

**A1SIN OXIDATION SURFACE AREA
USING 3D PROFILOMETRY**



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INTRO:

Oxidation resistance is critical for metal components in high temperature environments. Exposure to high temperatures can result in the depletion of the metal with rapid oxidation and material loss. Without protective coatings, surface oxidation adversely affects the performance and durability of the metal component. For example, engine parts, turbine blades, tooling and many others. It will be critical to test the protective coating chosen for a given application.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR OXIDATION RESISTENT COATINGS

To reliably understand and evaluate oxidation resistance the surface can be measured after an oxidation resistance test. Understanding surface parameters can lead to the best selection of processing and control measures. Insuring the quality control of such parameters will heavily rely upon quantifiable, reproducible and reliable inspection of the coating surface. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unique capability to measure extreme rough surfaces and steep angles. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle, absorption or reflectivity, Nanovea Profilometers succeed.

MEASUREMENT OBJECTIVE

The 3D Non Contact Profilometer will be used to characterize the surface of two samples with AlSiN coatings, one with a low level of silicon the other with a high level. The AlSiN coating was deposited on H13 Steel by magnetron sputtering then submitted to an oxidation resistance test (900°C-1 hour).



RESULTS:

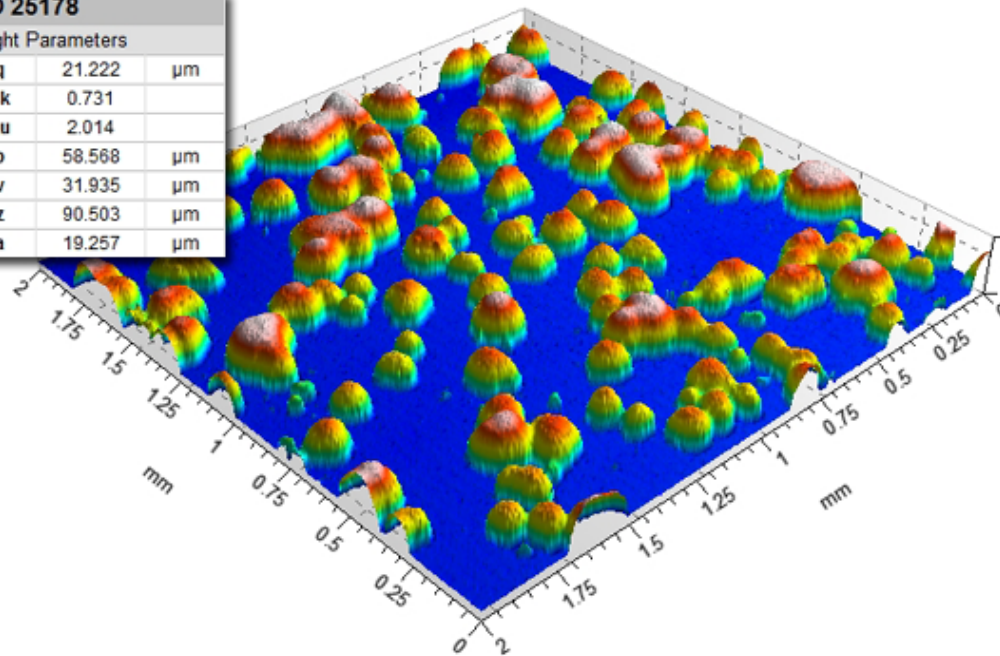
Sample 1 | Low Silicon

3D Profile & Roughness Results

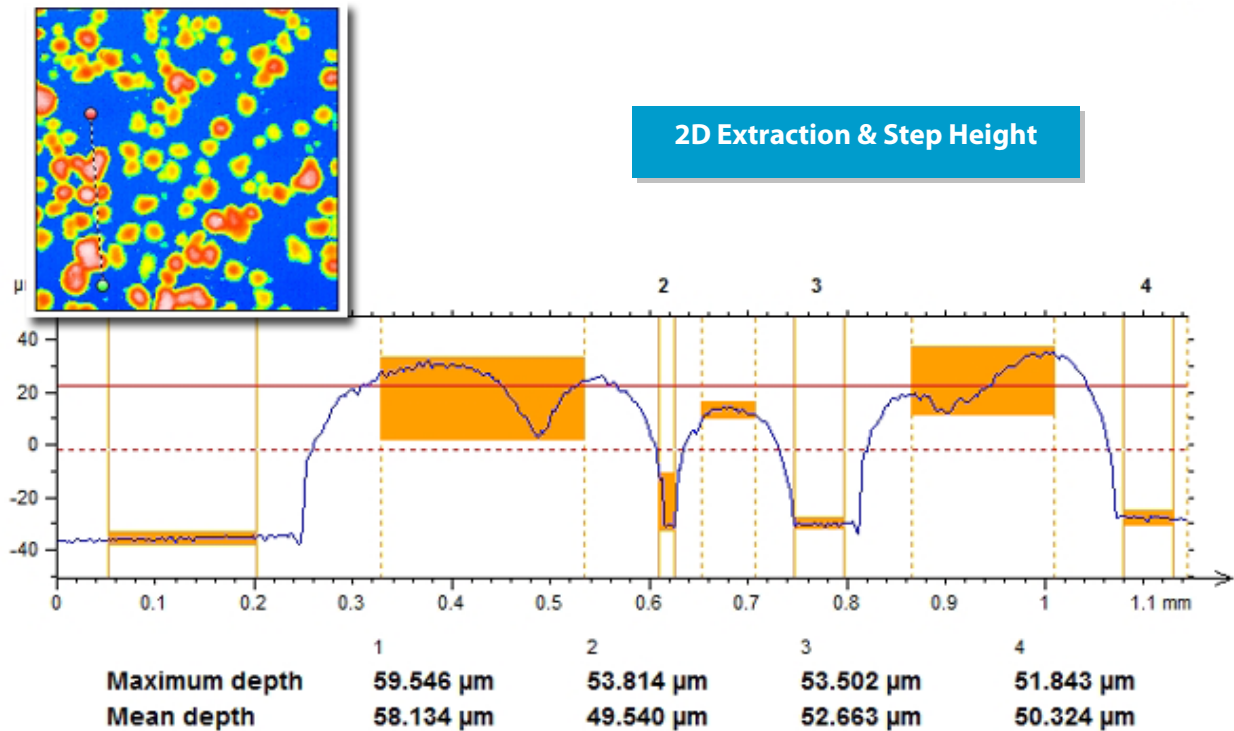
ISO 25178

Height Parameters

Sq	21.222	μm
Ssk	0.731	
Sku	2.014	
Sp	58.568	μm
Sv	31.935	μm
Sz	90.503	μm
Sa	19.257	μm

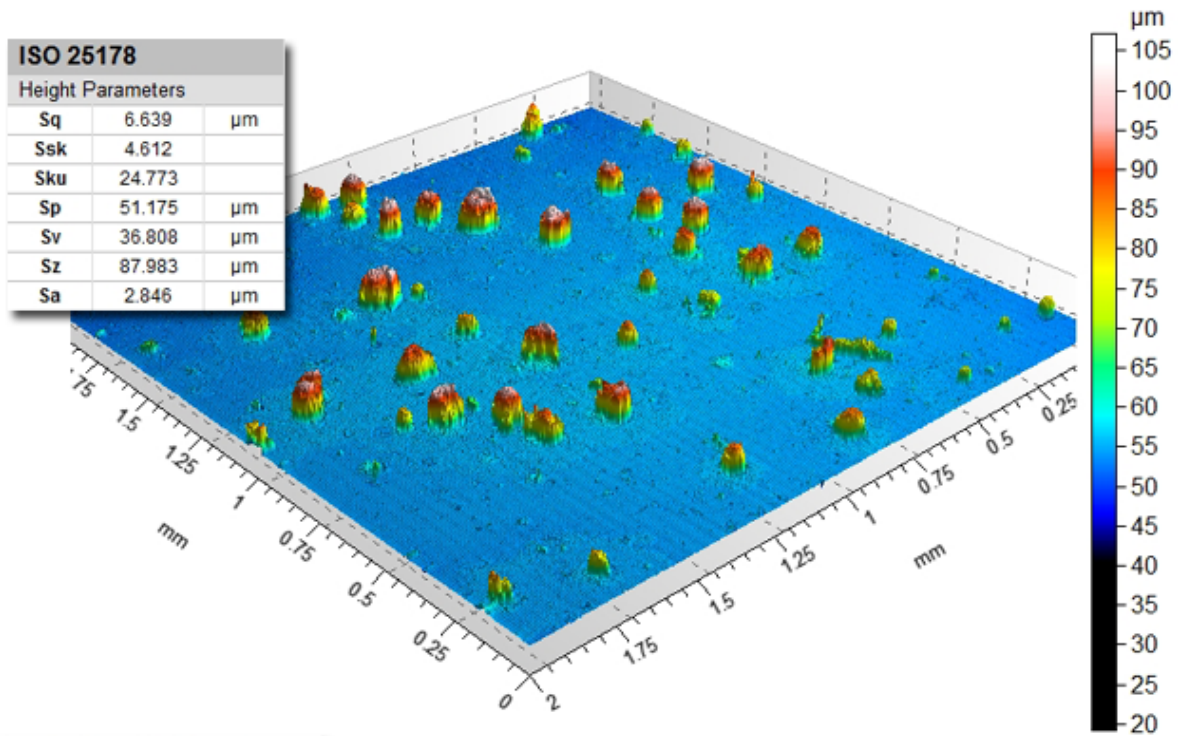


2D Extraction & Step Height

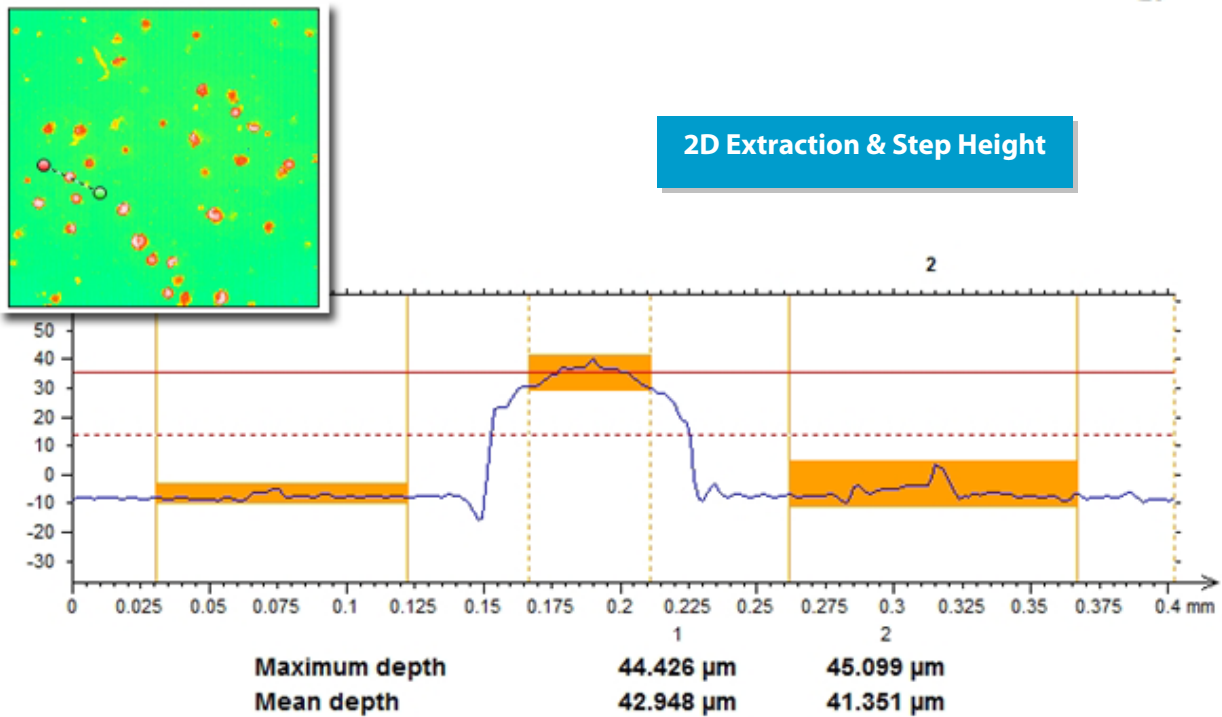


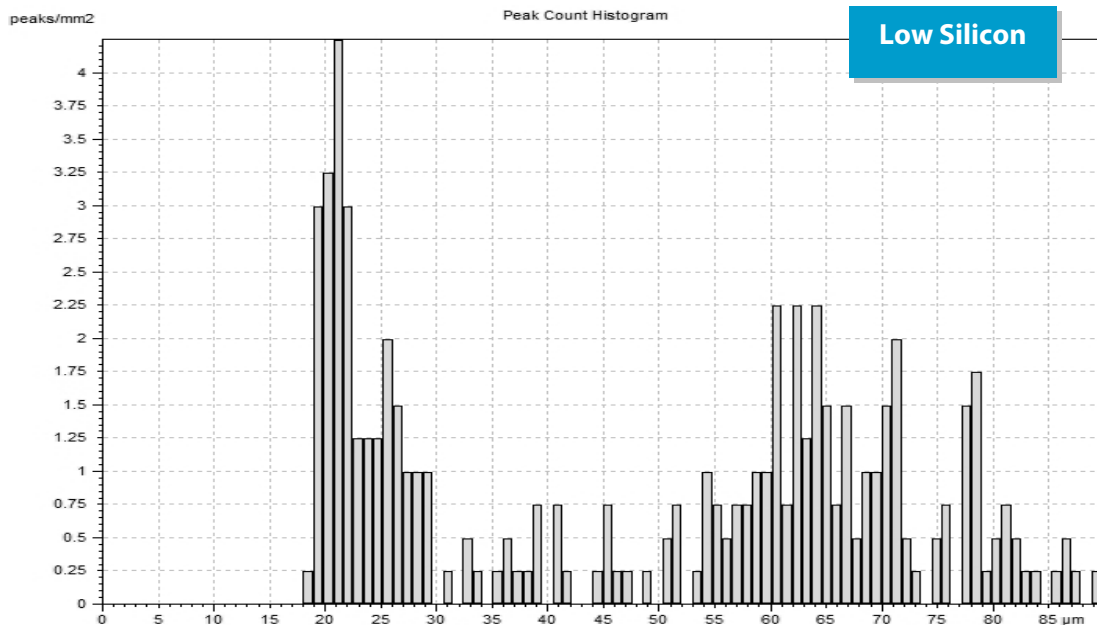
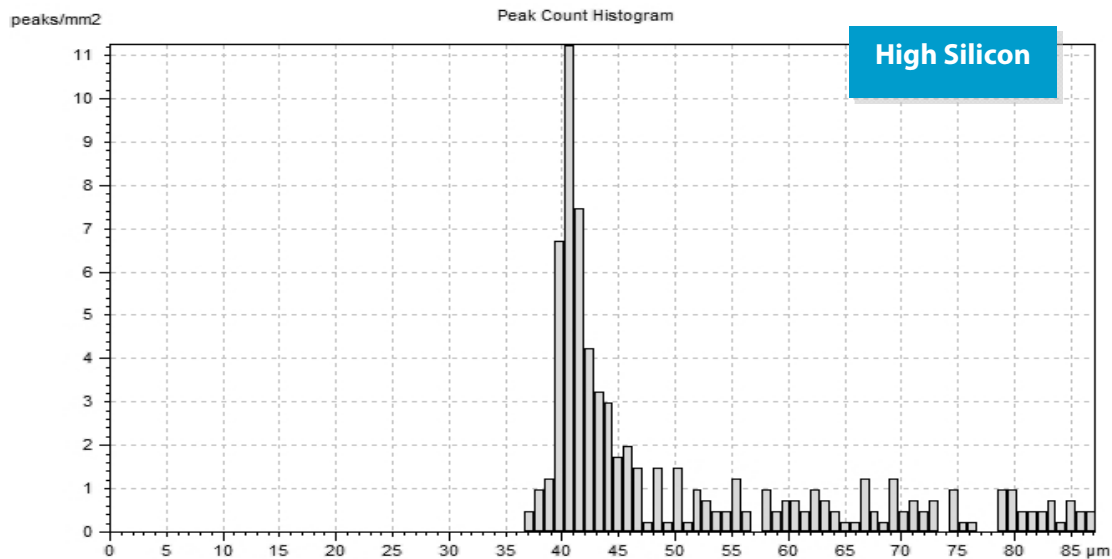
Sample 1 | High Silicon

3D Profile & Roughness Results



2D Extraction & Step Height



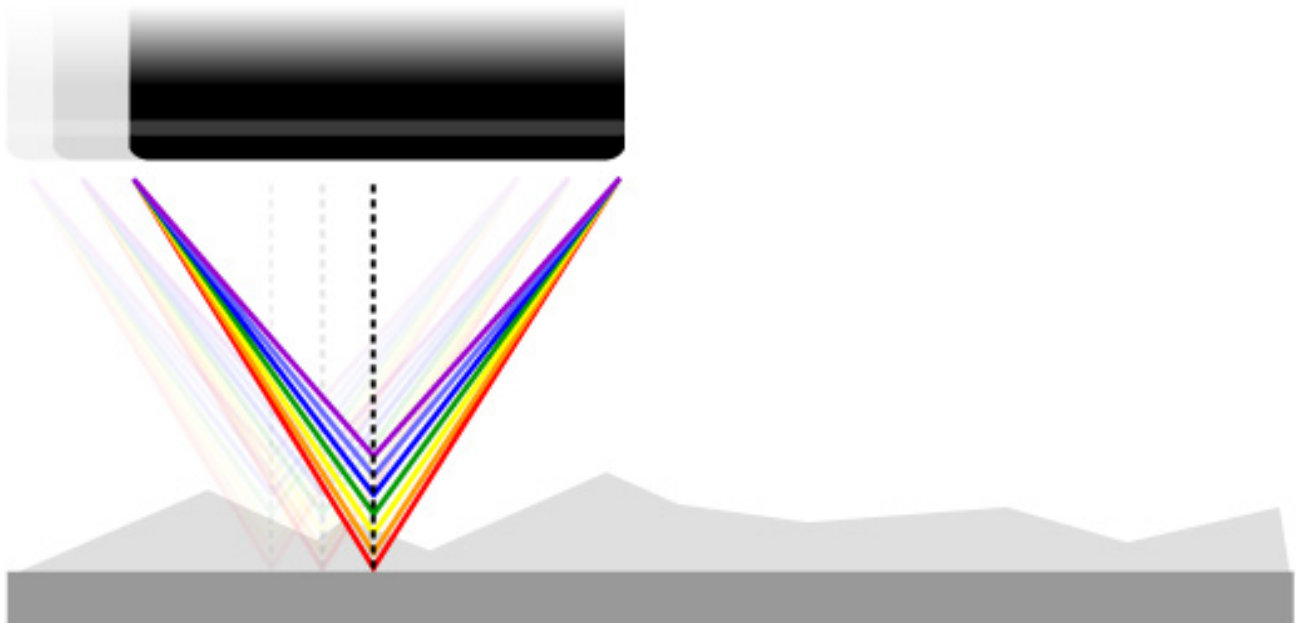


CONCLUSION:

In this application, we have shown how the Nanovea 3D Non Contact Profilometer can precisely characterize both the topography and the nanometer details of an oxidized surface. By comparing the two surfaces it has been clearly shown the AlSiN coating with high silicon performed much better than that with a lower. From the 3D surface measurements, areas of interest can quickly be identified and then analyzed with a list of endless measurements (Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and others). To further view in detail, a 2D cross section can quickly be chosen to analyze at nanometer range. With this information oxidized surfaces can be broadly investigated with a complete set of surface measurement resources.

MEASUREMENT PRINCIPLE:

The Chromatic Confocal technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white light will re-focus at a different distance from the lens (different height). When the measured sample is within the range of possible heights, a single monochromatic point will be focalized to form the image. Due to the confocal configuration of the system, only the focused wavelength will pass through the spatial filter with high efficiency, thus causing all other wavelengths to be out of focus. The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.



Unlike the errors caused by probe contact or the manipulative Interferometry technique, Chromatic Confocal technology measures height directly from the detection of the wavelength that hits the surface of the sample in focus. It is a direct measurement with no mathematical software manipulation. This provides unmatched accuracy on the surface measured because a data point is either measured accurately without software interpretation or not at all. The software completes the unmeasured point but the user is fully aware of it and can have confidence that there are no hidden artifacts created by software guessing.

Nanovea optical pens have zero influence from sample reflectivity or absorption. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent or opaque, specular or diffusive, polished or rough. Measurement includes: Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and many others.

DEFINITION OF HEIGHT PARAMETERS

Height Parameter		Definition
Sa	Arithmetical Mean Height	Mean surface roughness. $Sa = \frac{1}{A} \iint_A z(x, y) dx dy$
Sq	Root Mean Square Height	Standard deviation of the height distribution, or RMS surface roughness. $Sq = \sqrt{\frac{1}{A} \iint_A z^2(x, y) dx dy}$ Computes the standard deviation for the amplitudes of the surface (RMS).
Sp	Maximum Peak Height	Height between the highest peak and the mean plane.
Sv	Maximum Pit Height	Depth between the mean plane and the deepest valley.
Sz	Maximum Height	Height between the highest peak and the deepest valley.
Ssk	Skewness	Skewness of the height distribution. $Ssk = \frac{1}{Sq^3} \left[\frac{1}{A} \iint_A z^3(x, y) dx dy \right]$ Skewness qualifies the symmetry of the height distribution. A negative Ssk indicates that the surface is composed of mainly one plateau and deep and fine valleys. In this case, the distribution is sloping to the top. A positive Ssk indicates a surface with a lot of peaks on a plane. Therefore, the distribution is sloping to the bottom. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.
Sku	Kurtosis	Kurtosis of the height distribution. $Sku = \frac{1}{Sq^4} \left[\frac{1}{A} \iint_A z^4(x, y) dx dy \right]$ Kurtosis qualifies the flatness of the height distribution. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.
Spar	Projected Area	Projected surface area.
Sdar	Developed Area	Developed surface area.