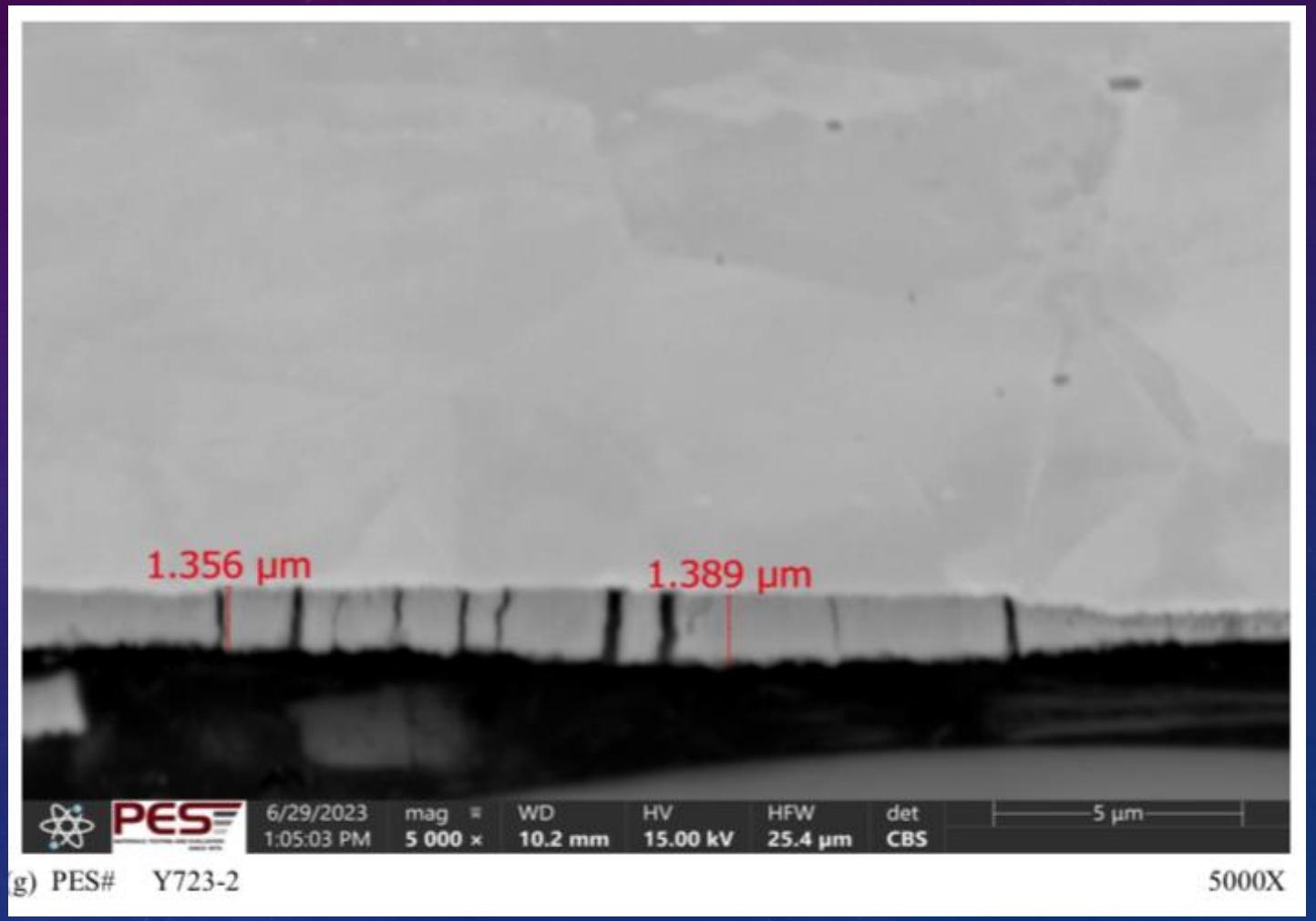
Metallography, Laser Scanning Microscopy and White Light Profilometry of Steel Pipe Surfaces

DAN HENKEL

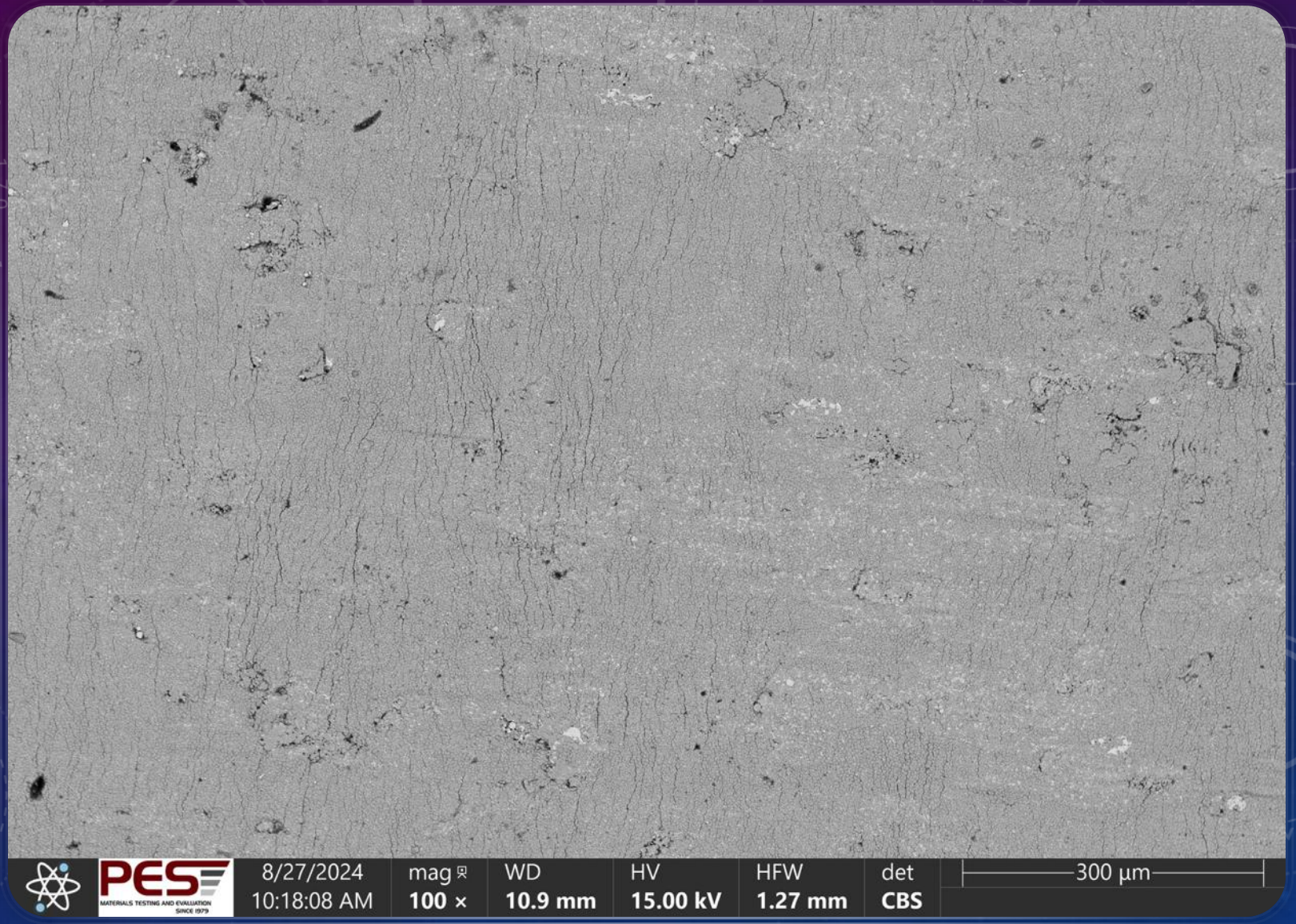
October 1, 2025

Magnetite Thickness Caltech Steel



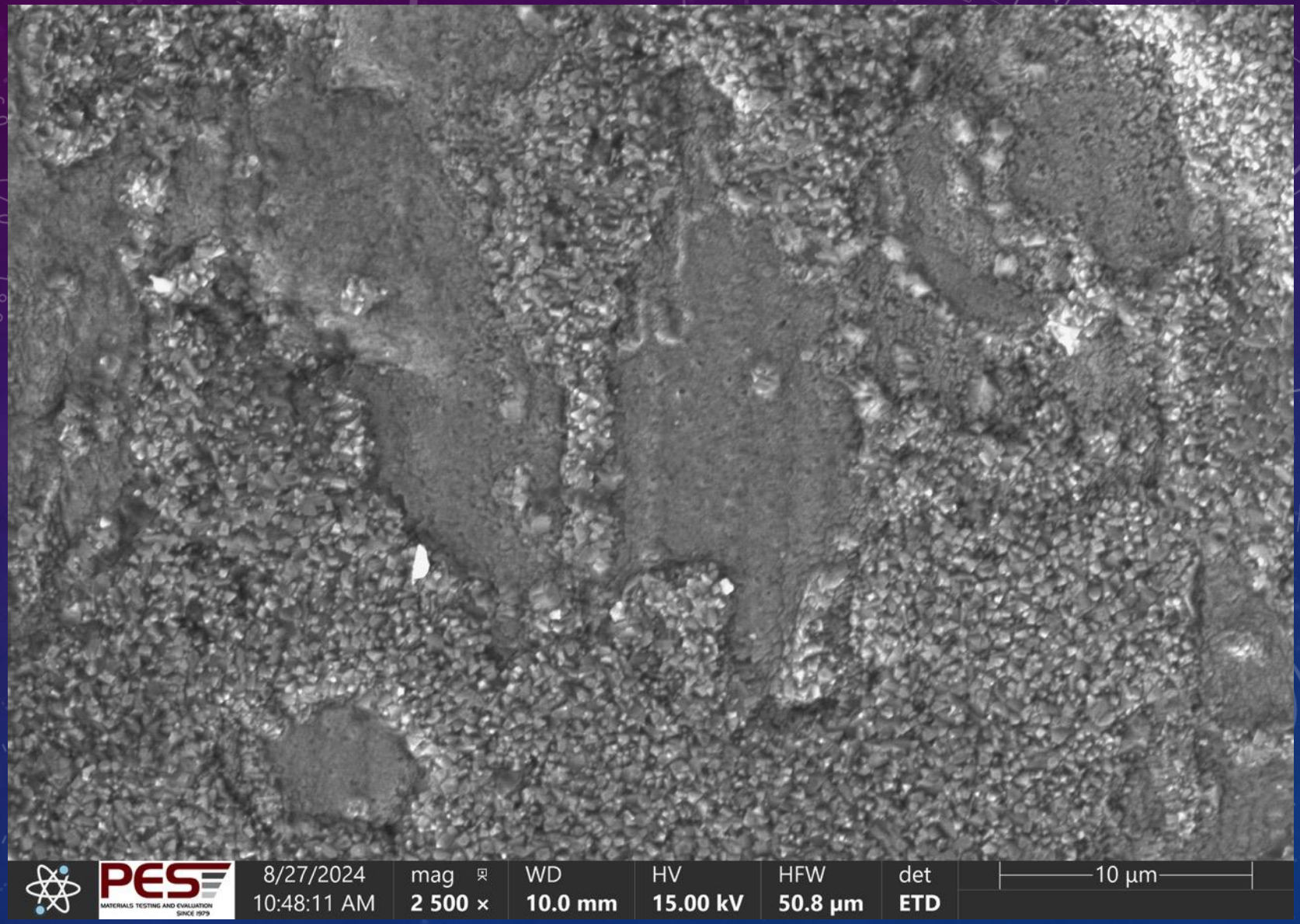
(g) PES# Y723-2 5000X

SURFACE OF CALTECH STEEL 100X



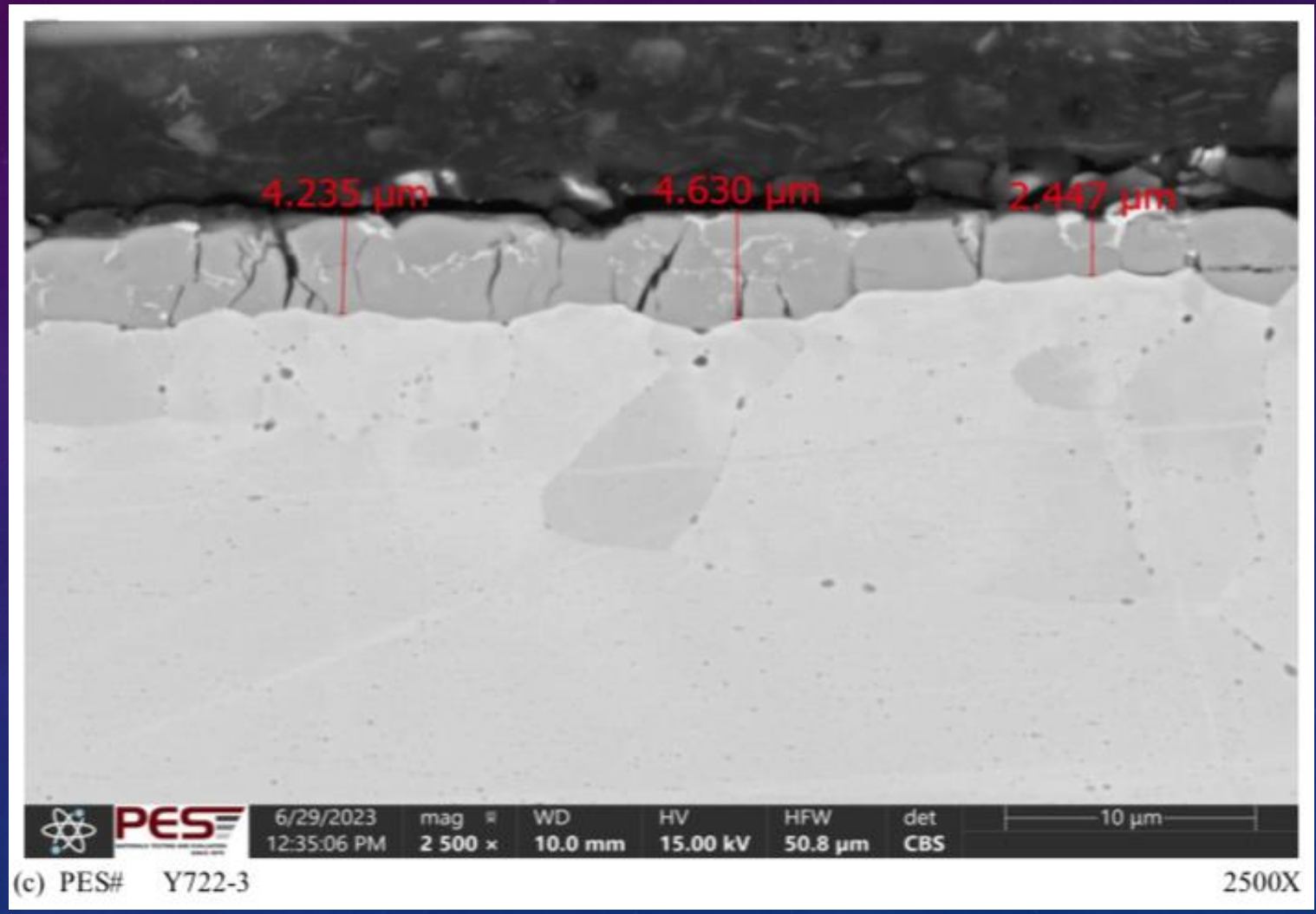
MATERIAL FORENSICS LLC

SURFACE OF CALTECH STEEL 2,500X

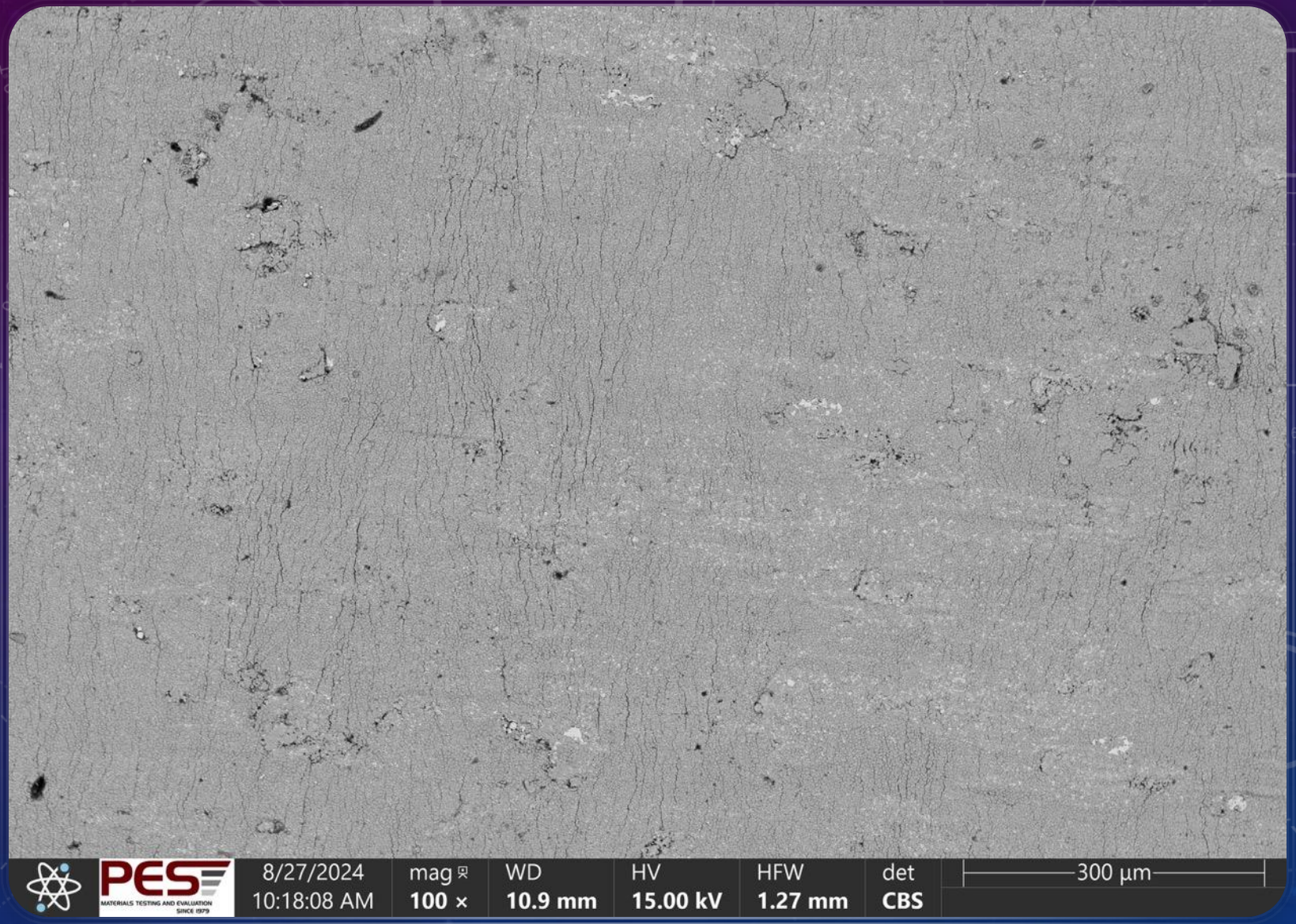


MATERIAL FORENSICS LLC

Magnetite Thickness CERN Steel

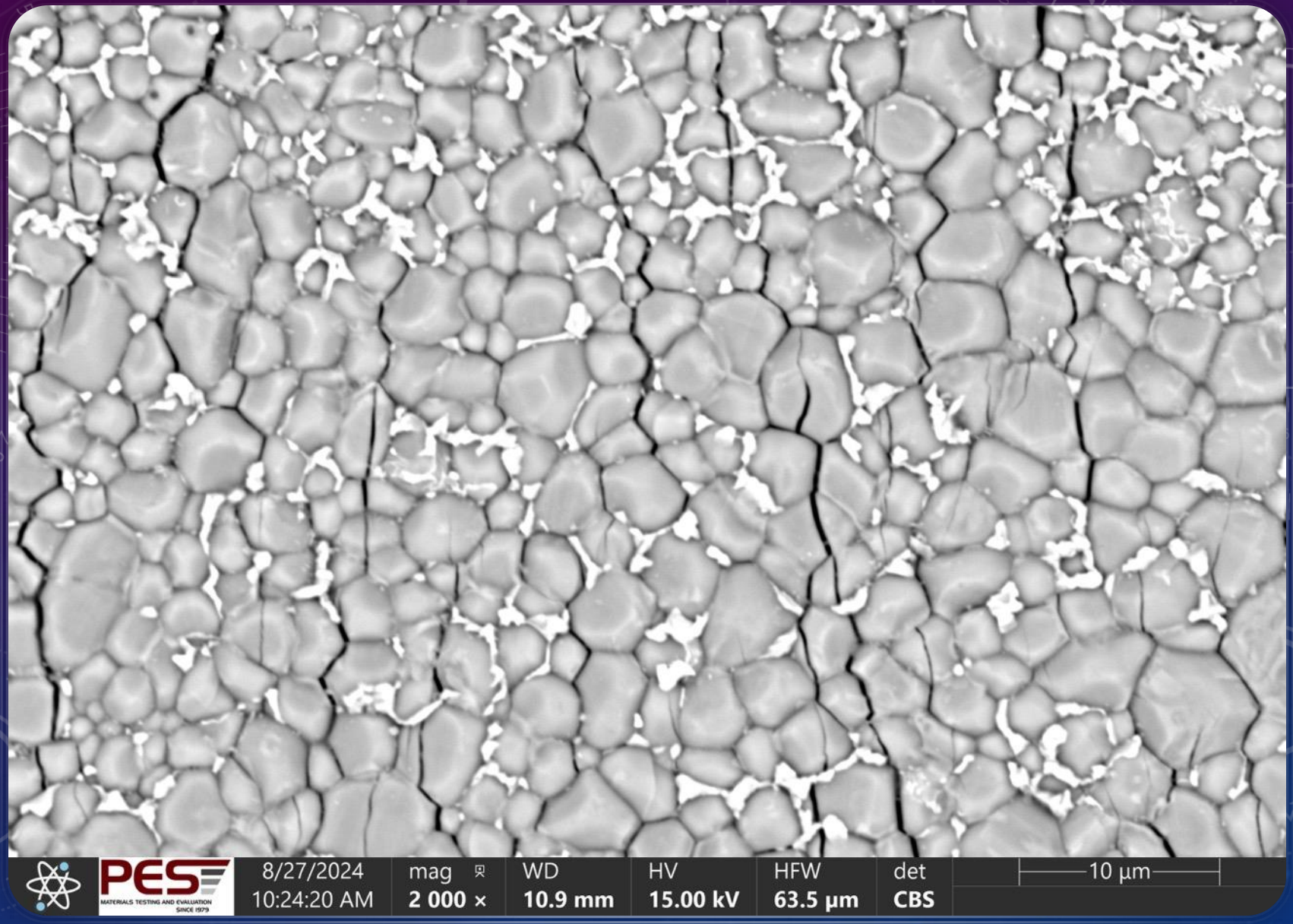


SURFACE OF CERN STEEL 100X



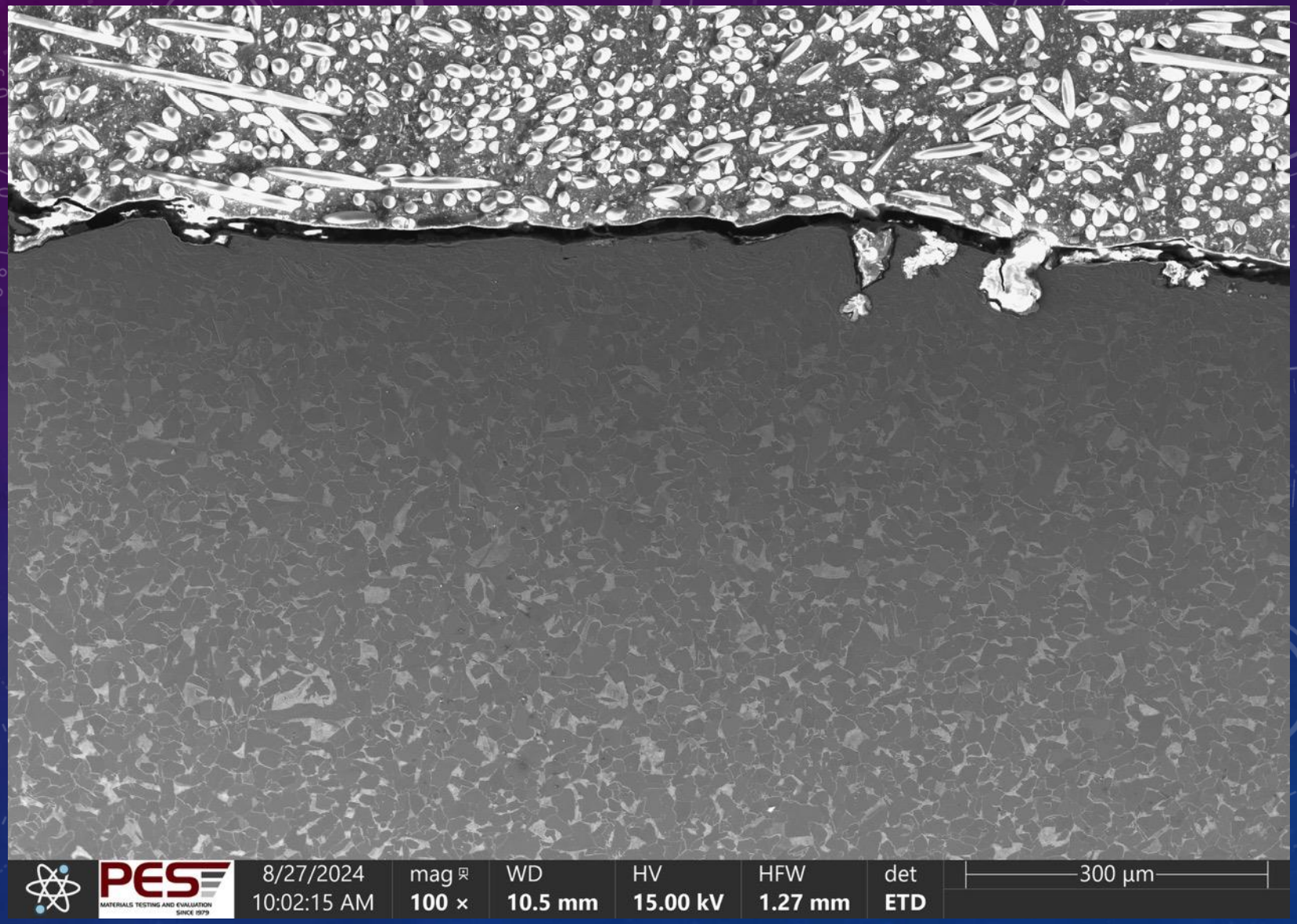
MATERIAL FORENSICS LLC

SURFACE OF CERN STEEL 2,000X



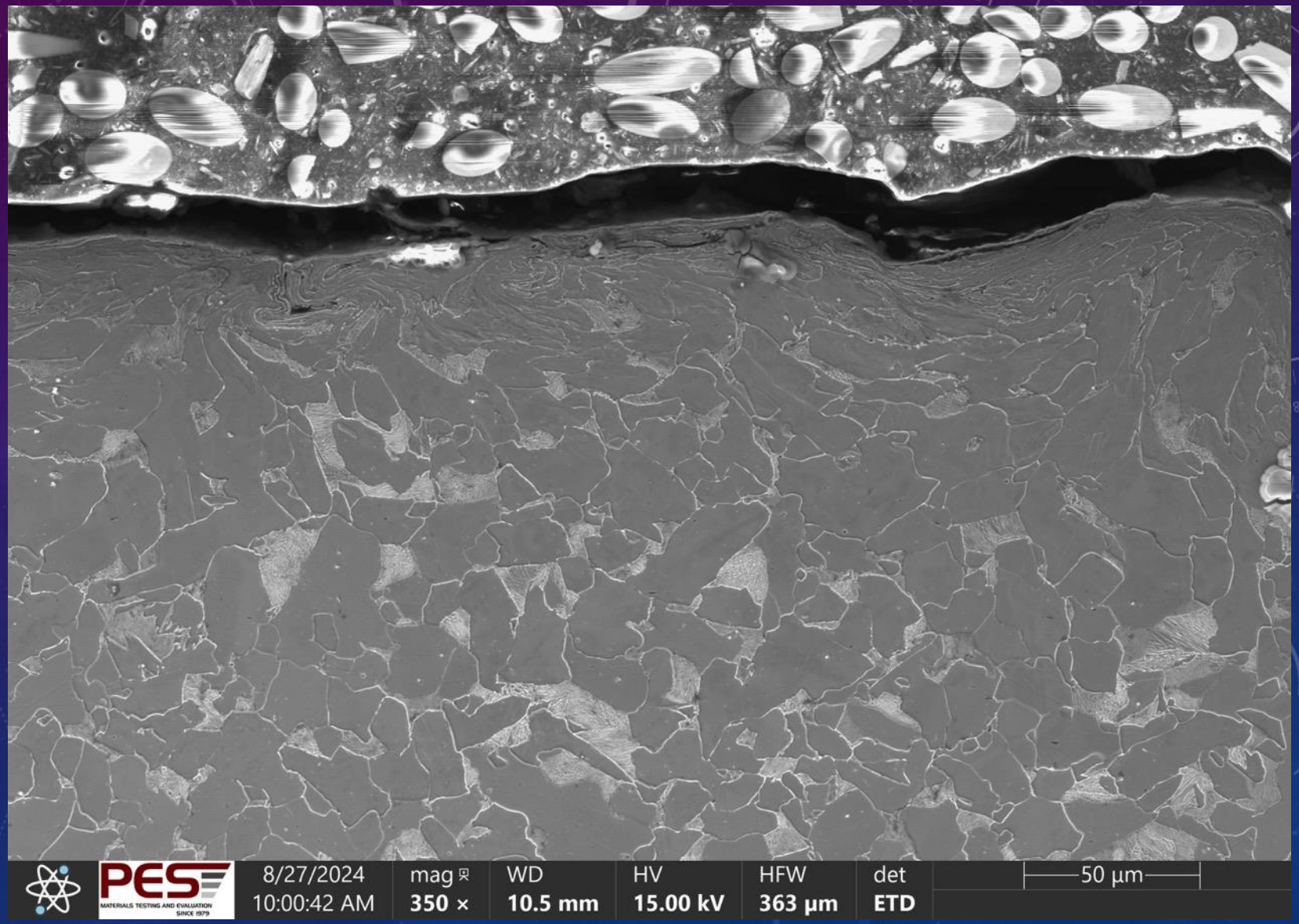
MATERIAL FORENSICS LLC

CROSS SECTION OF DURA-BOND STEEL 100X

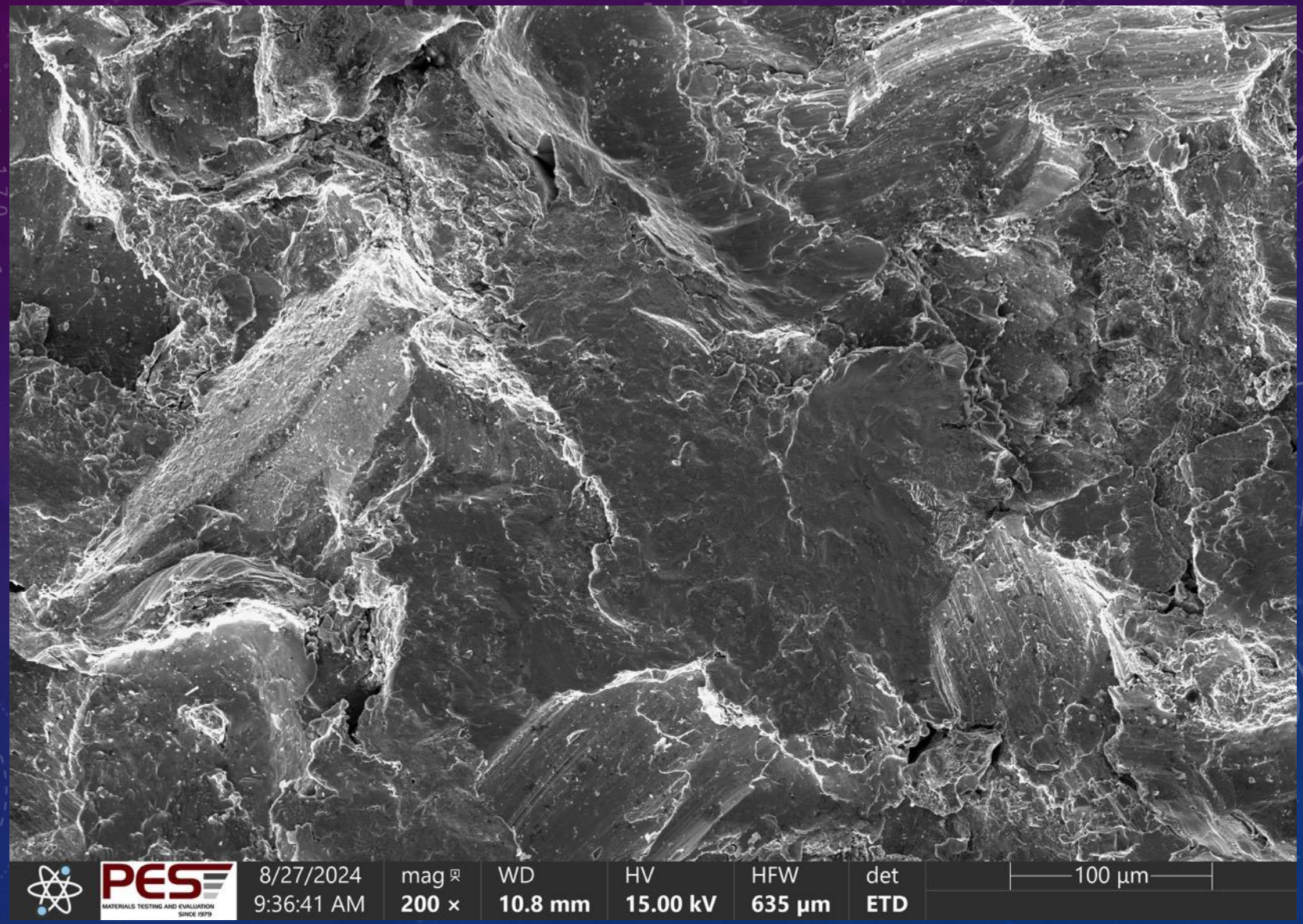


MATERIAL FORENSICS LLC

CROSS SECTION OF DURA-BOND STEEL 350X



SURFACE OF DURA-BOND STEEL 200X

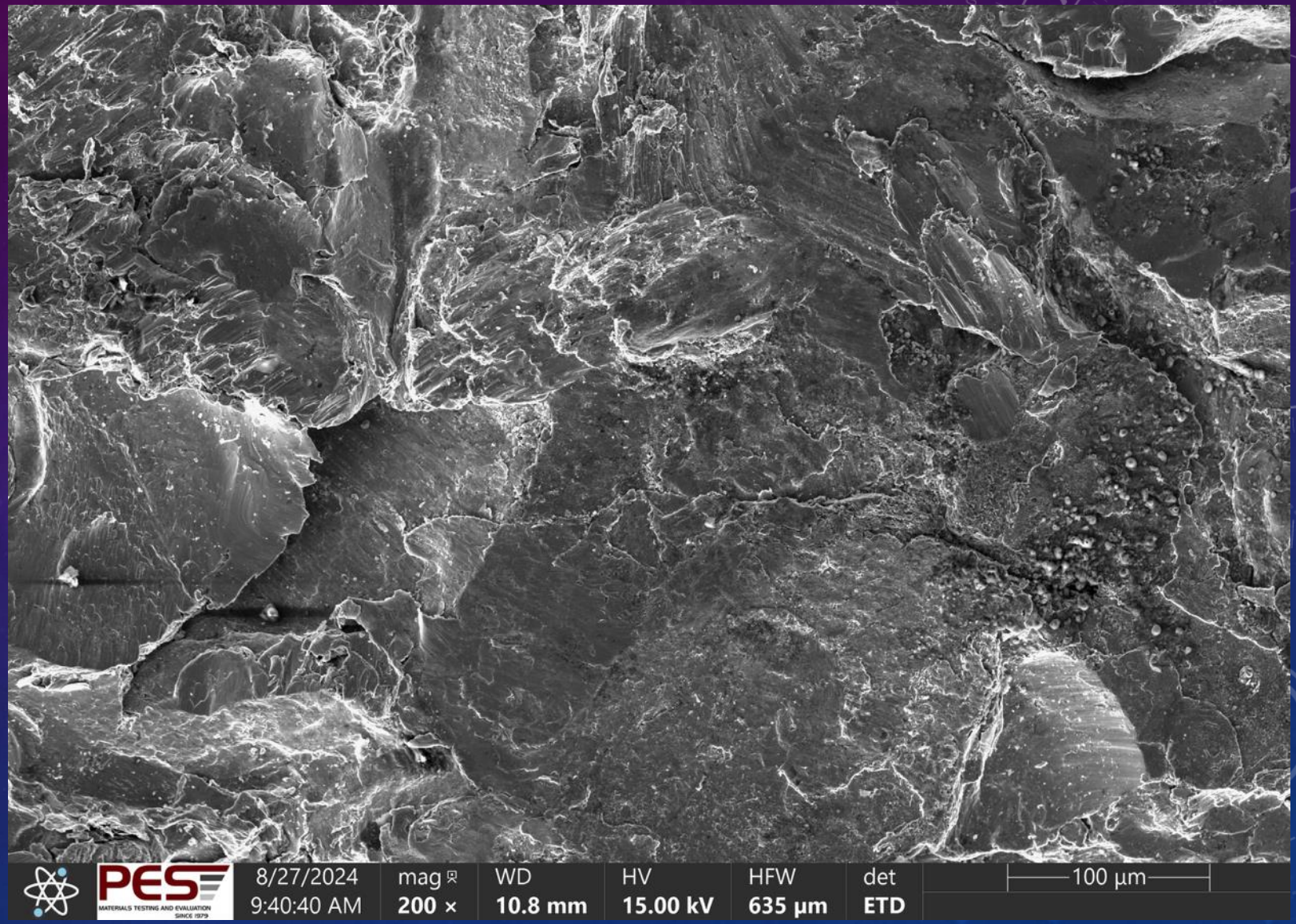


MATERIAL FORENSICS LLC

SURFACE OF DURA-BOND STEEL 2,500X

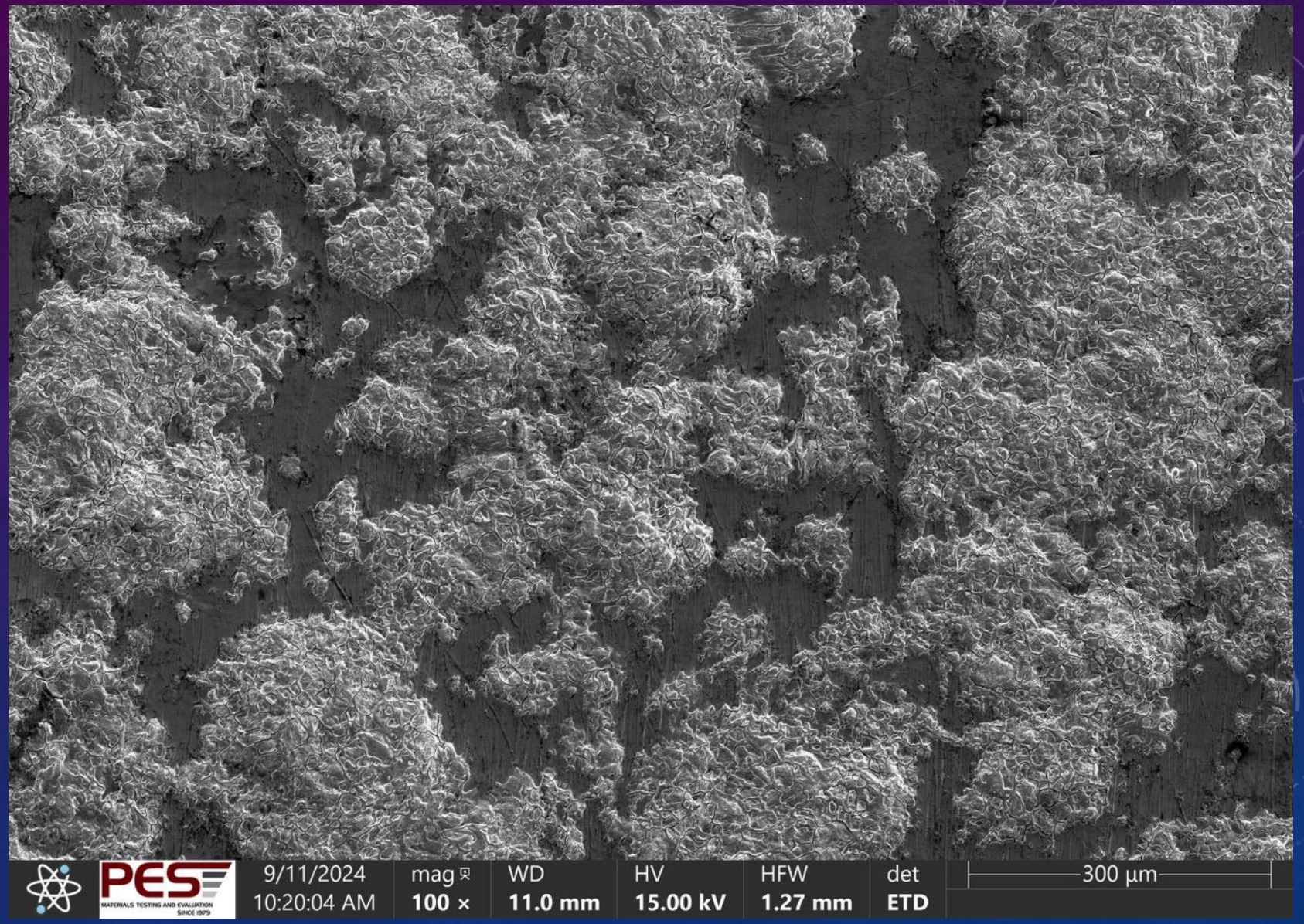
MATERIAL FORENSICS LLC

SURFACE OF DURA-BOND STEEL 200X



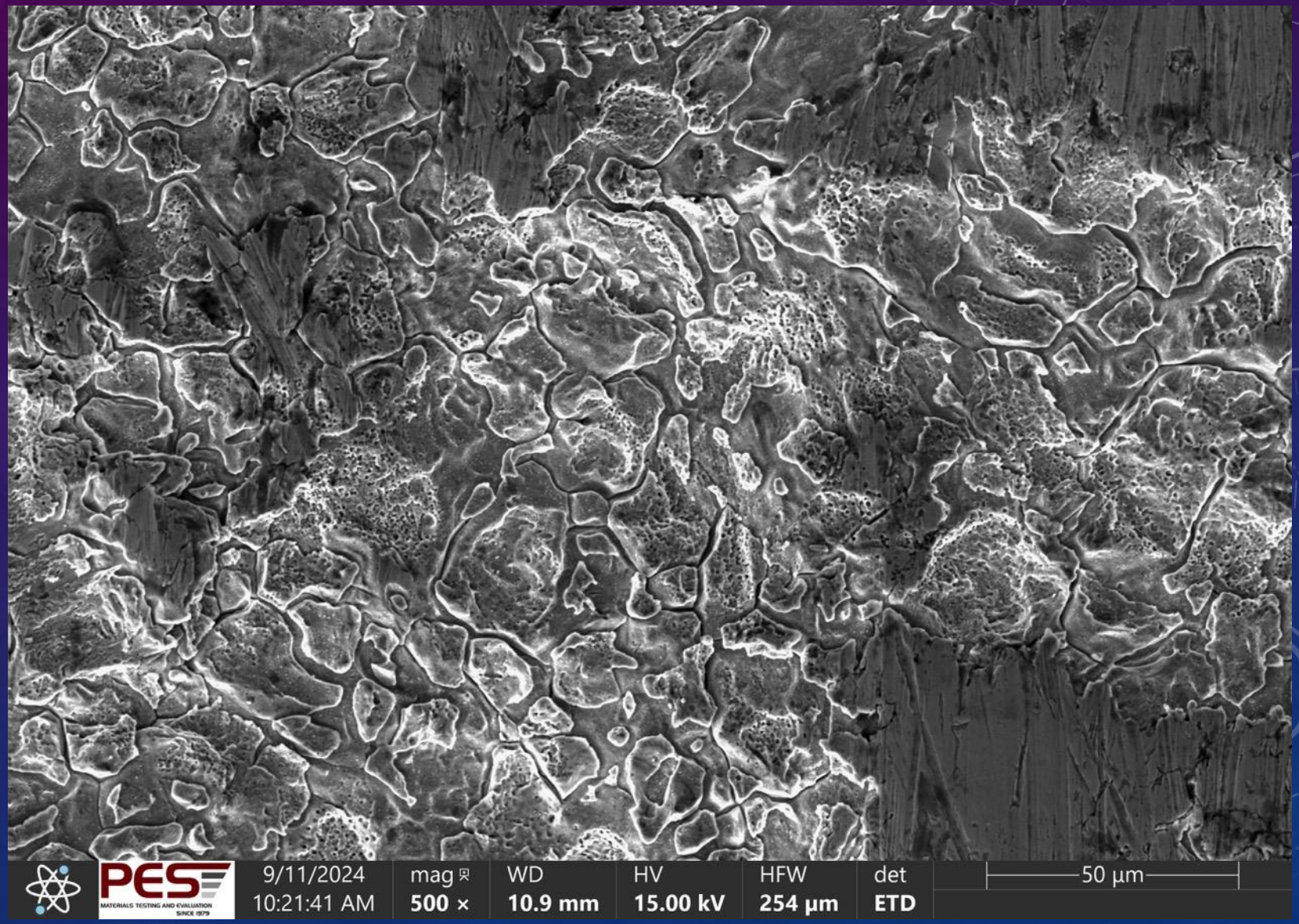
MATERIAL FORENSICS LLC

SURFACE OF LIGO STAINLESS STEEL 100X



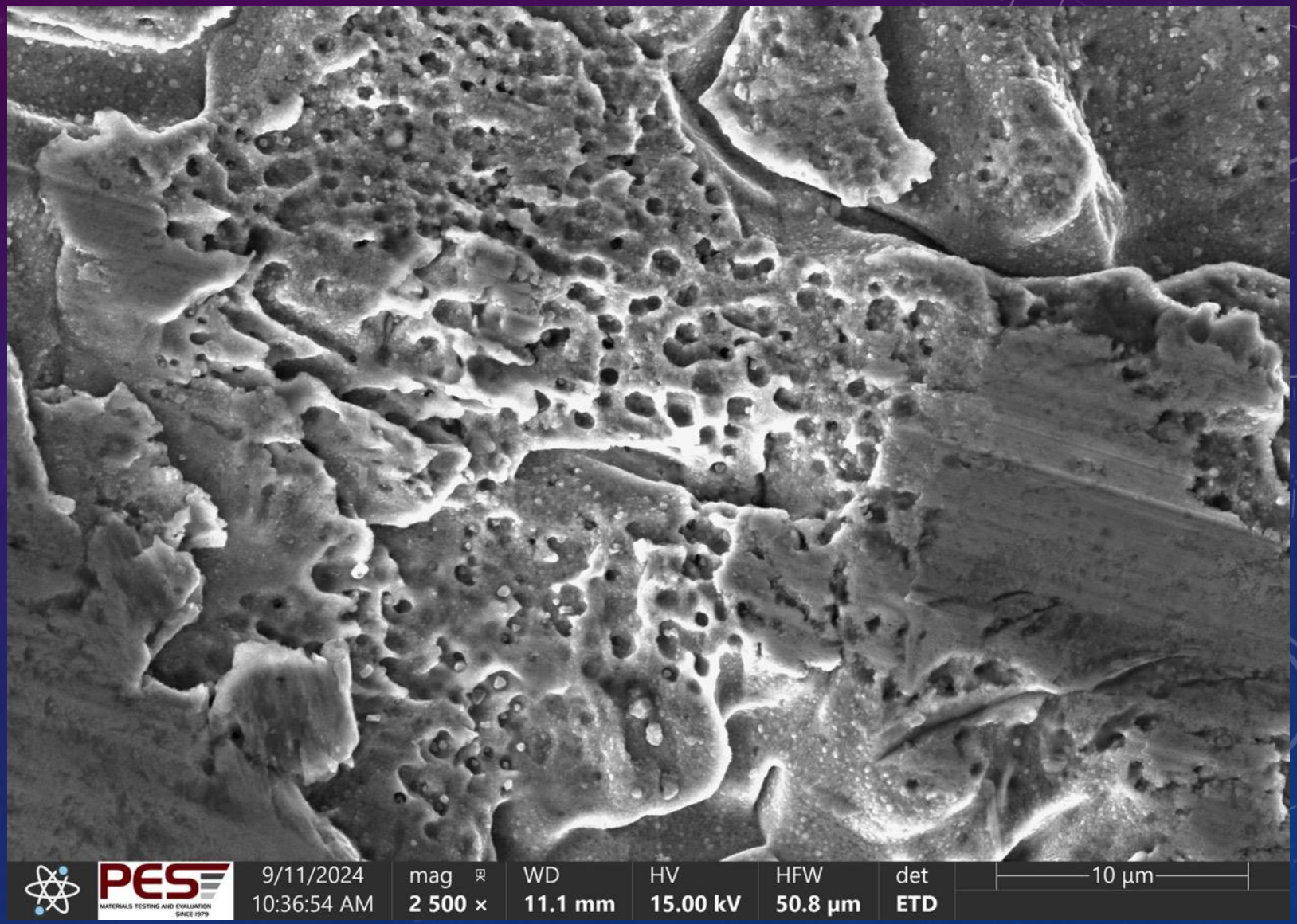
MATERIAL FORENSICS LLC

SURFACE OF LIGO STAINLESS STEEL 500X



MATERIAL FORENSICS LLC

SURFACE OF LIGO STAINLESS STEEL 2,500X



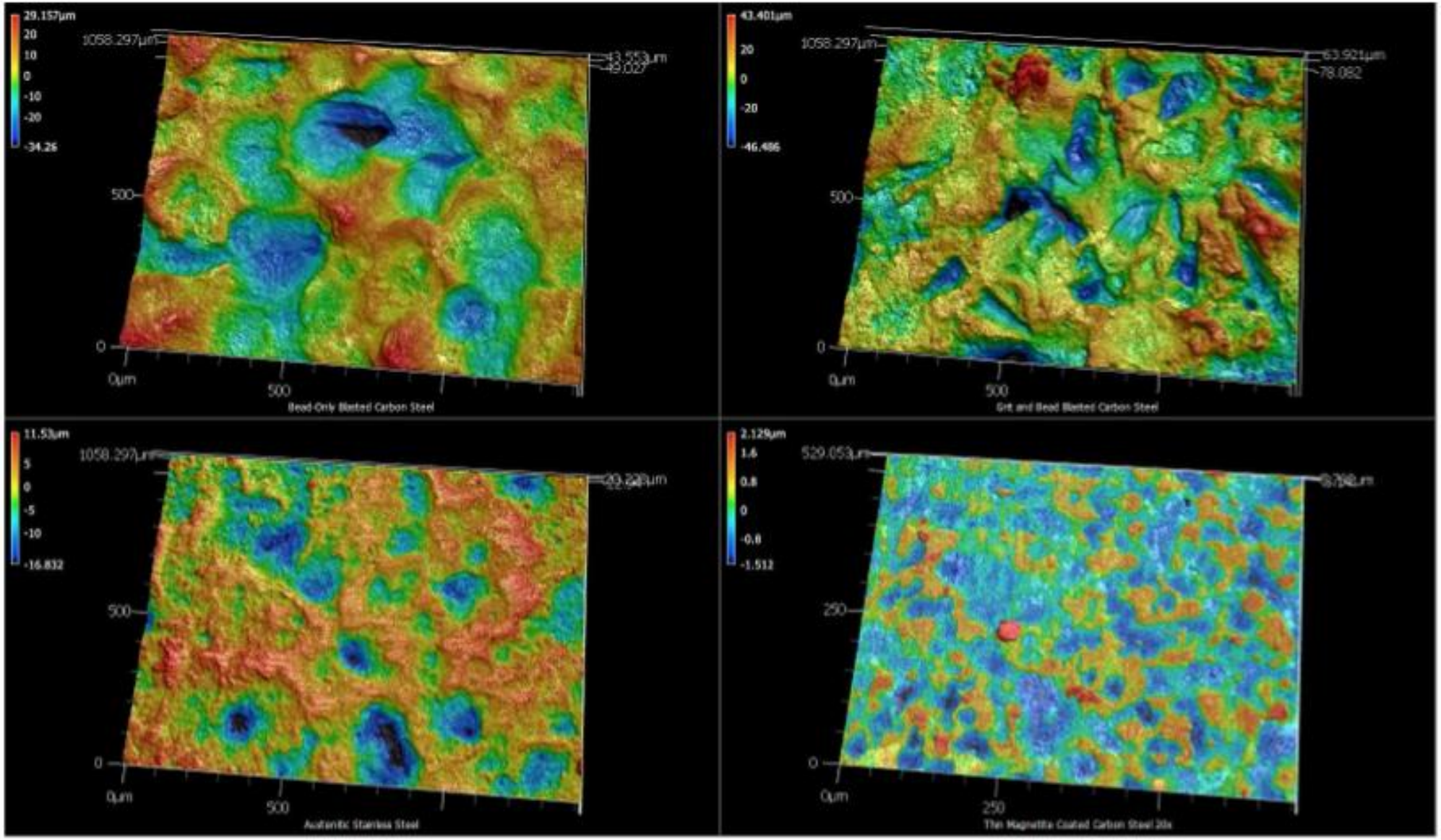
MATERIAL FORENSICS LLC

LASER SCANNING MICROSCOPY

(KEYENCE VK-X3000)


KEYENCE
LASER
MICROSCOPE

VK-X3000 3D Images

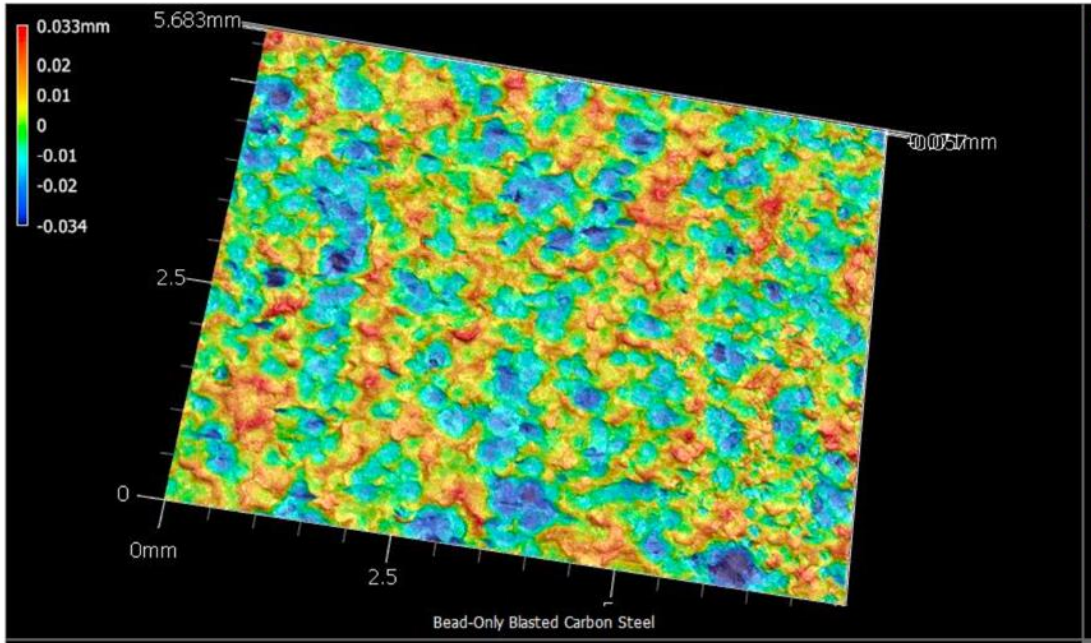


WHITE LIGHT PROFILOMETRY

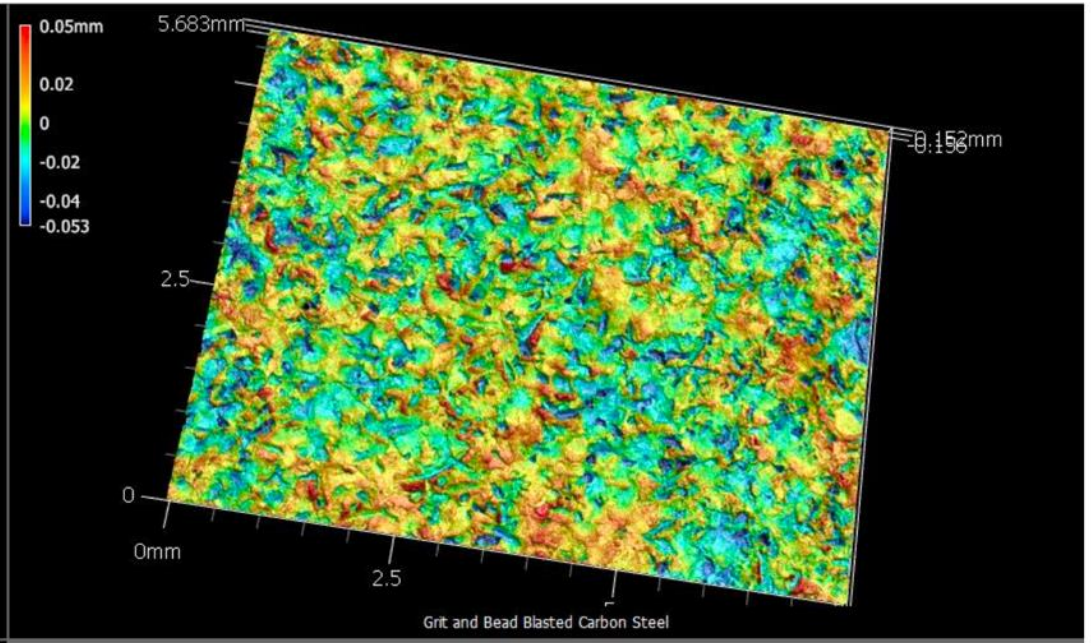
(KEYENCE VR-6000)


3D Optical Profilometer
VR-6000 Series
KEYENCE
VR series
POWER
ONE-SHOT 3D

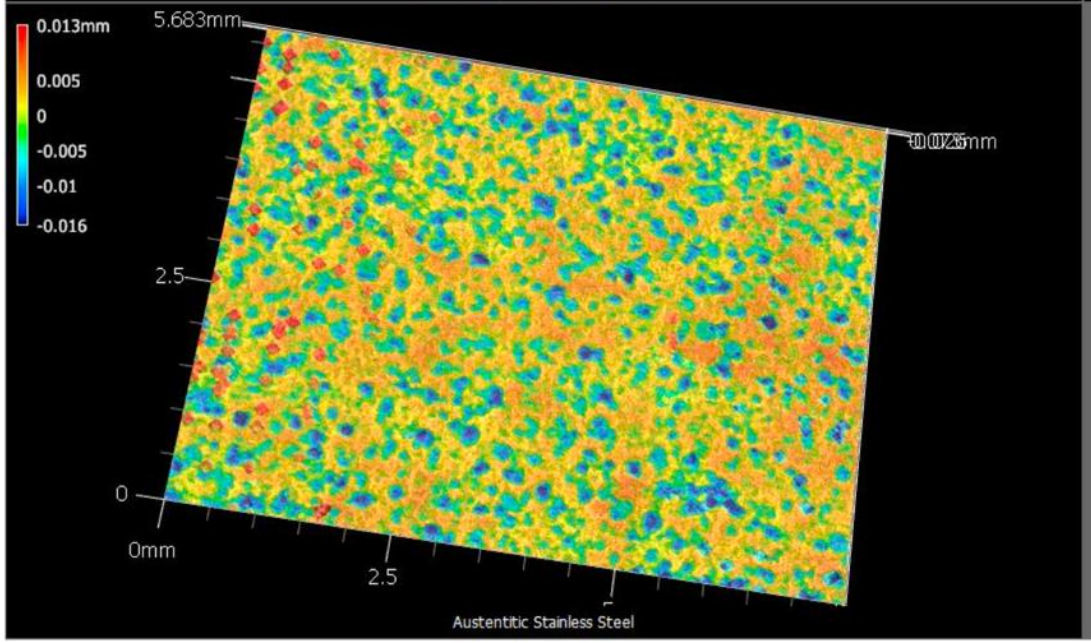
VR-6000 3D Images



Bead-Only Blasted Carbon Steel



Grit and Bead Blasted Carbon Steel

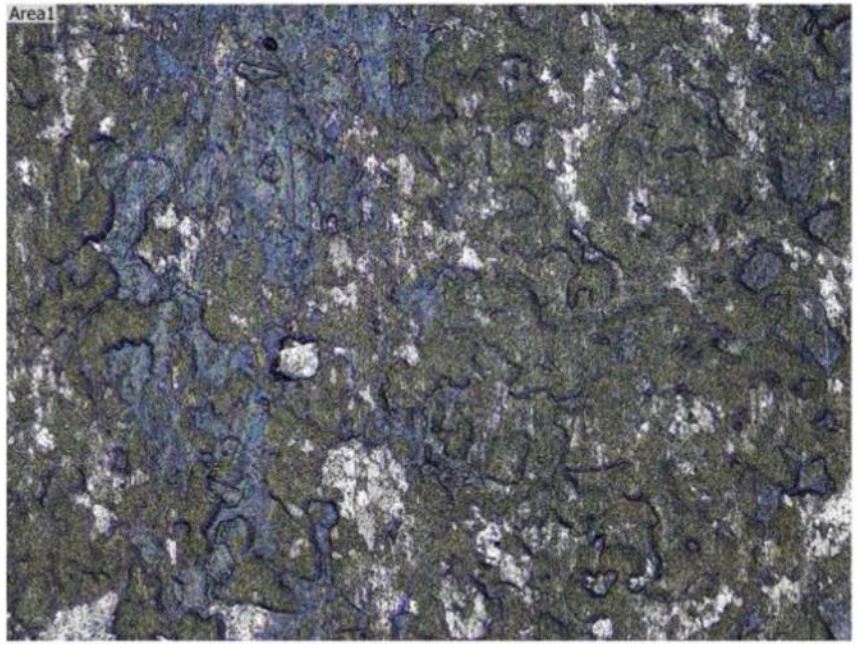


Austentitic Stainless Steel

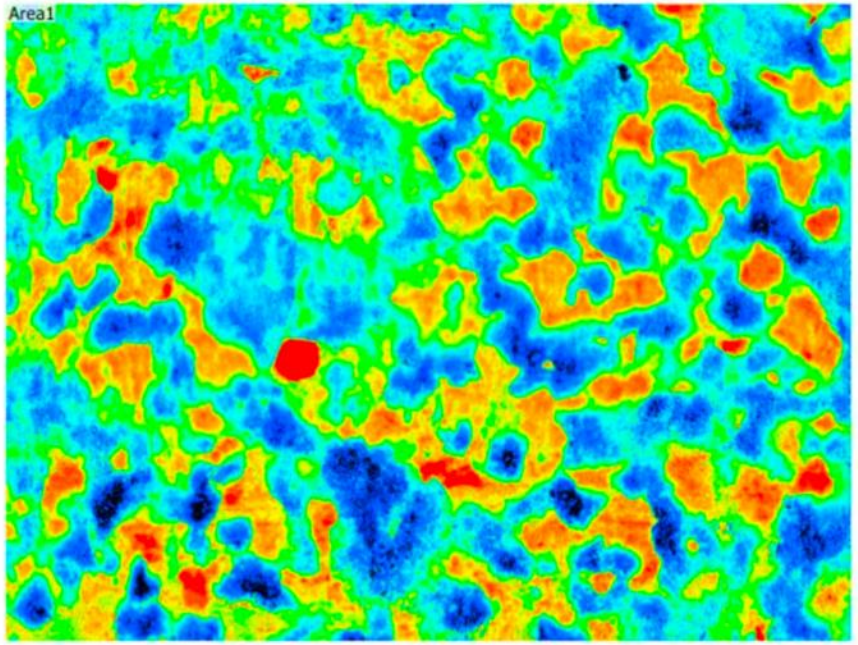
VK-X3000 Roughness Data

Surface roughness measurement Thin Magnetite Coated Carbon Steel 20x KEYENCE VK-X3000 Series

Main image



Scale-limited surface



Analysis condition

Roughness standard	ISO 25178-2:2012
Filter type	Gaussian
S-filter	None
F-operation	None
L-filter	None
End effect correction	Enabled

Measurement result

	Sa	Sz	Sq
	µm	µm	µm
Max.	0.622	8.922	0.764
Min.	0.622	8.922	0.764
Ave.	0.622	8.922	0.764
Std. DV	0.000	0.000	0.000
Area1	0.622	8.922	0.764

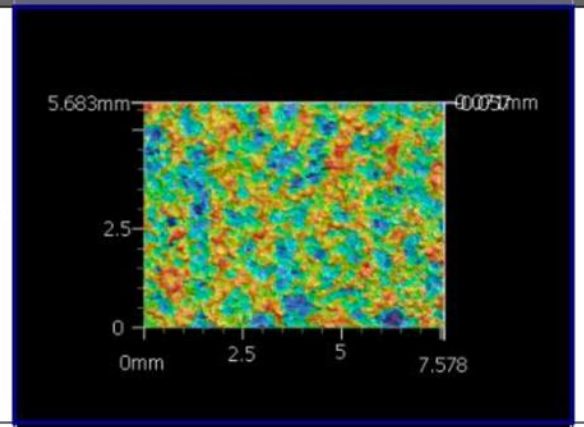
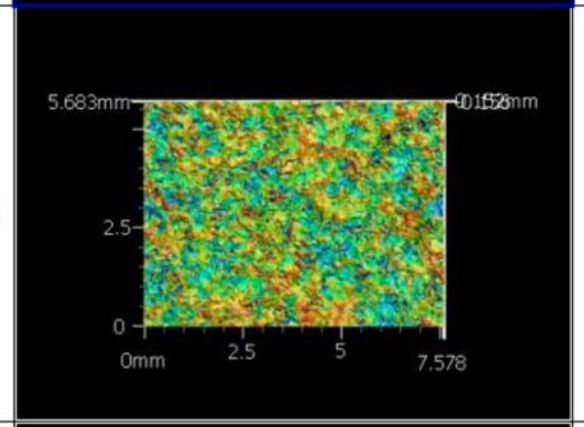
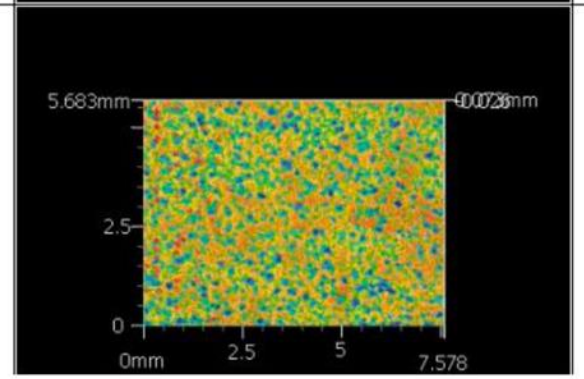
Measured date : 2/10/2025 1:07:47 PM

Objective Lens Power : 20X

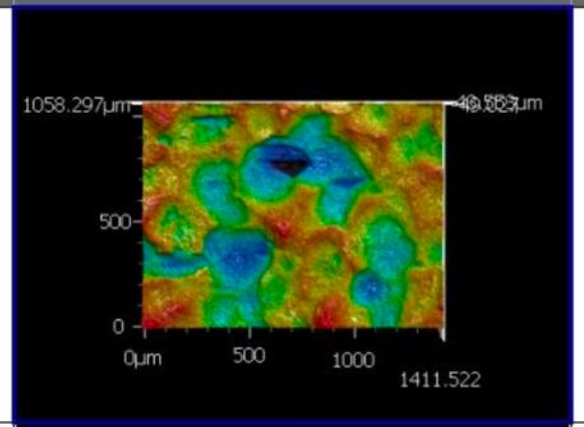
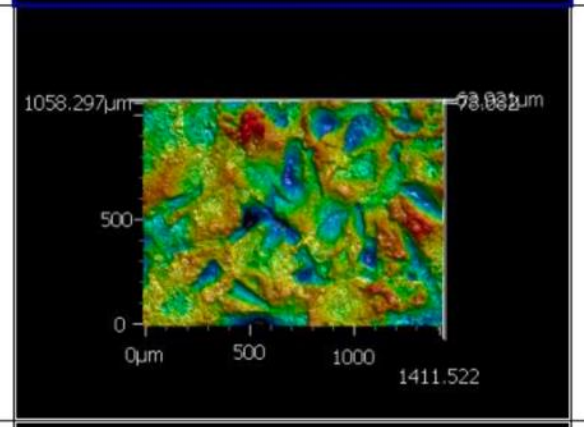
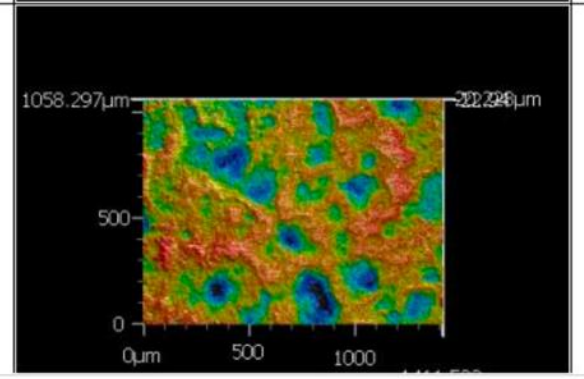
SURFACE ROUGHNESS

PROFILES, FLATNESS, AND ROUGHNESS IN AS LITTLE AS 1 SECOND

VR-6000 Roughness Data

Measurement data name	3D image	Surface roughness Area1 Sa µm	Sz µm	Sq µm
Bead-Only Blasted Carbon Steel		9.948	128.260	12.513
Grit and Bead Blasted Carbon Steel		13.191	307.810	17.261
Austenitic Stainless Steel		3.712	98.850	4.842

VK-X3000 Roughness Data

Measurement data name	3D image	Surface roughness Area1 Sa µm	Sz µm	Sq µm
Bead-Only Blasted Carbon Steel		9.386	92.580	11.790
Grit and Bead Blasted Carbon Steel		10.414	142.002	14.187
Austenitic Stainless Steel		4.470	43.168	5.626

ROUGHNESS PARAMETERS

Measurement data

Group1 | Image list

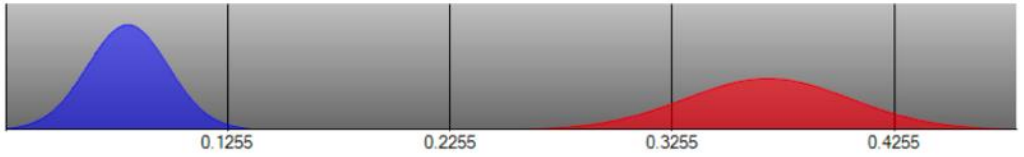
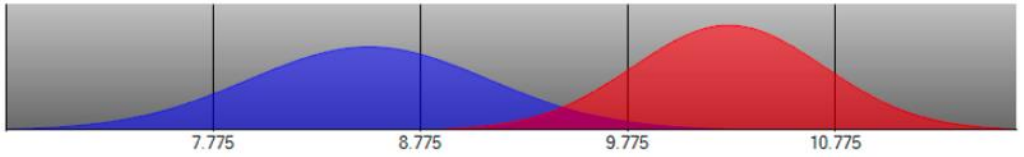
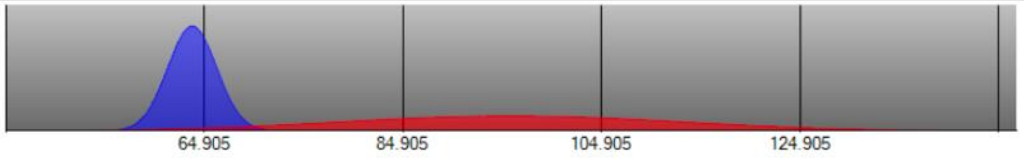
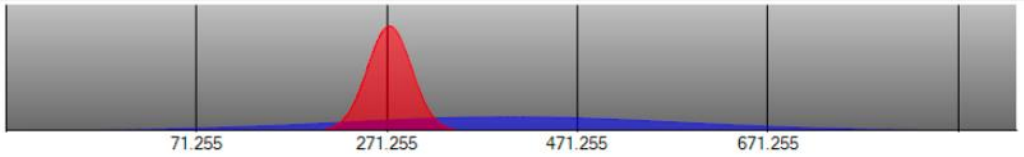
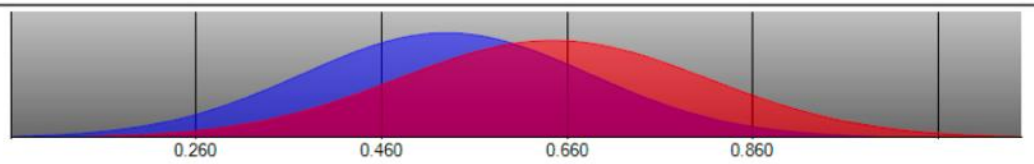
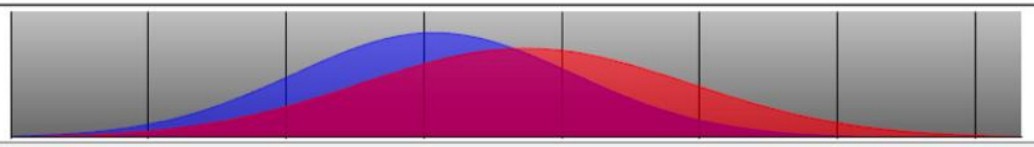
Measurement data name	Image	Area settings
Bead-Only Blasted Carbon Steel		All areas

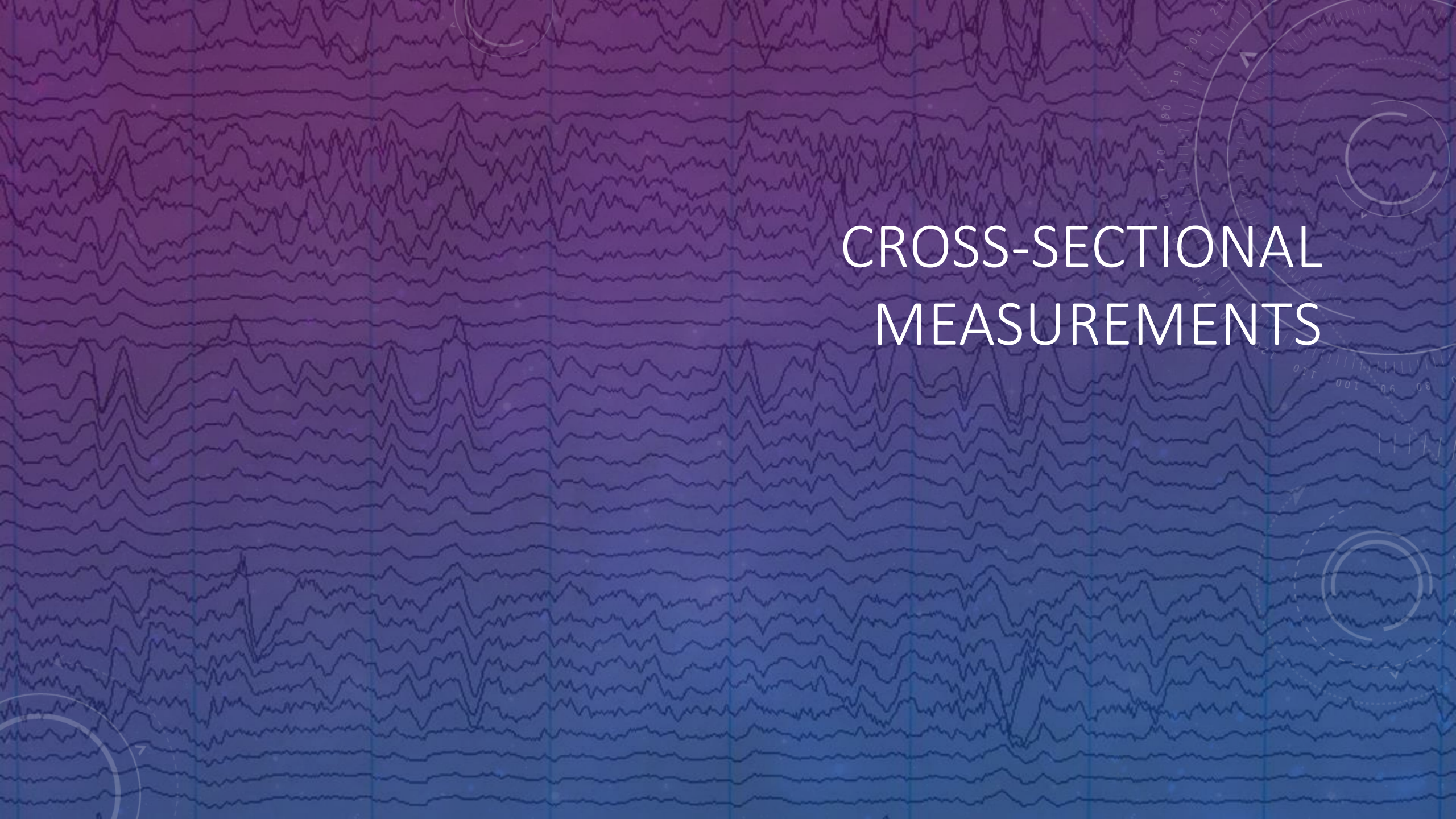
Group2 | Image list

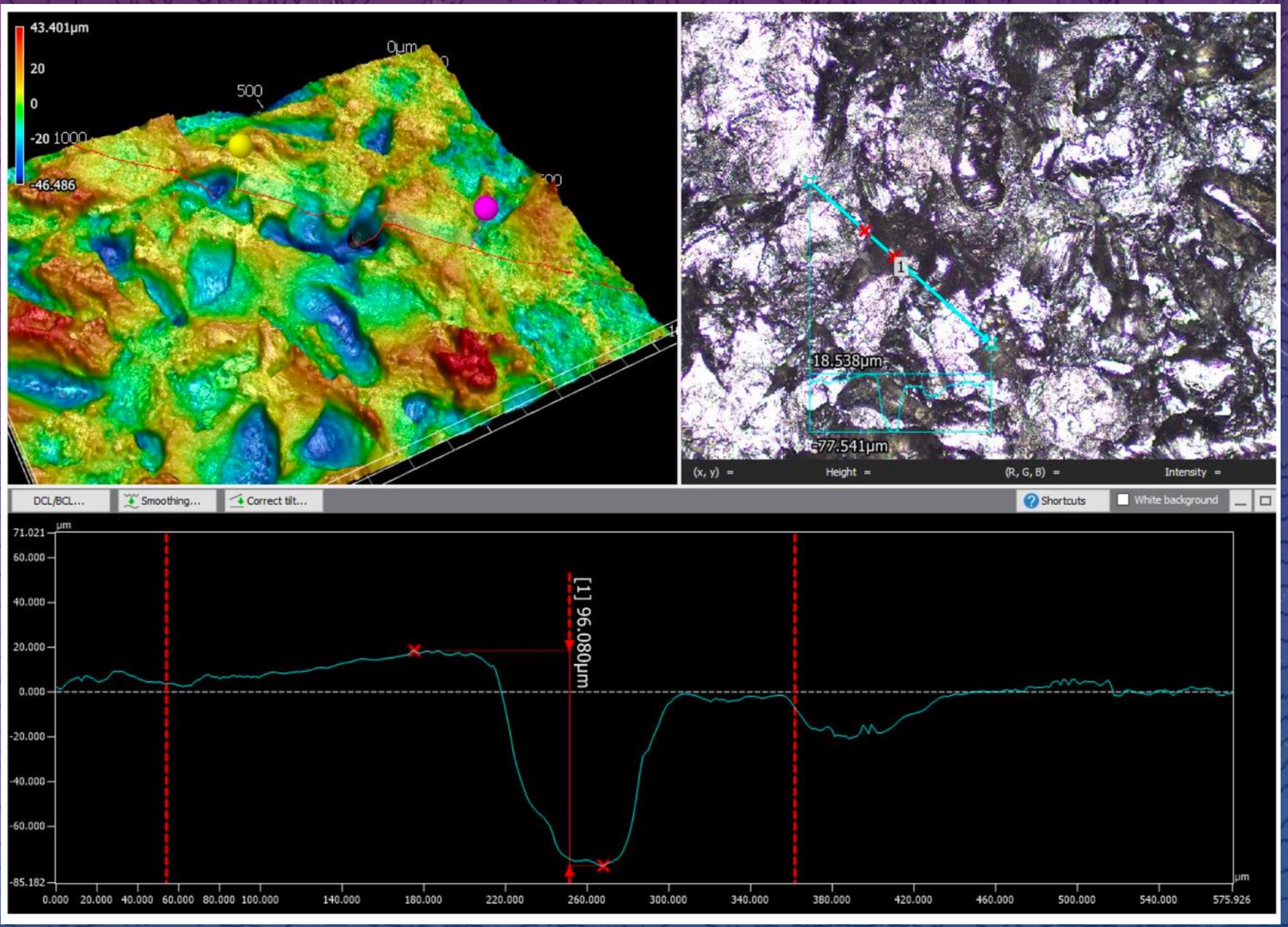
Measurement data name	Image	Area settings
Grit and Bead Blasted Carbon Steel		All areas

Analysis result

Parameters are ordered by degree of separation.
Select parameters to be added to a report.

Separation	Parameter	Name	Desc	Distribution	Ave.	Std. DV
★★★	Sdr	Developed interfacial area ratio (degree of increase of surface area when compared with a flat surface) * This value is 0.1 when the surface area increases by 10%.			Group1 0.0805 Group2 0.3686	Group1 0.0157 Group2 0.0322
★★★	Spc	Arithmetic mean peak curvature (peakedness) * The larger the value, the higher the peakedness.			Group1 210.230 Group2 481.605	Group1 28.389 Group2 30.922
★★☆	Sa	Arithmetic mean height of the surface			Group1 8.525 Group2 10.259	Group1 0.502 Group2 0.398
★★☆	Sz	Maximum height of the surface			Group1 63.682 Group2 95.806	Group1 2.128 Group2 14.677
★☆☆	RSm	Mean width of the profile elements (average of peak and valley cycle lengths)			Group1 401.883 Group2 274.150	Group1 158.042 Group2 20.542
☆☆☆	Str	Aspect ratio of the surface texture (presence of systematic creases) * This is a value from 0 to 1. The smaller the value, the more clear are the creases.			Group1 0.529 Group2 0.644	Group1 0.134 Group2 0.145
☆☆☆	Ra	Arithmetic mean height of the profile			Group1 6.298 Group2 7.627	Group1 1.817 Group2 2.135


CROSS-SECTIONAL
MEASUREMENTS


43.401µm
20
0
-20
-46.486
0µm
500
1000
18.538µm
77.541µm
(x, y) =
Height =
(R, G, B) =
Intensity =
DCL/BCL...
Smoothing...
Correct tilt...
Shortcuts
White background
µm
71.021
60.000
40.000
20.000
0.000
-20.000
-40.000
-60.000
-85.182
[1] 96.080µm
0.000
20.000
40.000
60.000
80.000
100.000
140.000
180.000
220.000
260.000
300.000
340.000
380.000
420.000
460.000
500.000
540.000
575.926