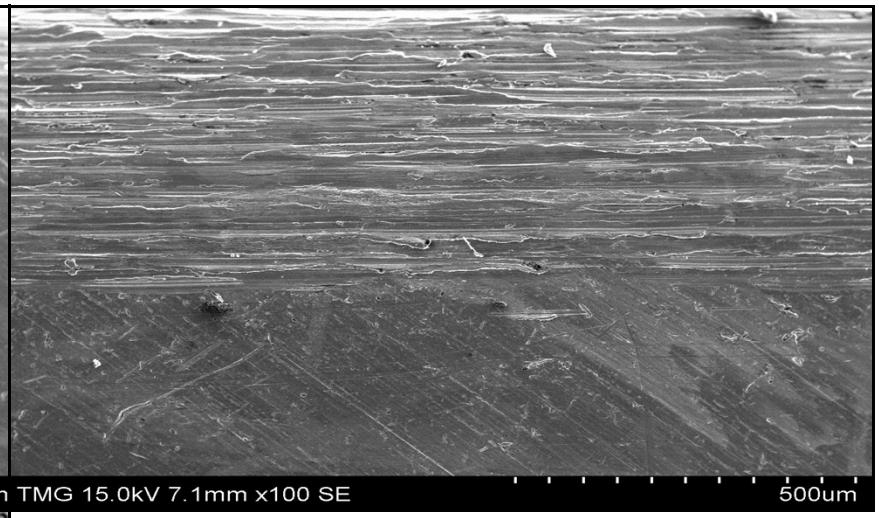


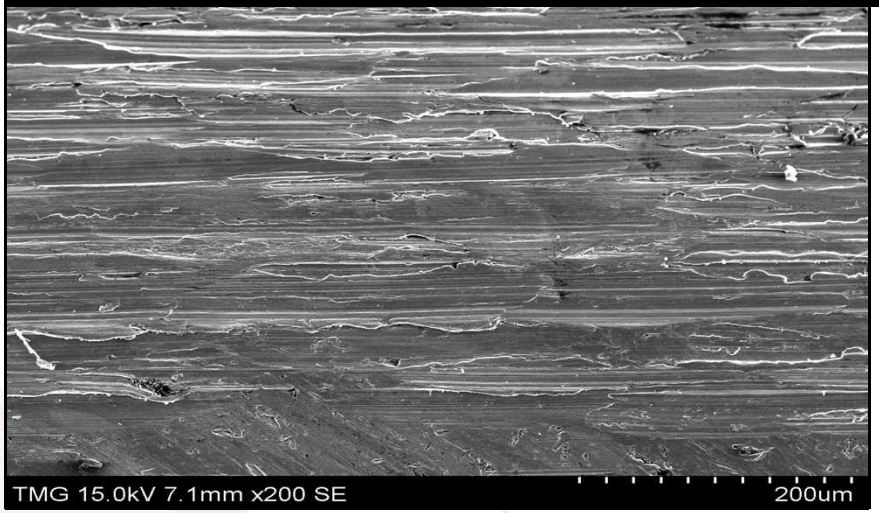
SEM image of the Water Jet Cutting Edges of LPB Coupons



SEM After Polishing the Edges of LPB Coupons

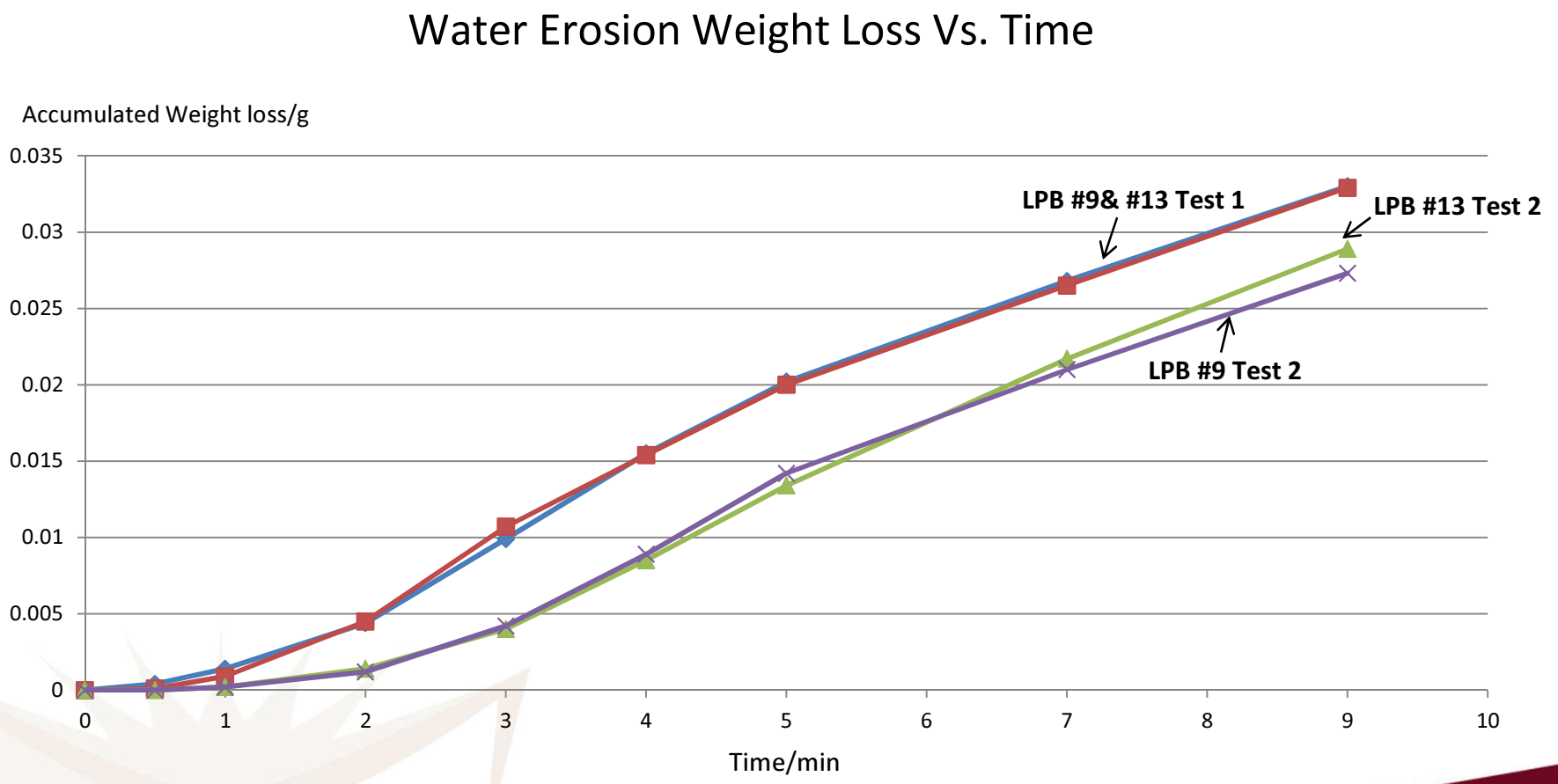




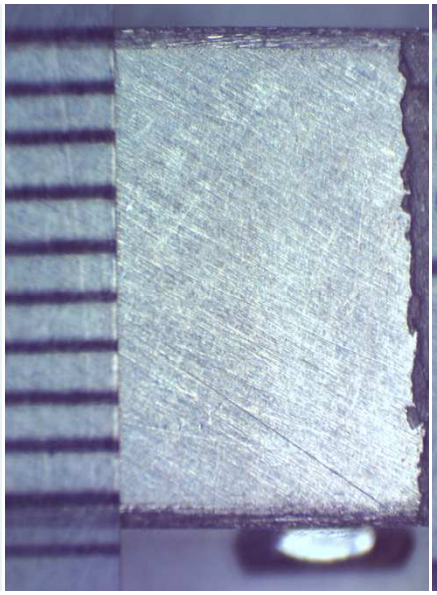
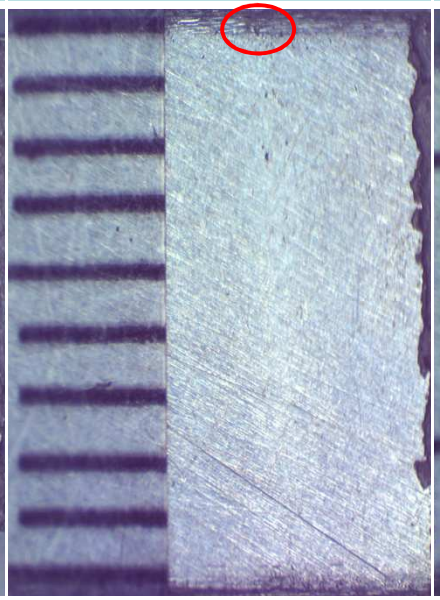
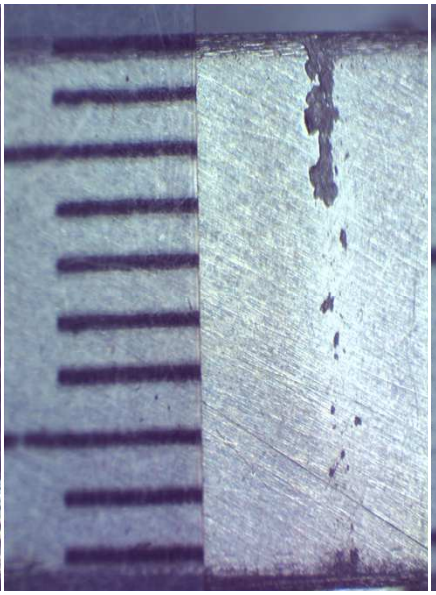
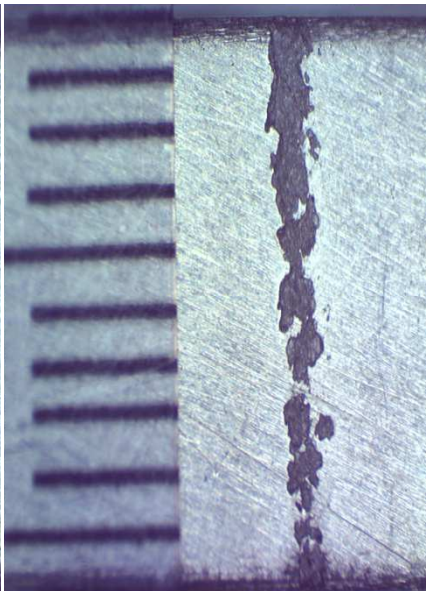
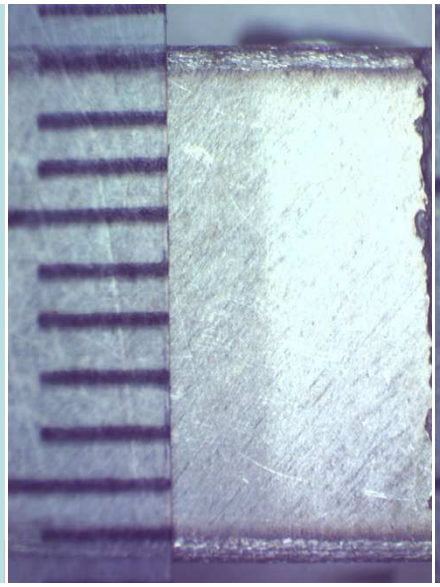
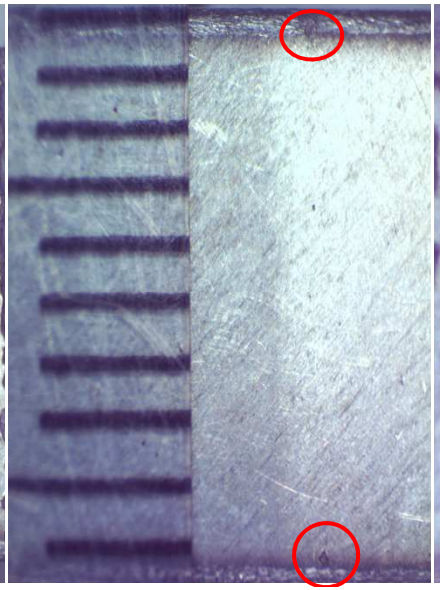
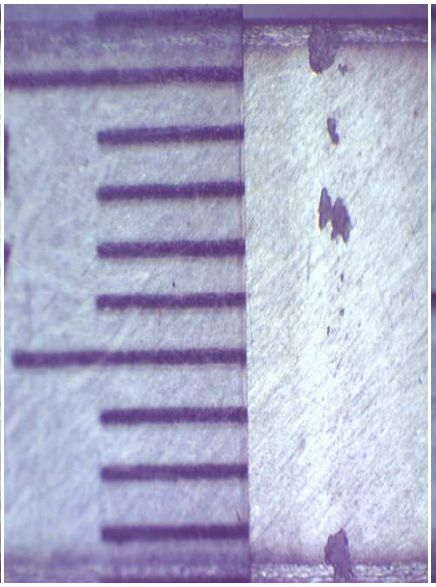
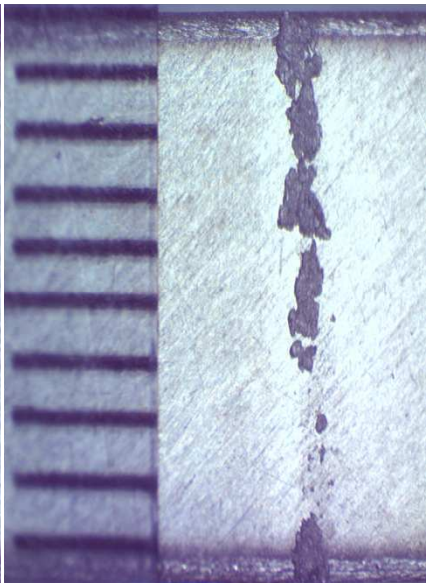


High speed polishing has been done to remove the stress released, micro-crack layer of LPB coupons.

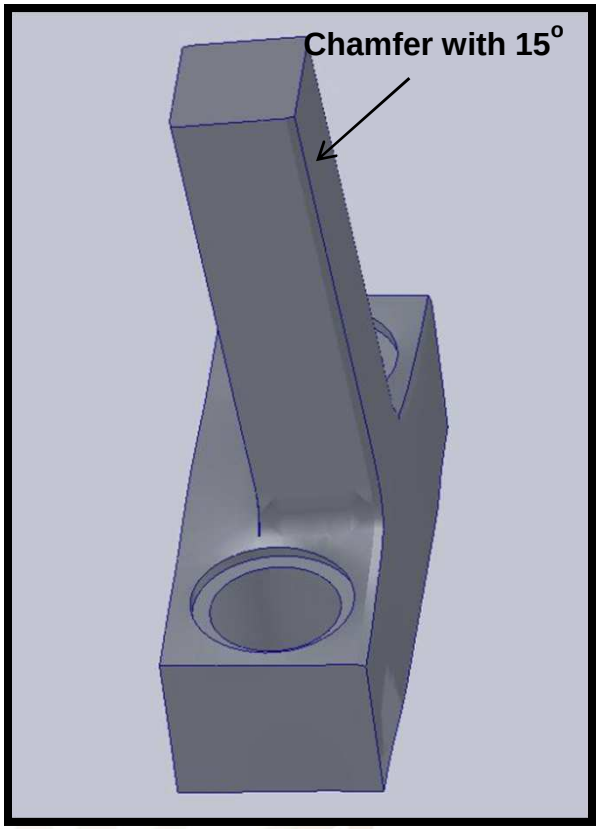
LPB Test1 **Vs.** LPB Test2



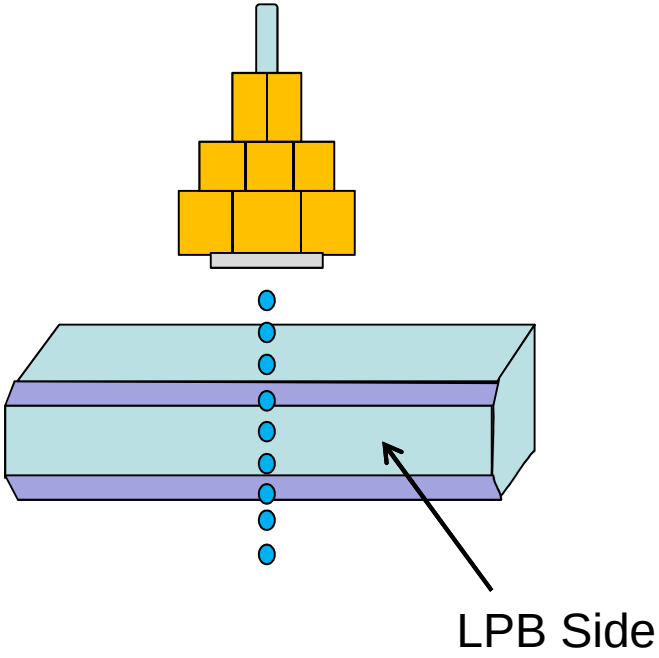
Erosion Surface

Time	0.5 min	1 min	2 mins	3mins
LPB #9				
LPB #13				

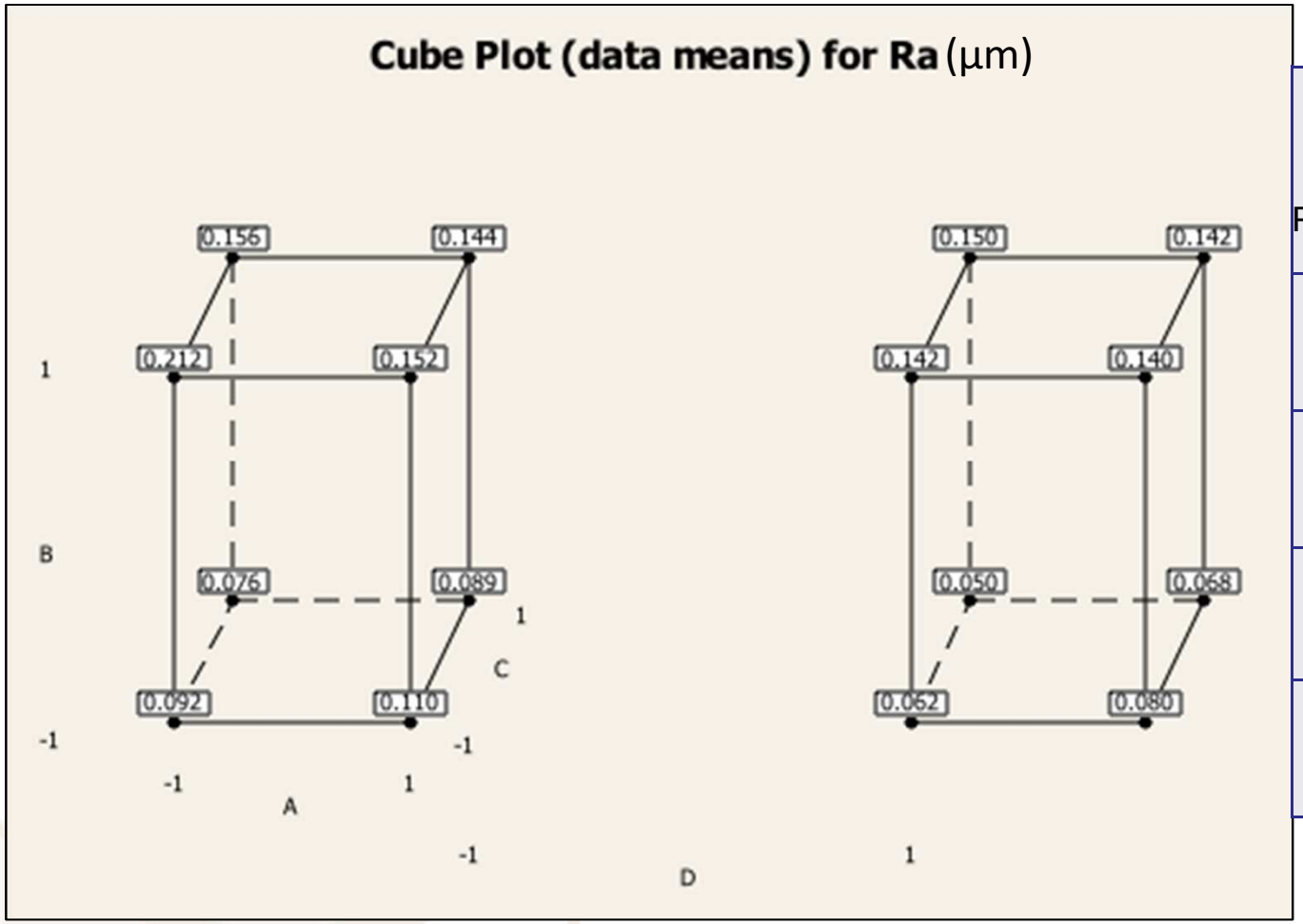
Solution For Water-jet Cutting Edges



Safety factor = 2.3



Surface Roughness Ra Vs. Incubation Period



Levels / Factors	High(+1)	Low(-1)
A: Spindle Velocity(r/min)	150	75
B: Feed(mm/r)	0.20	0.06
C: No. of passes	3	1
D: Pressure(bar)	200	100

Surface roughness (Ra) of bare Ti64 before LPB : 0.457µm

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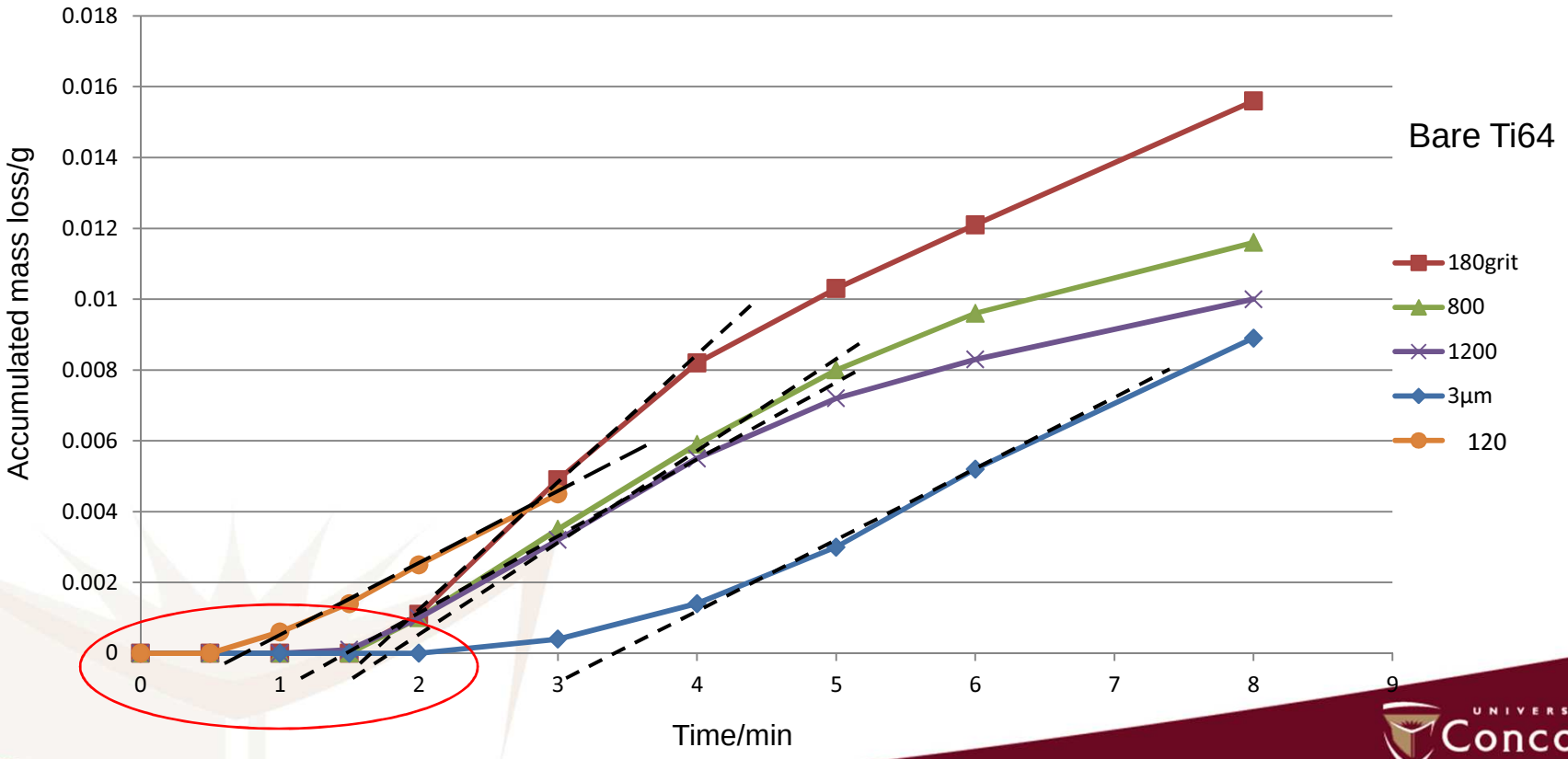
Surface Roughness Ra
Vs.
Incubation Period



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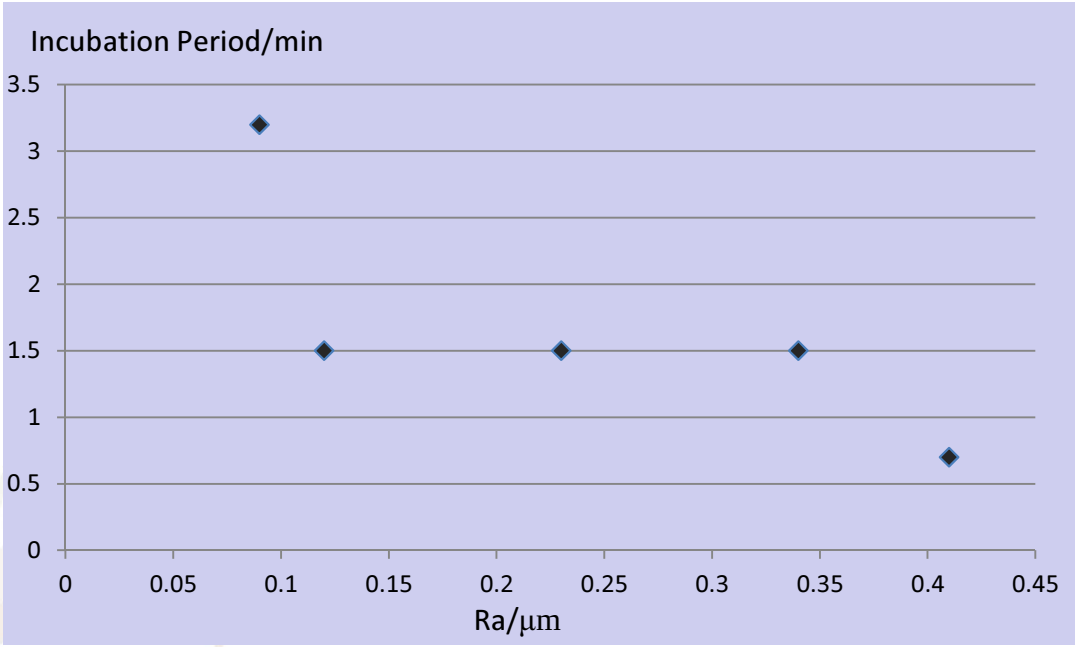
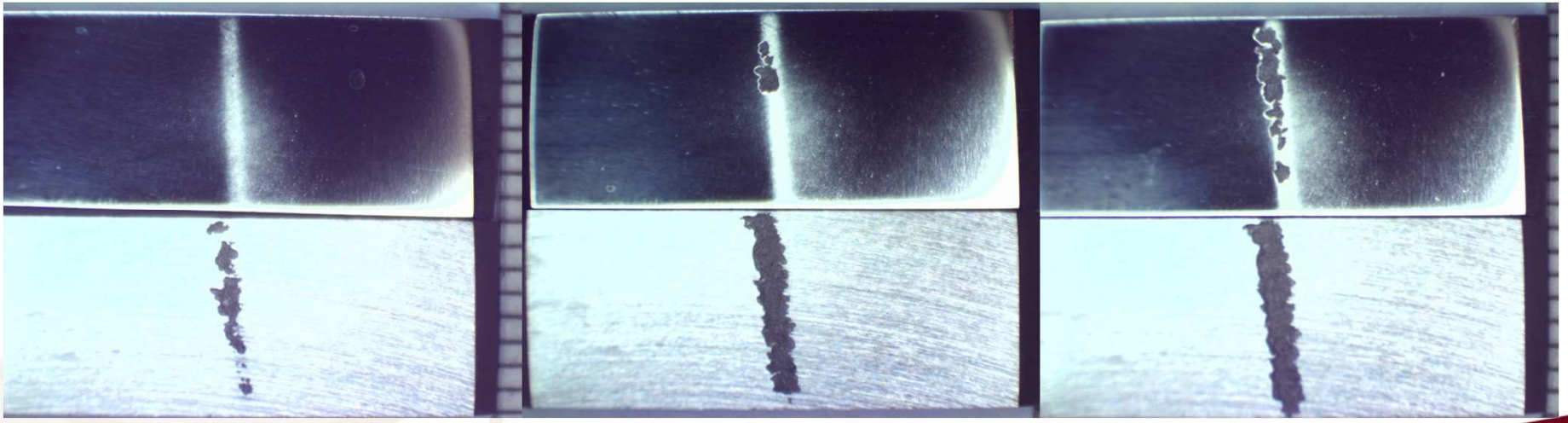
Ra Vs. Incubation Period

Grinding Grit	#120	#180	#800	#1200	#3 μm
Average Ra/μm	0.43	0.34	0.23	0.12	0.09
Incubation Period/min	0.7	1.5	1.5	1.5	3.2



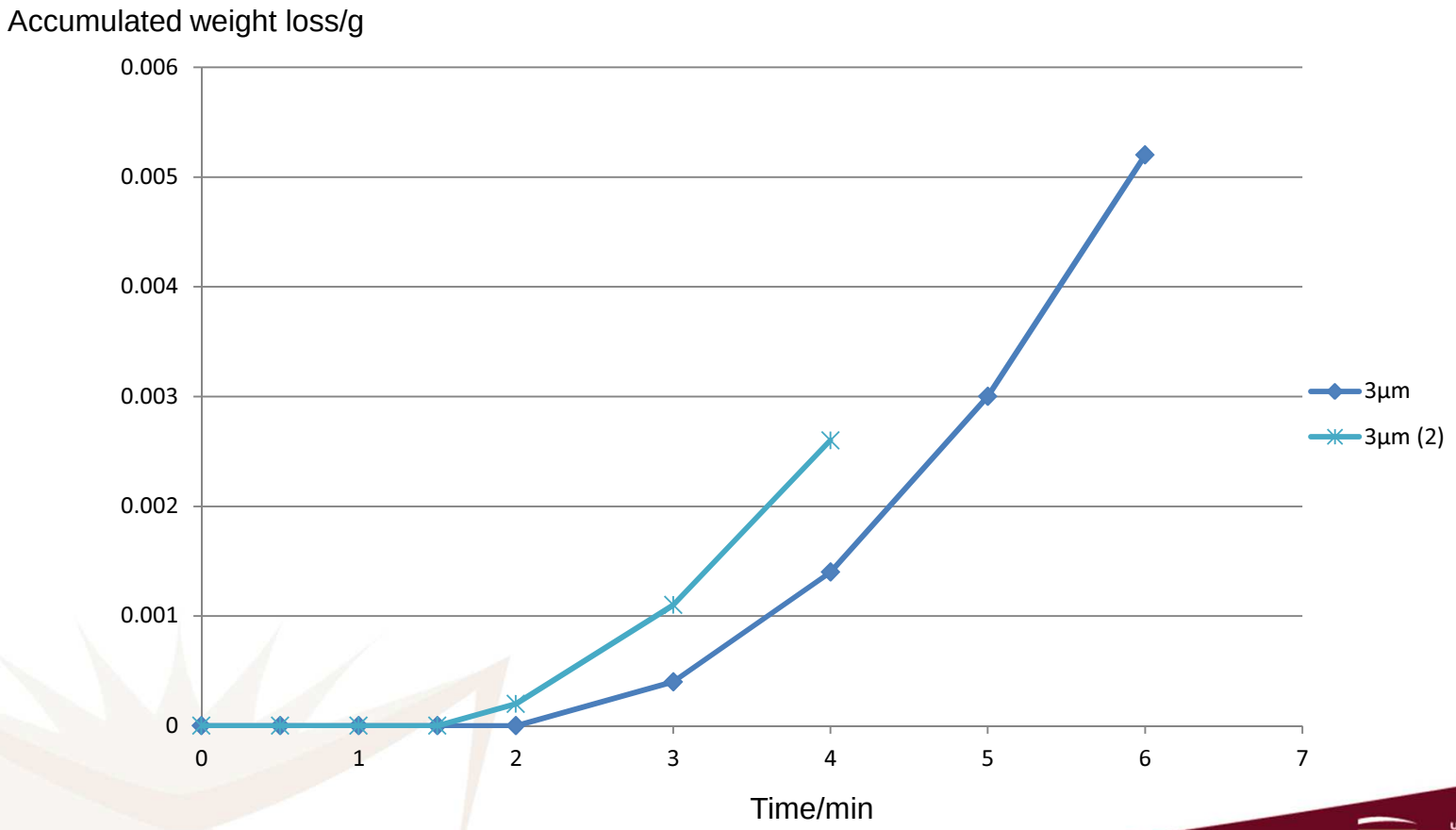
Erosion Surface Study

0.5 min 1 min 1.5 min

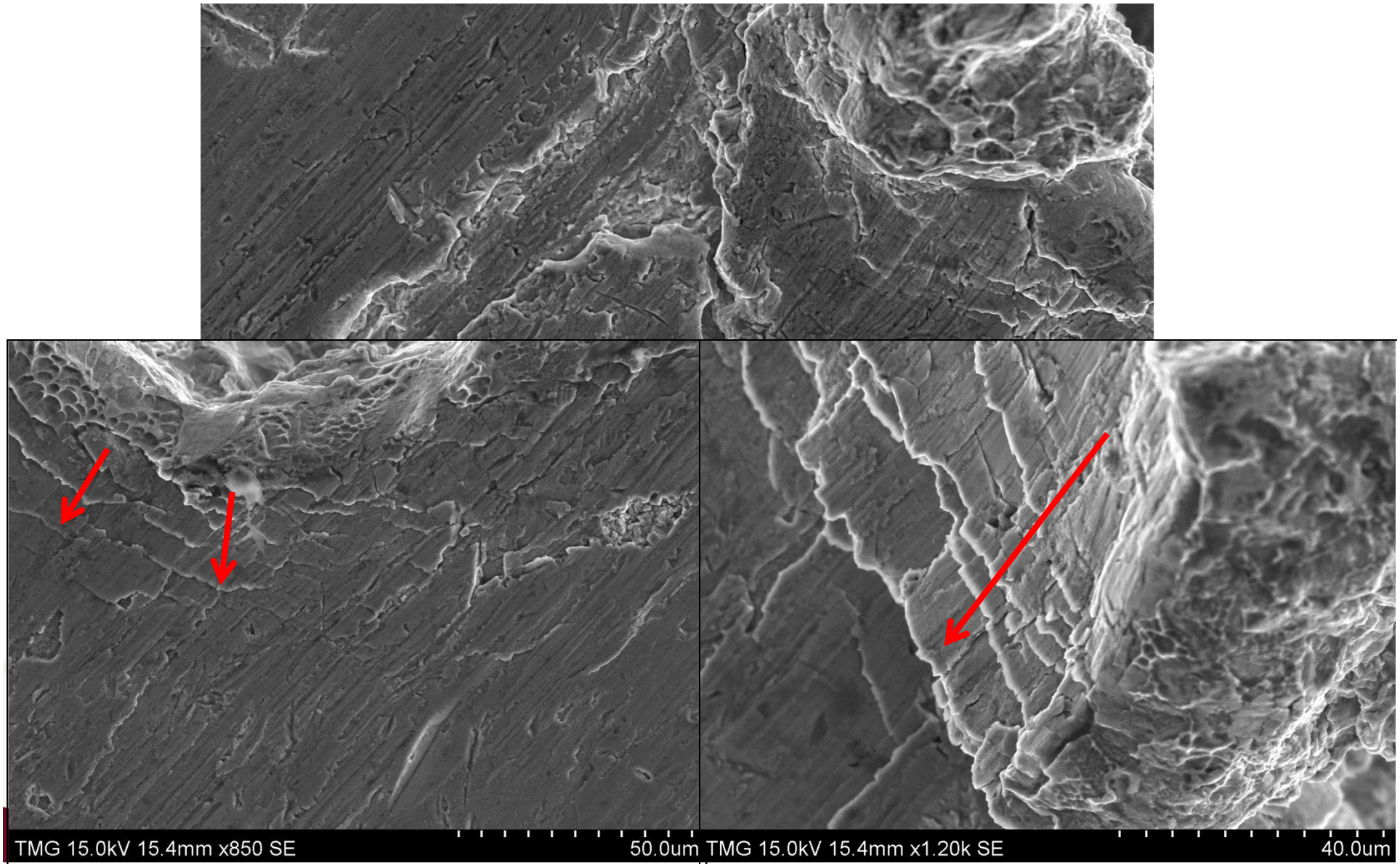


2 min 3 min 4 min

Repetition of the water erosion test for surface roughness effect study



Erosion Surface Study



Status of the work for the project

Main Activities	Description	Status
Review of low plasticity burnishing (LPB)	---	Finished
Manufacturing of LPB coupons	Full factorial design was used with 4 LPB process parameters to set up 16 different LPB conditions. LPB was operated with the newly purchased Ecoroll tool. 32 T-shape coupons were prepared from 16 LPB treated Ti64 disks.	Finished
Process optimisation and evaluation of process parameters on mechanical effects	Based on DOE, samples were characterized by **residual stress measurements**, hardness measurements, surface roughness measurements and microstructure analysis.	Finished
Water erosion tests	LPB with various stress distributions tested on the water erosion rig. Correlation of water erosion performance and residual stress.	In progress

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THANKS