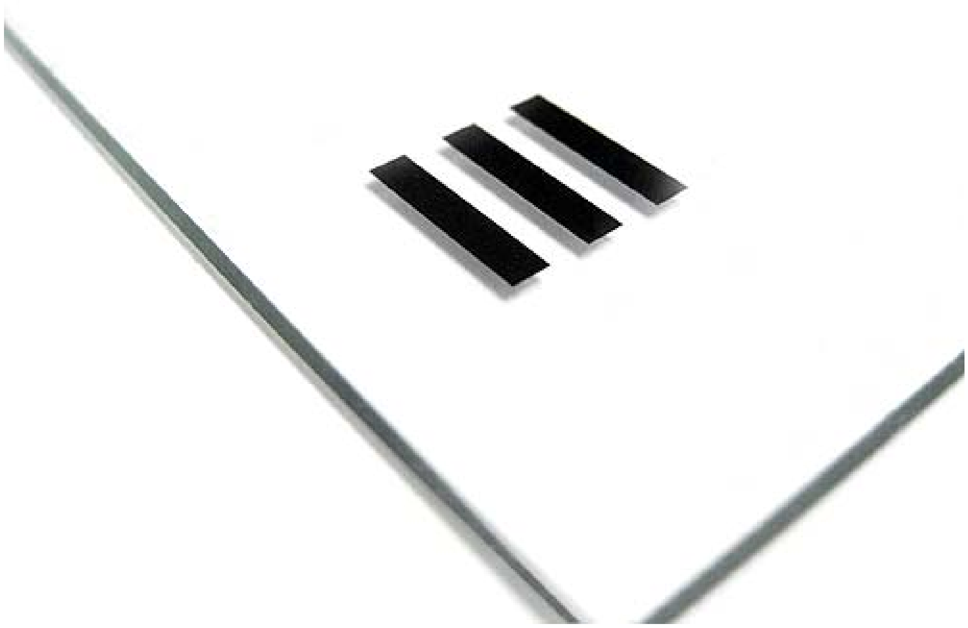
Thin Film Thickness Measurement
With 3D Metrology



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INTRO:

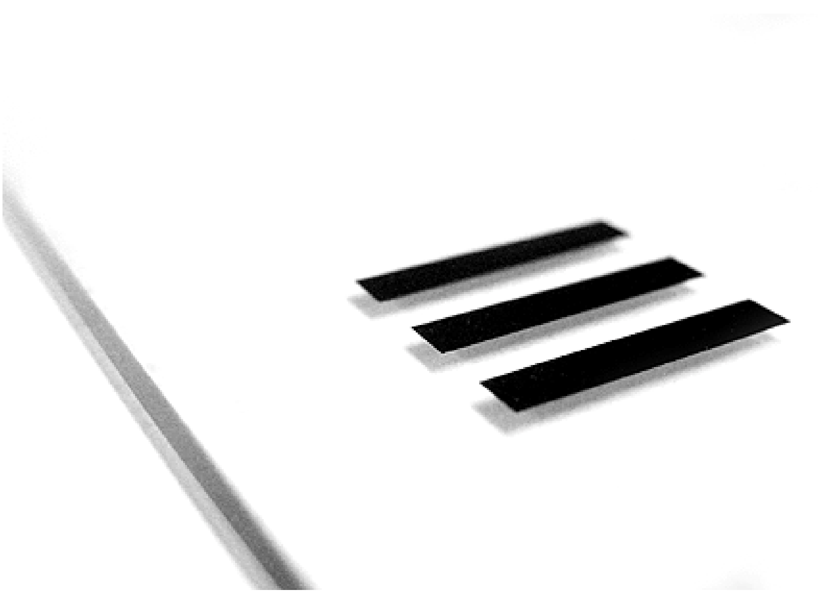
Thin-film deposition is the act of applying a thin film to a surface, any technique for depositing a thin film of material onto a substrate or onto previously deposited layers. "Thin" is a relative term, but most deposition techniques primary concern is the control of layer thickness within a few tens of nanometers. This is crucial for manufacturing the coatings on optics, electronics, packaging and most recently the rise of solar cells.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR QUALITY CONTROL

From the description above, it can safely be said that thin film thickness control is highly important to the manufacturing process of various highly demanded applications. The ideal technique for assuring this control would be a highly accurate, non-contact, high speed measurement with no disturbance from transparent and or reflective surfaces.

MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the thickness of two different areas of highly reflective chrome that has been deposited on transparent glass. By measuring selected areas on the glass and on the chrome, we can derive the mean, maximum and minimum height differences.

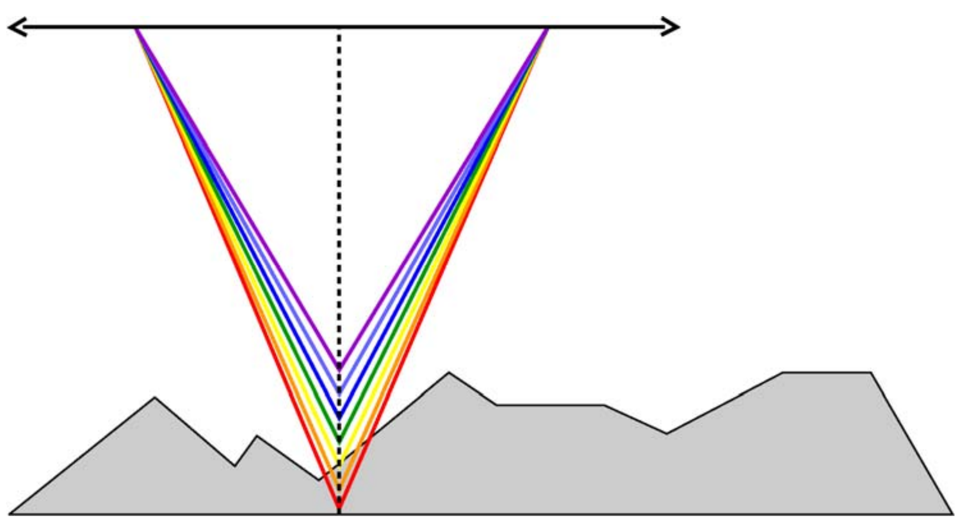


MEASUREMENT SET-UP & TIPS:

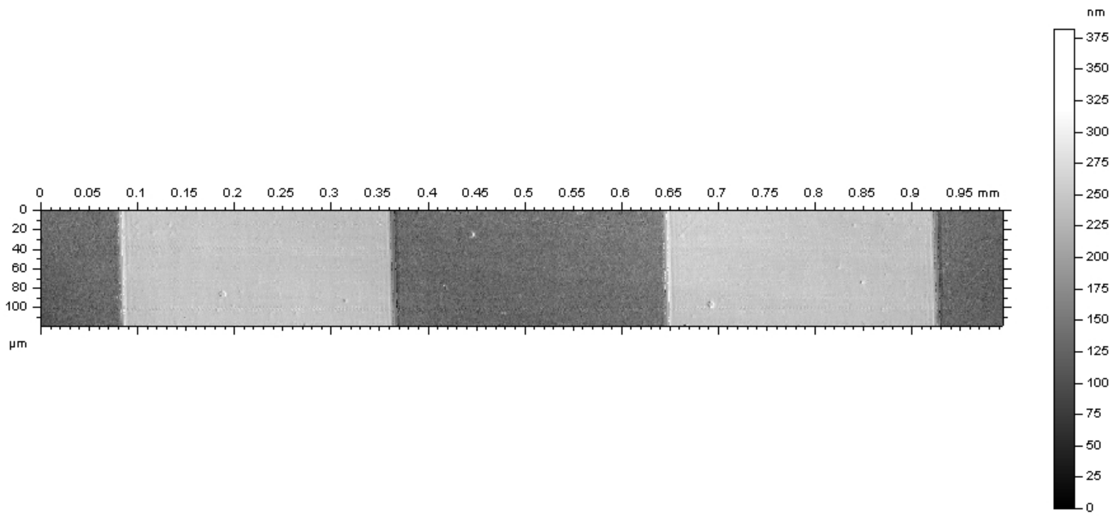
In this particular application, we have a highly reflective layer of chrome and a less reflective piece of glass in the same measurement area. With other optical measurement techniques, this will cause a false measurement and actually make it appear as if the chrome layer was lower than the glass substrate. With the axial chromatism principle used by the ST400, this is not the case. To obtain accurate results in cases like this, there is a function that allows the measurement of two different acquisition rates simultaneously and therefore does not allow light saturation. Cleaning the surface is not necessary, but in this case compressed air was used. If there was a piece of dust that was on the surface, this would have been measured, and consequently would have skewed the average thickness values.

MEASUREMENT PRINCIPLE:

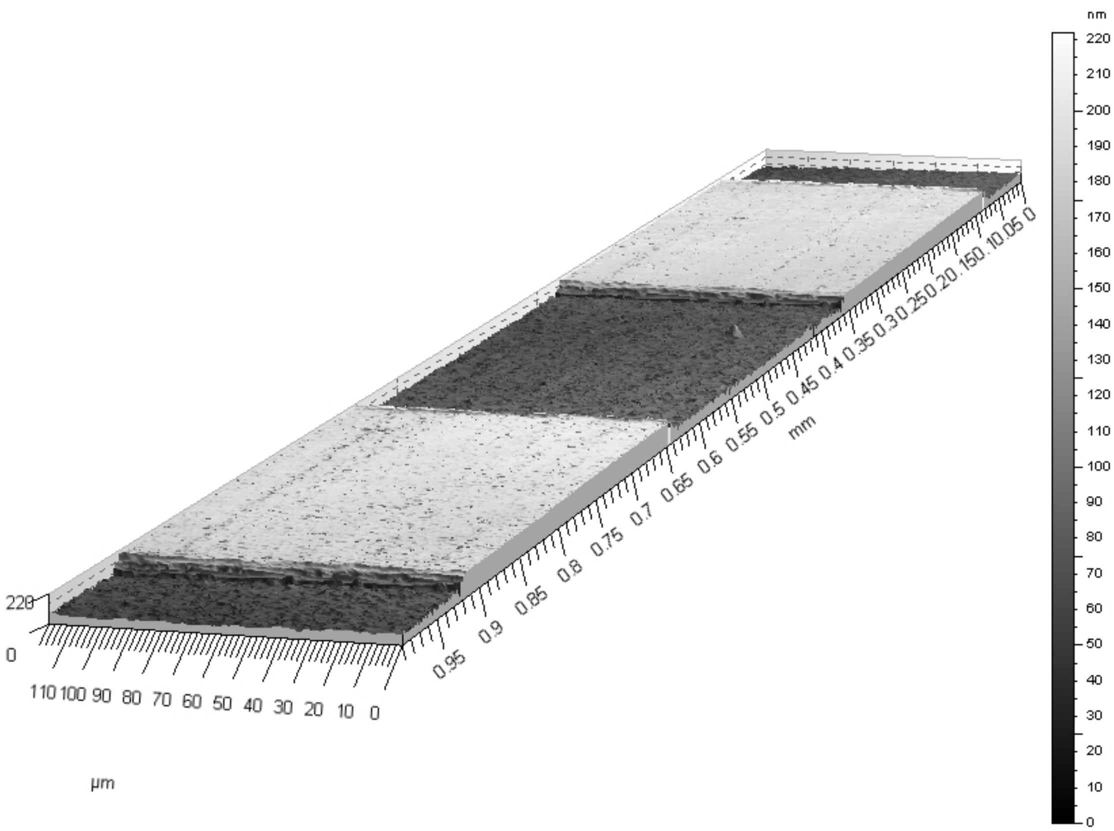
The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white 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.

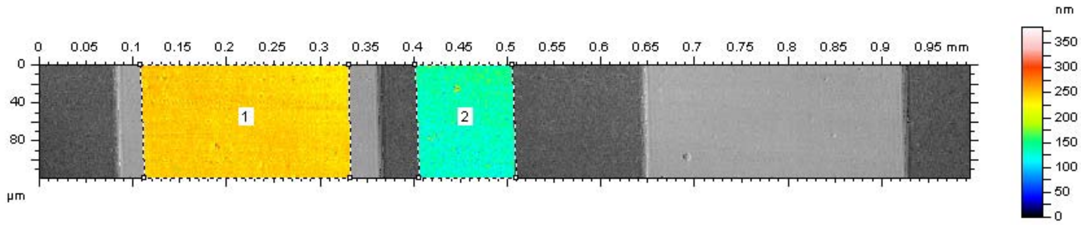


The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.

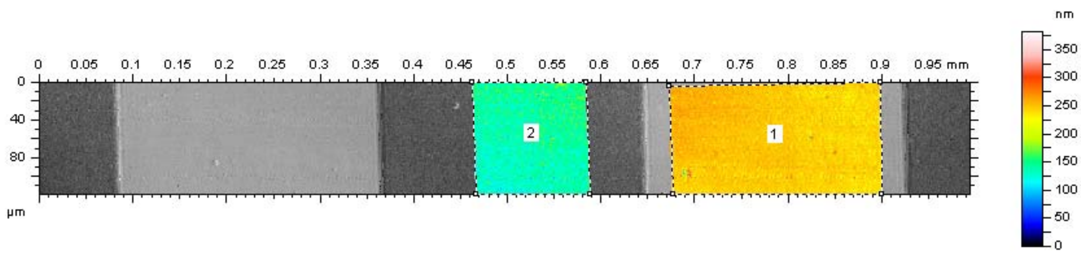


False color representations of same surface





$Z\ (mean)^1 - Z\ (mean)^2$ = **107.7nm**
$Z\ (min)^1 - Z\ (mean)^2$ = **-63.3nm**
$Z\ (max)^1 - Z\ (min)^2$ = **306.8nm**



$Z\ (mean)^1 - Z\ (mean)^2$ = **104.5nm**
$Z\ (min)^1 - Z\ (mean)^2$ = -**72.8nm**
$Z\ (max)^1 - Z\ (min)^2$ = **300.3nm**

CONCLUSION:

By selecting areas both on the glass and on the chrome, we are able to accurately calculate its thickness. This is represented most obviously by subtracting the mean of the two respective areas. The minimum and maximum values also show that the chrome has inconsistencies in its thickness. The fact that the minimum differences are negative suggests that there were scratches that actually penetrated the glass surface below the chrome. While the maximum differences show nearly triple that of the average, suggesting that either the chrome is very inconsistent or there was something on the glass and/or chrome that skewed these values.

The results above clearly illustrate the Nanovea ST400's ability to precisely measure thin films in the 100nm range, and in other such applications it has been shown on even thinner films. With the ST400 it is also possible to make these types of measurements on transparent films on transparent or opaque substrates.