NANOVEA
A Better Measure

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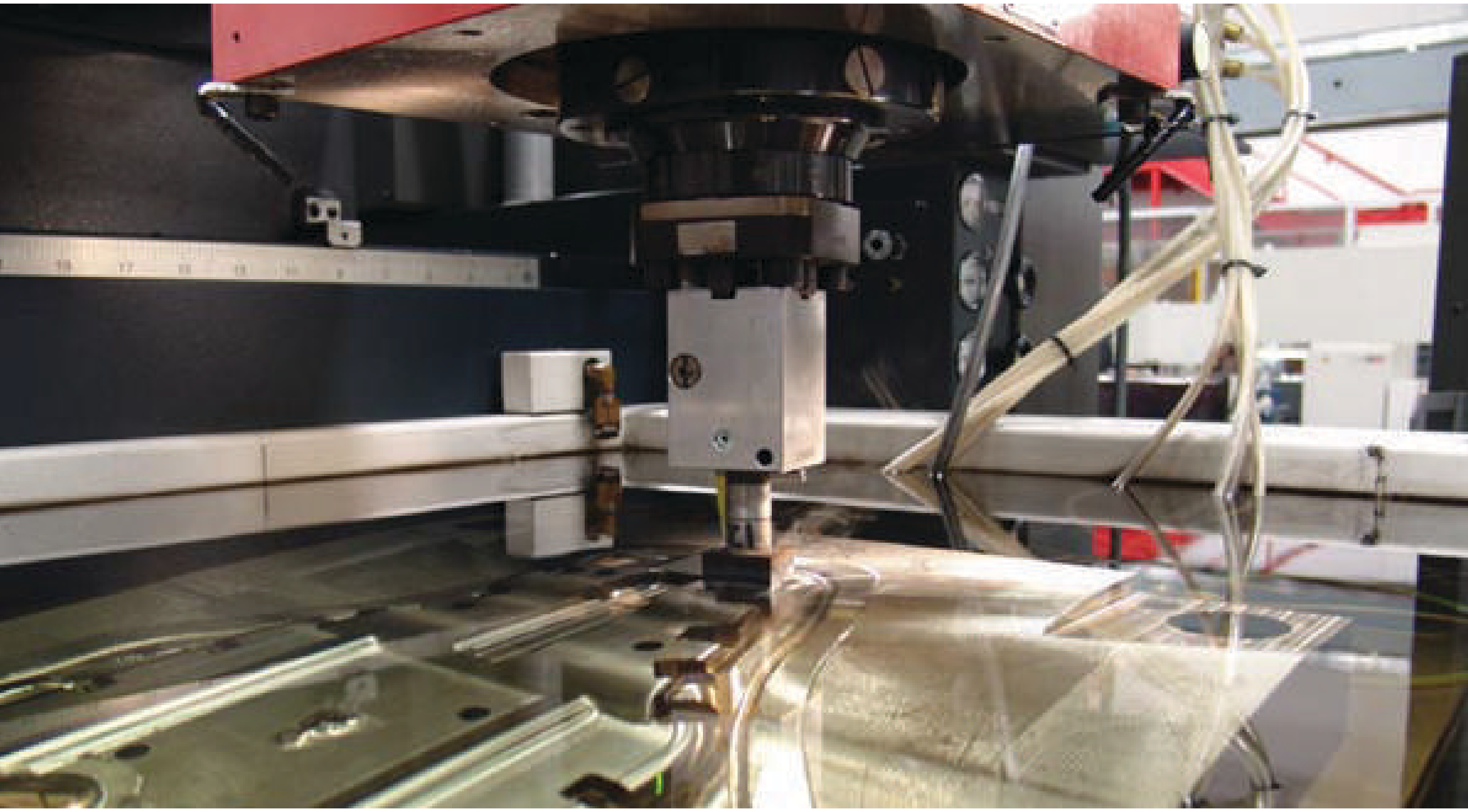

Quality Analysis on Electrical Discharge Machined Metals

Electrical discharge machining, or EDM, is a manufacturing process that removes material via electrical discharges [1]. This machining process is generally used with conductive metals that would be difficult to machine with conventional methods.

As with all machining processes, precision and accuracy must be high in order to meet acceptable tolerance levels. In this application note, the quality of the machined metals will be assessed with a Nanovea 3D non-contact profilometer.

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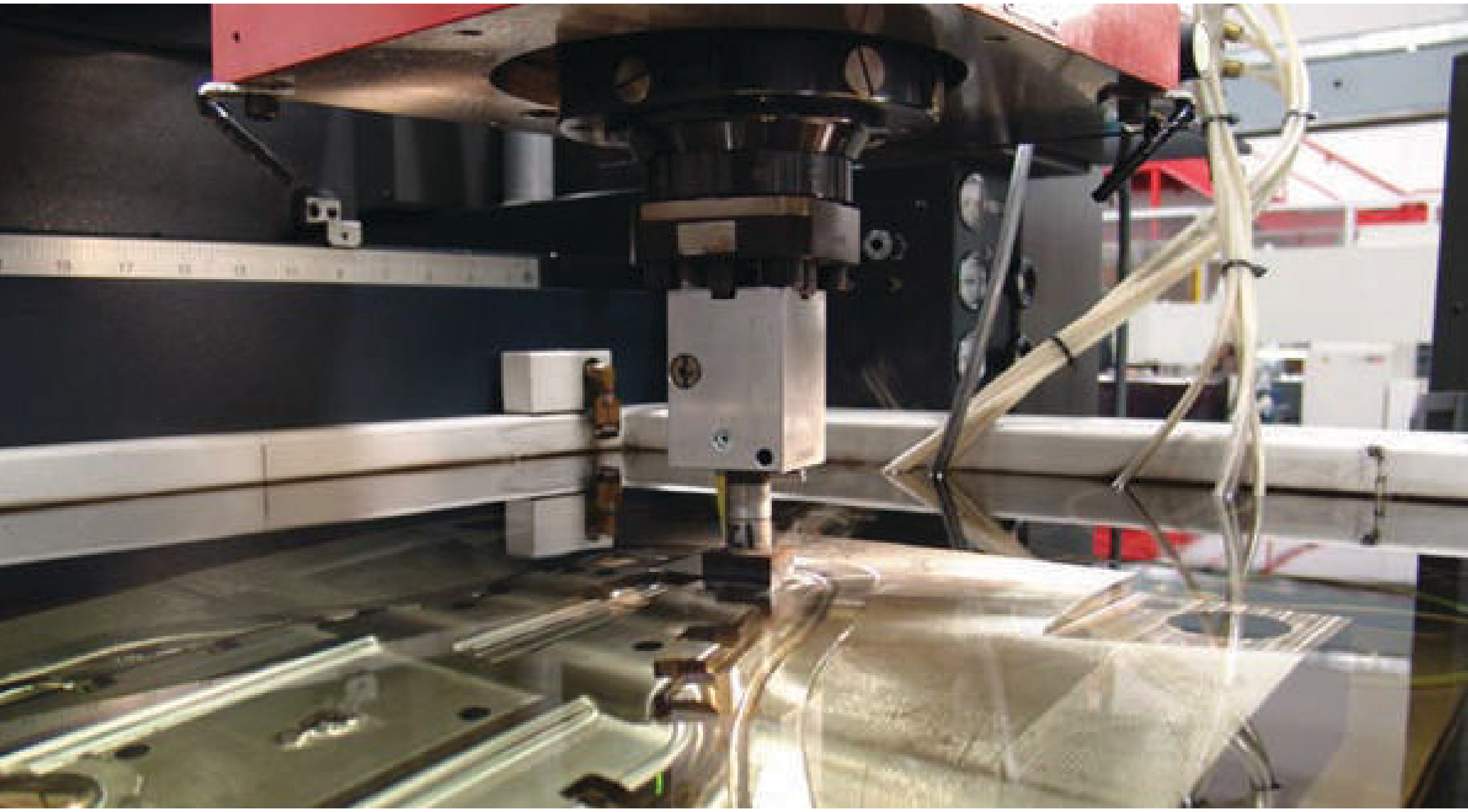


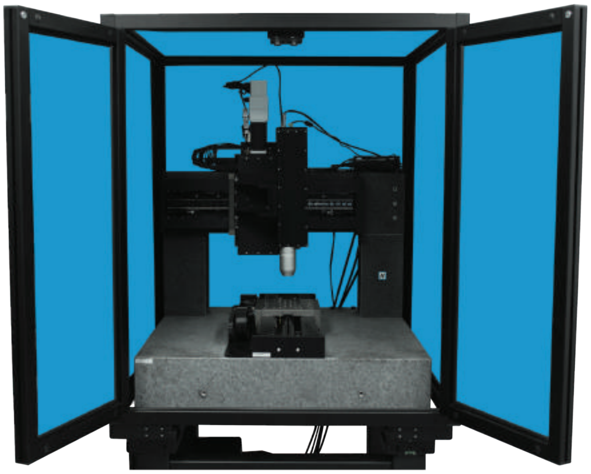
Importance of Profiling Machined Metals

As machining becomes more precise, simple measurement tools, such as rulers or calipers, no longer meet the level of accuracy needed to satisfy tighter tolerance requirements. High resolution measurement tools must be used. In order to not bottleneck the production process, the measurement time of quality control instruments must match the manufacturing speed as well. The ideal quality control instrument will have high scanning resolution, short measurement time (including sample preparation and setup) and simple user-friendly analysis tools and software.

The Nanovea 3D line sensor is the ideal instrument for quality control inspections of machined metals. It is able to quickly scan and produce high resolution surface scans within seconds which can then be analyzed to quantify multiple dimensions of a machined part(s). It's ability to measure all types of materials, regardless of curvature, makes it ideal for use in measuring a vast range of surfaces in quality control applications.

Equipment Featured

NANOVEA HS2000



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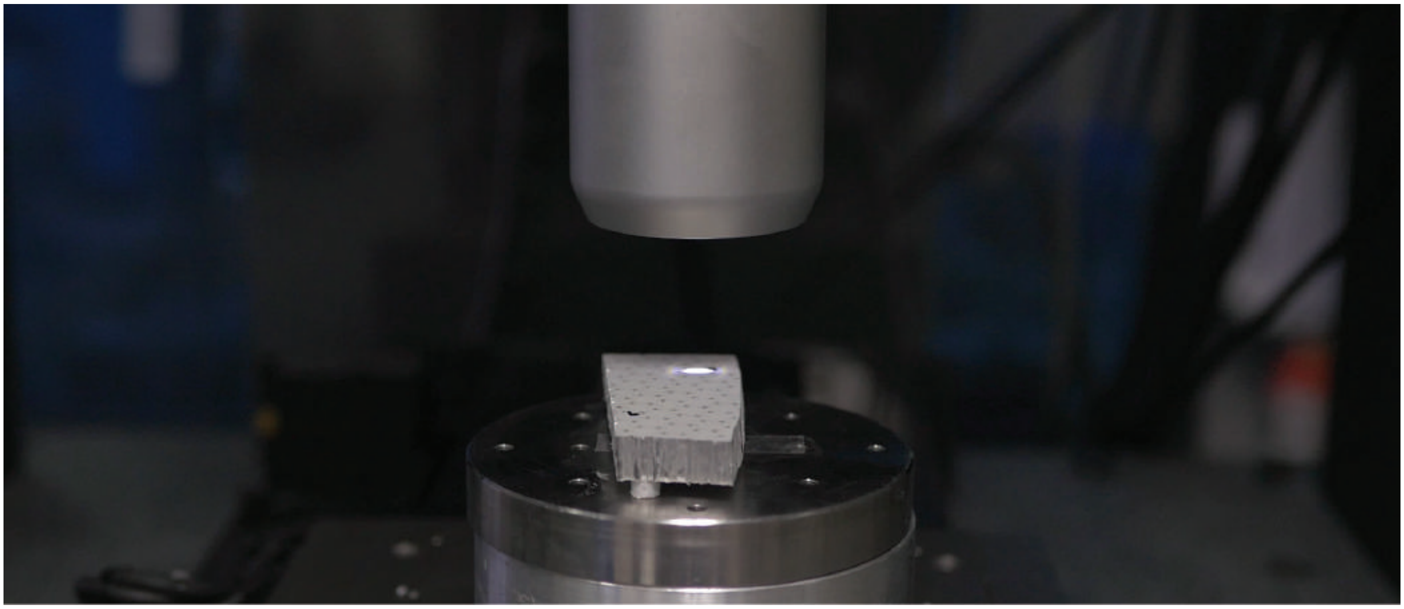
Measurement Objectives

Two metallic samples with hexagonal patterned holes drilled via wire EDM were inspected with Nanovea's high-speed line sensor. The roundness, equivalent diameter, and spacing were quantified to observe the precision and accuracy of the WEDM machining process.



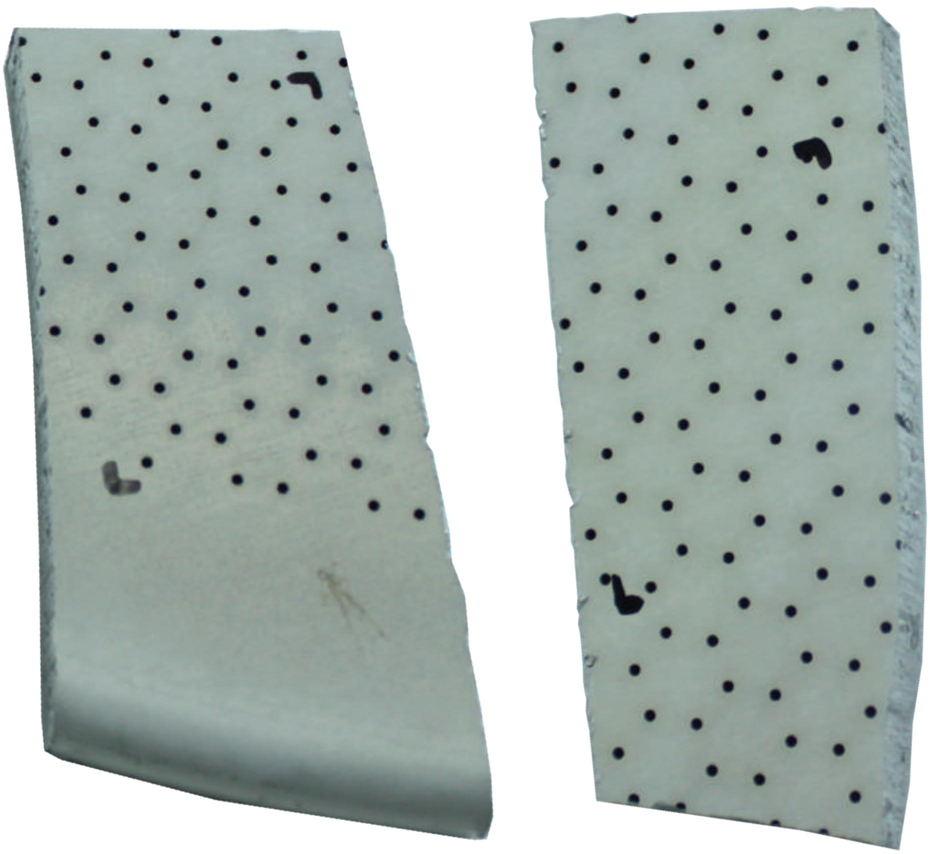
Profilometry Results

Measurement Parameters

Table 1:

Test Parameter	Value
Instrument	HS 2000L
Optical Sensor	LS2 (1000µm height range)
Scan size (mm)	40mm x 20mm
Step size (µm)	10µm x 10µm
Scan time (h:m:s)	00:00:38

Samples Tested



Two metallic samples with hexagonal patterned holes drilled via wire EDM

Results: Sample A

Sample A

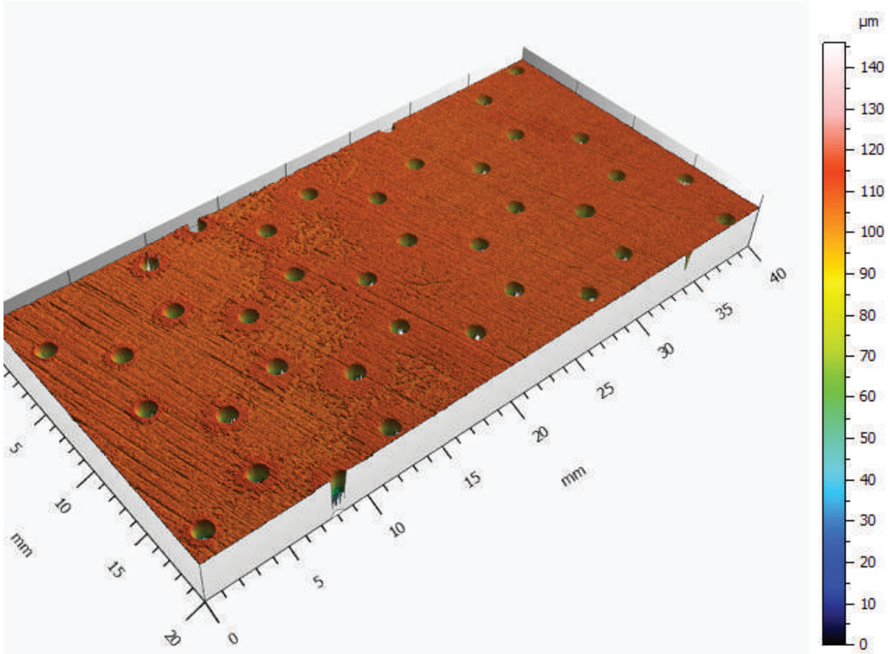
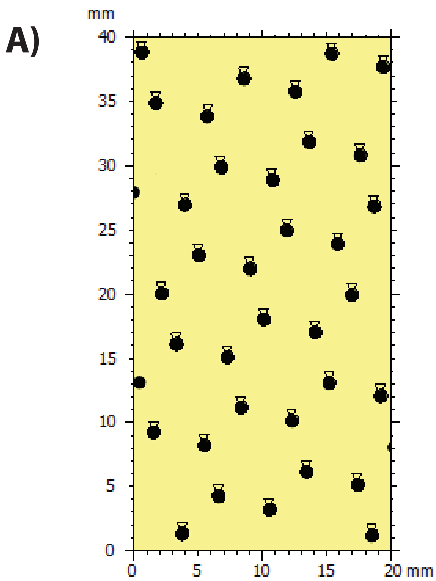


Figure 1: 3D view of scan taken for Sample A



Number of motifs	35		
Parameters	**Stat.**	**Value**	**Unit**
Equivalent diameter	**Mean**	**0.9887**	**mm**
	Std dev	**0.004767**	**mm**
Roundness	**Mean**	**0.9630**	
	Std dev	**0.01758**	

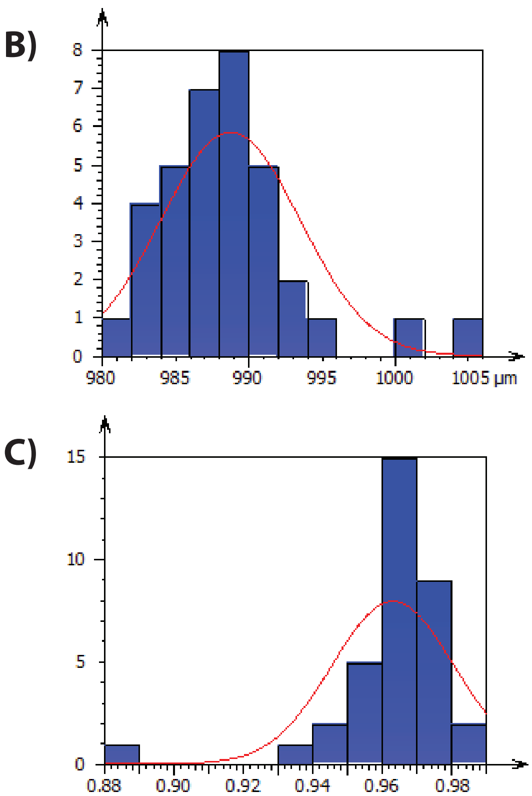


Figure 2: A) Motif analysis of holes B) histogram of equivalent diameter distribution C) histogram of roundness distribution for Sample A

Profilometry Results

Sample A

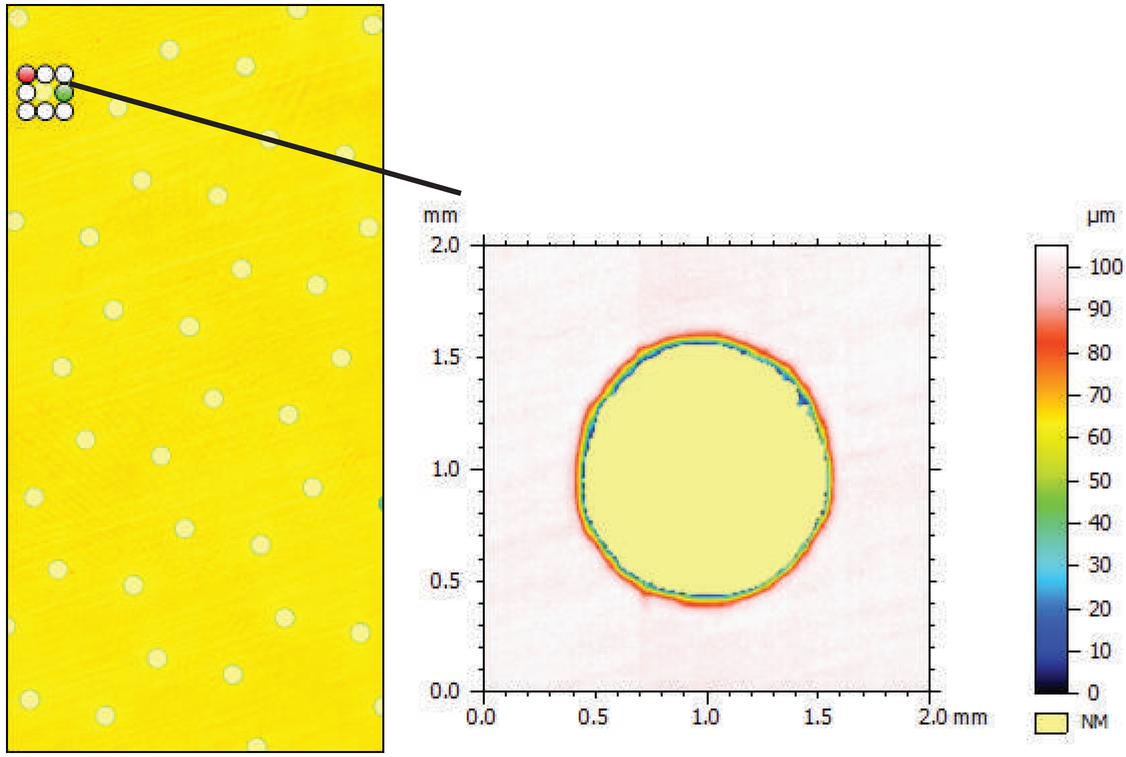


Figure 3: Extracted area of hole with outlying roundness for Sample A

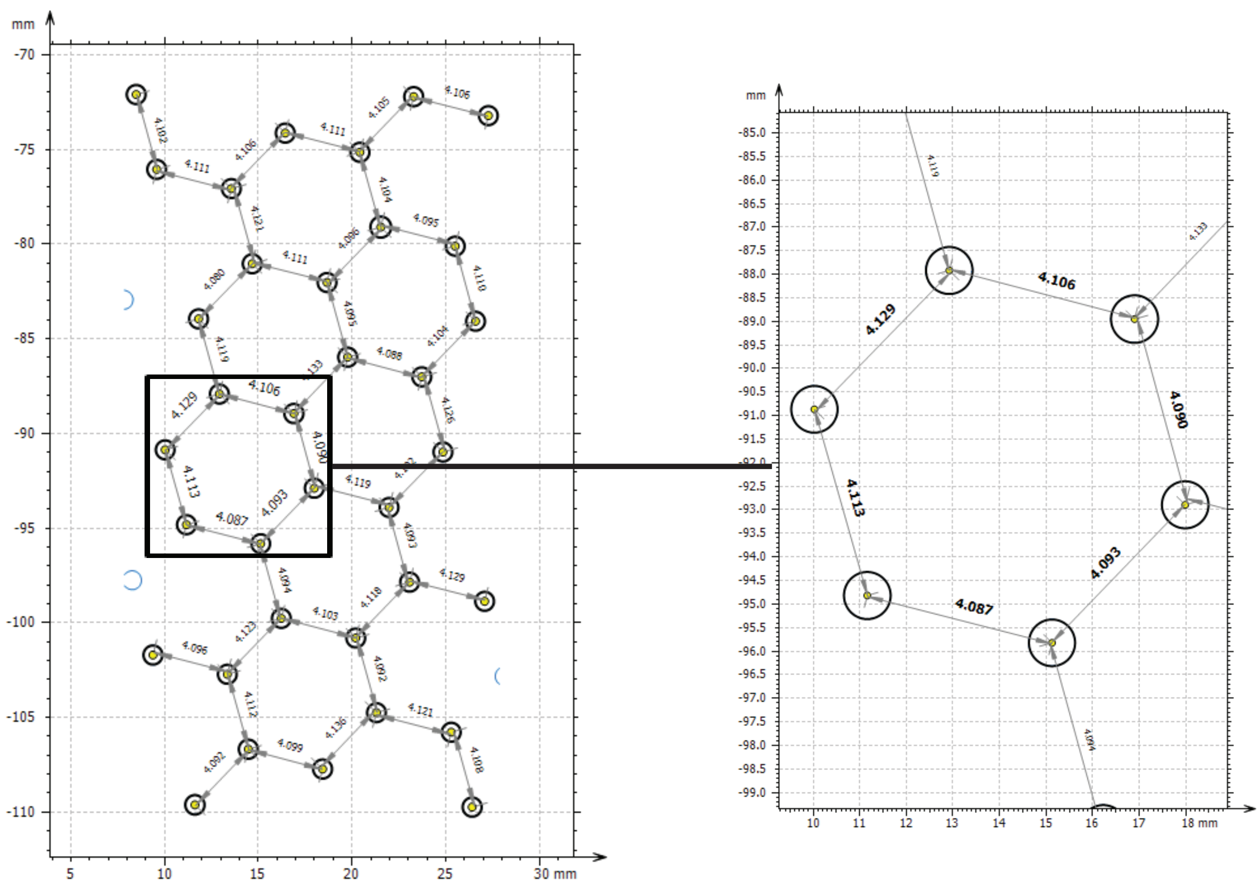
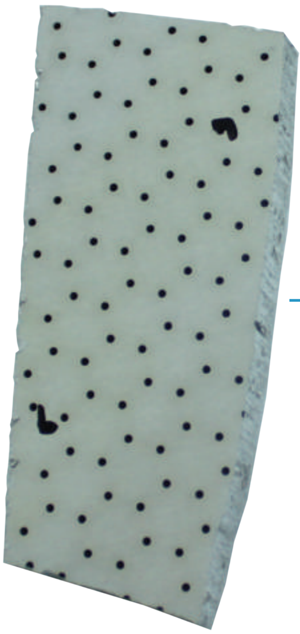


Figure 4: Contour analysis of spacing between holes for Sample A

Results: Sample B



Sample B

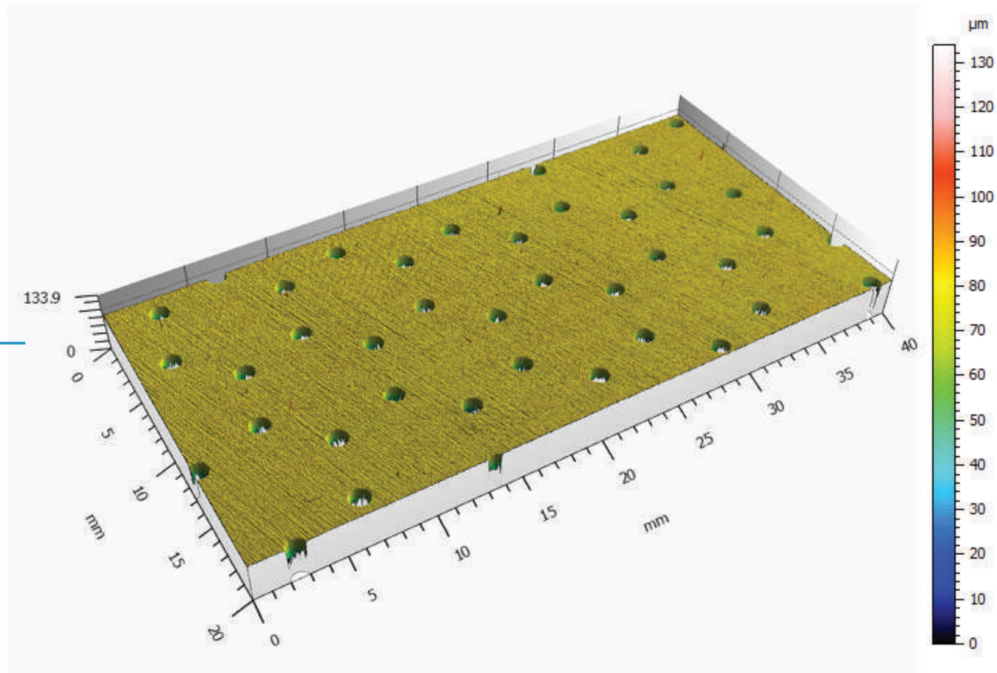
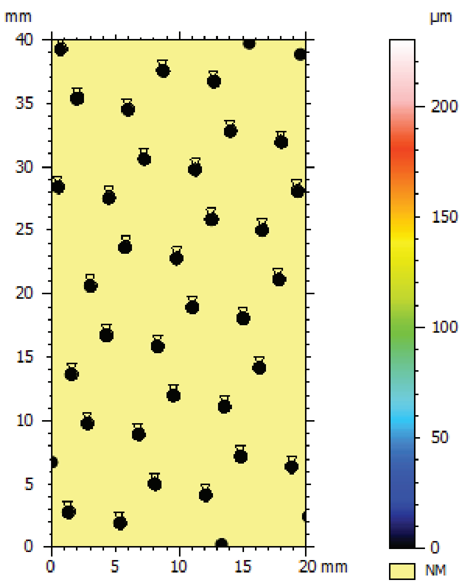


Figure 5: 3D view of scan taken for Sample B

A)



Number of motifs	34		

Parameters	Stat.	Value	Unit
Equivalent diameter	Mean	0.9842	mm
	Std dev	0.005733	mm
Roundness	Mean	0.9630	
	Std dev	0.007861	

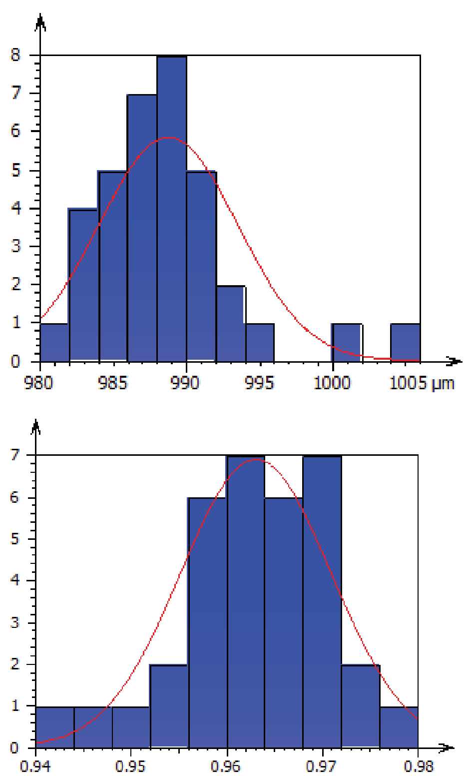


Figure 6: A) Motif analysis of holes B) histogram of equivalent diameter distribution
C) histogram of roundness distribution for Sample B

Profilometry Results

Sample B

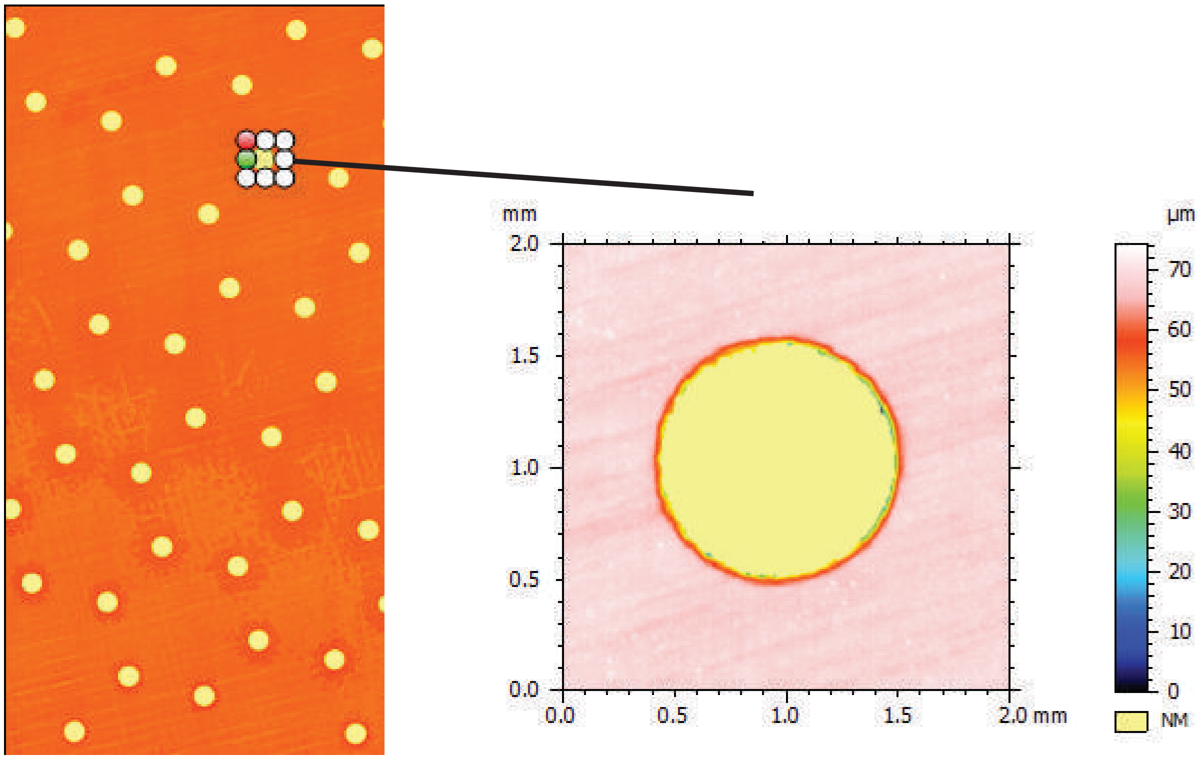


Figure 7 :Extracted area on outlier in equivalent diameter for Sample B

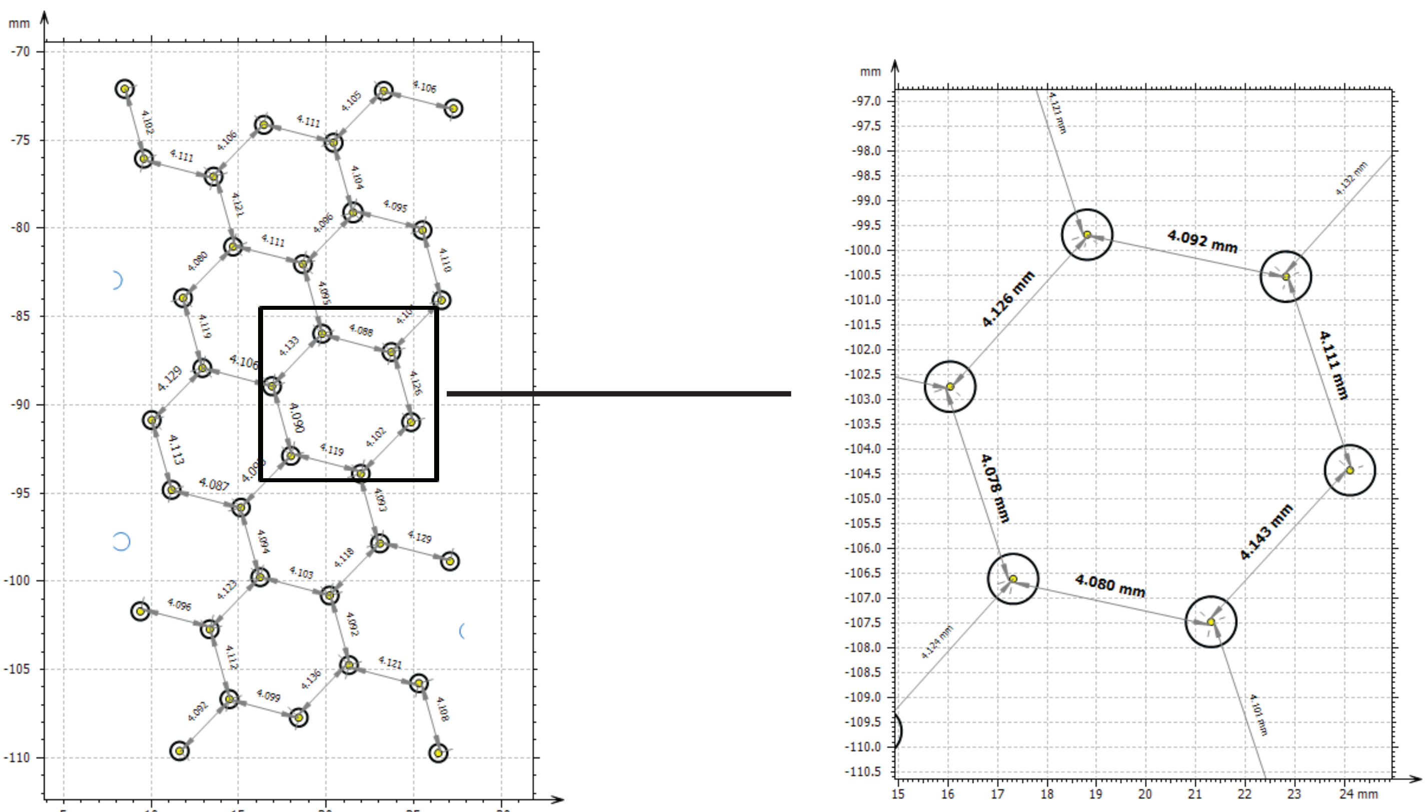


Figure 8: Contour analysis of spacing between holes for Sample B

Discussion

A 40mm x 20mm area was scanned, with nanometer level resolution, within 38 seconds. The results for Sample A and B are very similar. A hole density of approximately 4.25 holes/cm2 was seen on both samples. Sample specific details are stated below.

The holes on Sample A were observed to have an equivalent diameter of 0.9887 ± 0.0048mm and roundness of 0.9630 ± 0.0176 (note: a roundness value of 1 is considered a perfect circle) using a Motifs study. The histograms show that the majority of holes had an equivalent diameter near the mean of 0.9887mm. Two holes are seen to be two standard deviations above the mean. Depending on the acceptable tolerances, these holes may not pass quality control requirements. For roundness, only one hole is significantly differ-ent. The outlier can be closely inspected by extracting it and its surrounding area as seen in Figure 3. The average spacing between each hole and its nearest neighbors (3 for hexagonal patterns) is 4.107 ± 0.013mm.

A Motifs analysis on Sample B shows that the holes on that sample have an equivalent diameter of 0.9842 ± 0.0057mm and roundness of 0.9630 ± 0.0079. One hole was singled out from the rest due to its outlying equivalent diameter, which can be seen in Figure 7. The contour analysis in Figure 8 shows the spacing between holes to be 4.107 ± 0.16mm, almost the same as Sample A.

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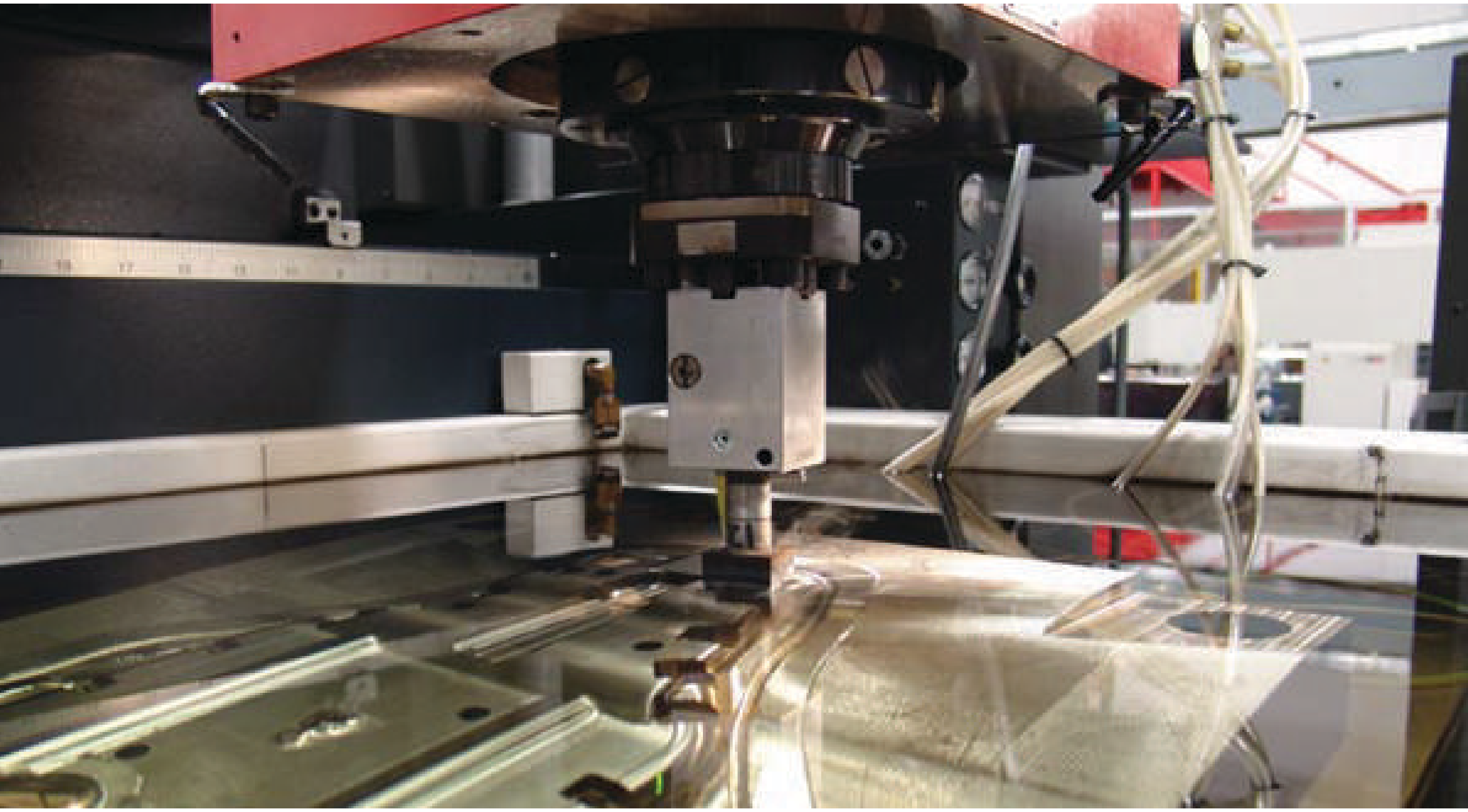

Conclusion

The equivalent diameter, roundness, and spacing of samples machined via wire EDM were quantified to observe the precision and accuracy of wire EDM machining. Very small differences were found between both samples. Few holes from the two samples measured fell outside several standard deviation from the mean, and were singularly inspected by extracting the area that contained the outlying hole of interest from the original scan. Multiple dimensions were measured on each sample with our analysis software, a software that is capable of creating templates for quick and automatic generation of results like those seen in this document. Our study has shown that Nanovea's profilometry technology is capable of providing quick and accurate measurements for quality control applications on machined parts.

You can explore our extensive digital library of application notes for more applications that our Profilometers have been used for.

https://nanovea.com/app-notes/profilometry

References

[1] Jameson, Elman C. Electrical discharge machining. Society of Manufacturing Engineers, 2001.

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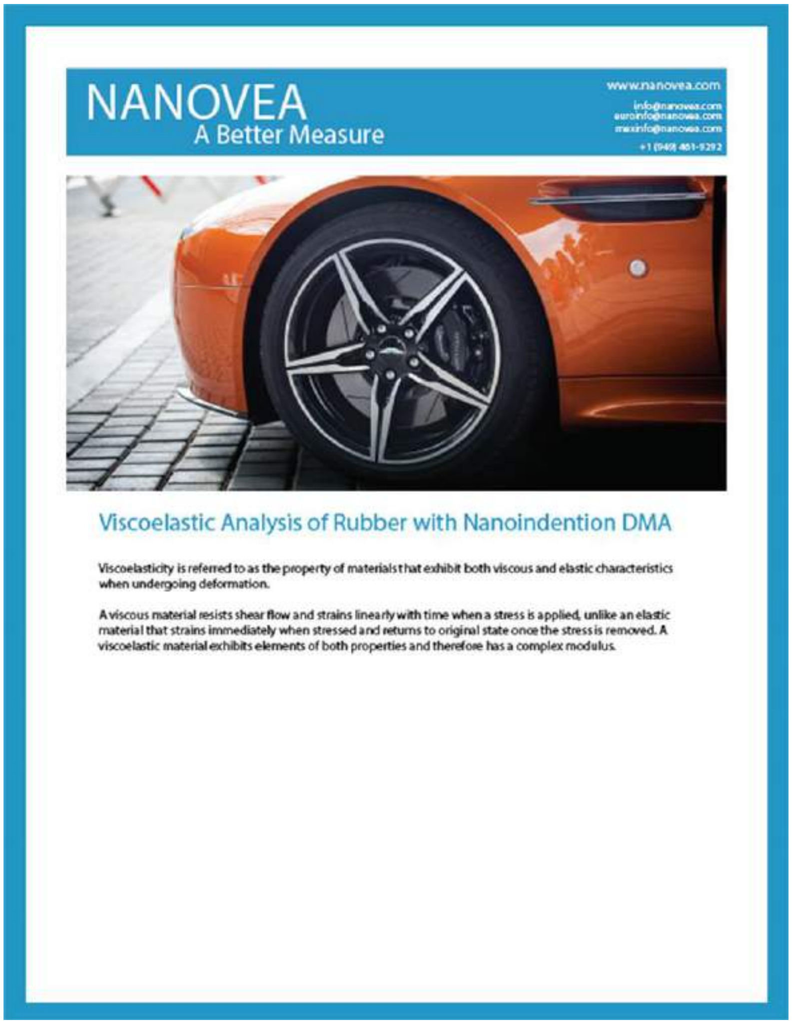
Recommended Reading

Check out our other application note where we conduct a Viscoelastic Analysis on Rubber with Nanoindentation

Click here to read!



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Viscoelastic Analysis of Rubber with Nanoindention DMA

Viscoelasticity is referred to as the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation.

A viscous material resists shear flow and strains linearly with time when a stress is applied, unlike an elastic material that strains immediately when stressed and returns to original state once the stress is removed. A viscoelastic material exhibits elements of both properties and therefore has a complex modulus.