Characterisation of the degradation of lignin-coated particle board under accelerated ageing conditions of temperature and humidity

Introduction

Oriented strand board (OSB) is a type of engineered lumber, similar to particle board, formed by combining adhesives and then compressing layers of wood strands (flakes) in specific orientations. The low cost of this material is the most important factor in the choice for many manufacturers to adopt it. However, its high water absorption, leading to failure of the adhesive matrix and eventually the entire composite, coupled with its low surface quality and appearance, has led a company based in British Columbia, Canada, to invent a protective coating that can be applied to the material and significantly improve its value. In this study, a novel lignin-based polymer has been used as a protective coating and the effect of determined ambient conditions have been studied on the outcomes of hardness, mass and surface quality. In this project, two types of lignin based coatings has been employed; simple coloured Lignin coating and a lignin-alumina powder coating. Given the inherent modes of degradation of polymer-based materials, including composites [1-3], under these conditions, such an investigation was warranted for this novel material.

Test Procedure

Coated samples were provided by the company cut in square shape pieces with the approximate size of 80mm x 80mm. Each material was cut into five samples, for a total of 10 samples. These samples were sealed on the five faces that did not have the lignin-based polymer coating, with an elastomeric resin, in order to guarantee a seal on those five sides. All samples weighted using a Qualitest MDS-300 electronic densimeter, measured for hardness on the Shore D scale using a Qualitest BS 61 II tester. Furthermore, the surface profile of each sample with coloured lignin coated samples were tested for surface quality, or specifically, surface roughness, using a Bruker Contour GKT White Light Interferometer (WLI). The coloured lignin samples only required this test, due to surface quality being an outcome of importance, unlike the alumina composite samples, which are used for high-grip surfacing.

The samples were then subjected to two weeks of elevated humidity (relative humidity of 99%) and temperature (50°C), to simulate accelerated ageing conditions. A Thermotron SM-4-800 environmental chamber was used to achieve this.

All samples were tested and data analysis performed according to ASTM D2240-05 for hardness measurements and ISO 4287-1997 for surface texture profilometry. All measurements were taken five times for repeatability and statistical robustness. Data reported in the results are averages.

Results

It was found that there were statistically insignificant differences found in the samples, between the before and after exposure conditions. This was the case for the mass, density and surface roughness measurements. The results have been presented in table and graphical form below for ease of interpretation.

(a) (b) (c)

Figure 1: The samples and conditioning chamber used in this study, the (a) lignin-alumina coated samples, the (b) coloured lignin coated samples and the (c) Thermotron SM-4-800 environmental chamber for exposure.

Table 1: Mass of colored lignin coated samples (grams)

Sample	Before exposure	After exposure	% Water absorption
1	59.936	60.111	0.2920
2	55.99	56.151	0.2876
3	53.199	53.329	0.2444
4	55.583	55.748	0.2969
5	67.724	67.963	0.3529

Table 2: Mass of alumina-lignin coated samples (grams)

Sample	Before exposure	After exposure	% Water absorption
1	37.661	37.845	0.4886
2	36.845	36.978	0.3610
3	37.868	38.011	0.3776
4	38.03	38.134	0.2734
5	39.161	39.342	0.4622

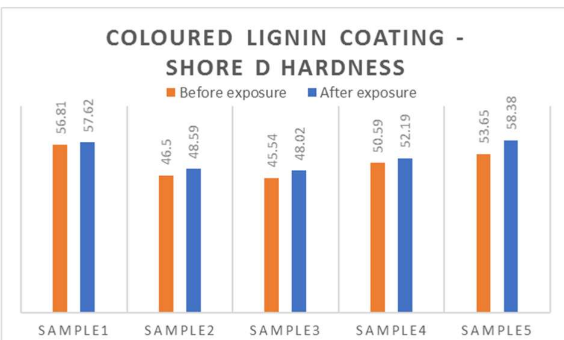


Figure 2: Shore D hardness values of coloured lignin samples before and after exposure.

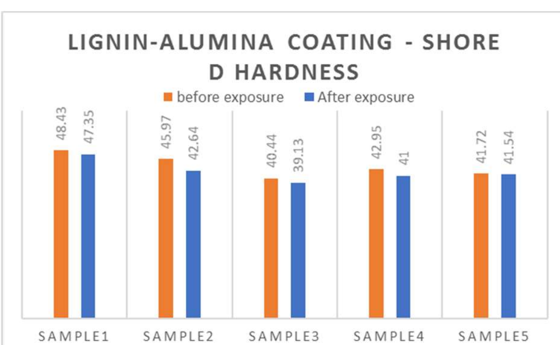


Figure 3: Shore D hardness values of alumina-lignin samples before and after exposure

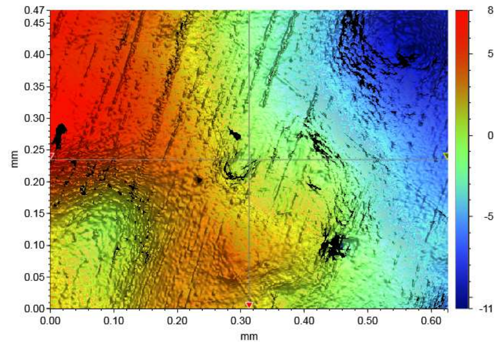


Figure 4: Surface roughness parameter R_a contour plot of coloured lignin sample 1 prior to exposure (R_a = 1.625μm).

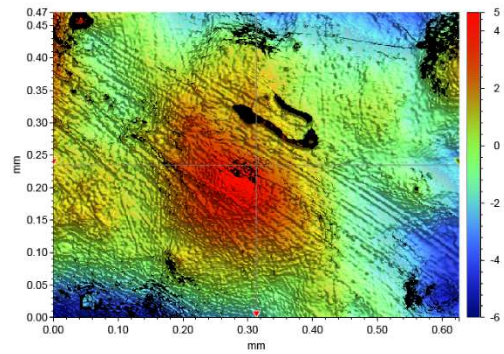


Figure 4: Surface roughness parameter R_a contour plot of coloured lignin sample 1 after to exposure (R_a = 1.717μm).

There was little noise or variation observed in the mass or hardness measurements. However, due to the nature of the surface roughness measurements, the results were highly variable. This high variance in the results contributed to the conclusion that there was no statistical significance between the R_a values before or after exposure. Overall, the evidence collected supports the conjecture that the novel lignin-based polymer acts as an excellent protective coating for the lower quality OSB substrate material, allowing it to be used in applications where moisture is high and aesthetics are important.

References

[1] Heinrick, M., Crawford, B., Milani, A. S. (2017). "Degradation of fibreglass composites under natural weathering conditions", Medcrave Online Journal of Polymer Science, 1 (1): 04 – 12.

[2] Abeysinghe, H. P., Edwards, W., Pritchard, G., Swampillai, G. J. (1982). "Degradation of crosslinked resins in water and electrolyte solutions". Polymer, 23(12), 1785-1790.

[3] Mohammadi, M. S., Solnickova, L., Crawford, B., Komeili, M., Milani, A. S. (2014). "Investigating the unrecovered displacement of glass fibre reinforced polymers due to manufacturing conditions", Journal of Multifunctional Composites 2(2), pp. 100-104.

Towards Understanding the effect of temperature and humidity on the properties of coated O.S.B

Oriented strand board (**OSB**) is a type of engineered lumber similar to particle board, formed by adding adhesives and then compressing layers of wood strands (flakes) in specific orientations. The low cost of this material is the most important factor to tempt manufacturer to use it. However, its high water absorption and low surface quality lead researchers to invent protective coating. In this study, Lignin, has been used as a protective coating and the effect of determined ambient condition has been studied on its properties. In this project, two types of Lignin based coatings has been employed; simple colored Lignin coating and Lignin-Alumina powder coating.

1. Test procedure:

Coated samples were cut in square shape pieces with the approximate size of $80 * 80\ mm^2$. Then, 5 wooden samples selected randomly for the further tests. All samples weighted before and after temperature and humidity exposure. Besides, to measure the effect of ambient condition the surface quality the hardness of each sample measured via Qualitest BS 61 II tester twice (before and after exposure). Furthermore, the surface profile of each sample with Colored Lignin coating was tested via White Light Interferometer (WLI) tester.

2. Test Results

2.1. Sample weights:

Tables 1 and 2 are depicting the mass distribution of coated OSB samples before and after the temperature and humidity exposure for the both Lignin based coatings.

sample	before exposure	after exposure	% water
1	59.936	60.111	0.291978
2	55.99	56.151	0.2875513
3	53.199	53.329	0.2443654
4	55.583	55.748	0.2968533
5	67.724	67.963	0.3529029

Table 1- Mass distribution of colored Lignin coated sample

sample	before exposure	after exposure	% water
1	37.661	37.845	0.4885690
2	36.845	36.978	0.3609716
3	37.868	38.011	0.3776275
4	38.03	38.134	0.2734683
5	39.161	39.342	0.462194

Table 2- Mass distribution of Lignin-Alumina coated sample

2.2. Hardness Testing:

For each test coupon, 10 random points selected to test the hardness. Figures 1 and 2 are presenting the average value of hardness for each sample. As it is shown in Figure 1, for all the samples with Lignin-Alumina coating, the hardness is reducing after the exposure.

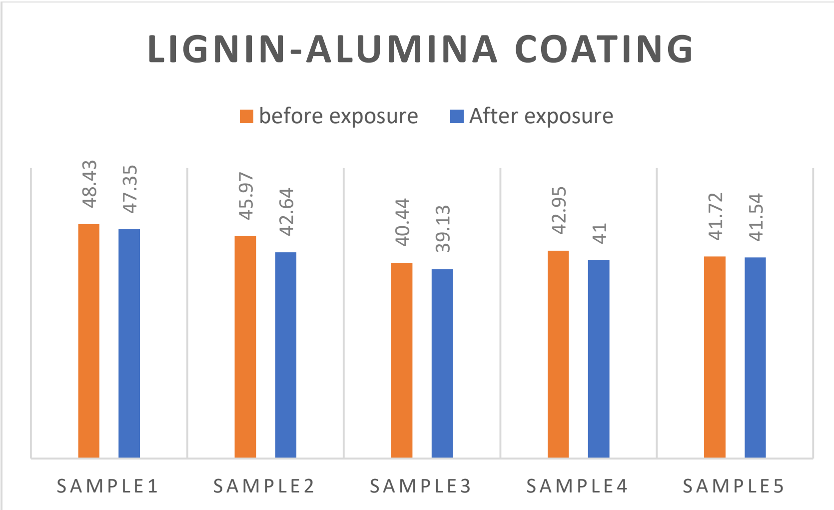


Figure 1- The change in hardness of wooden samples with Lignin-Alumina coating

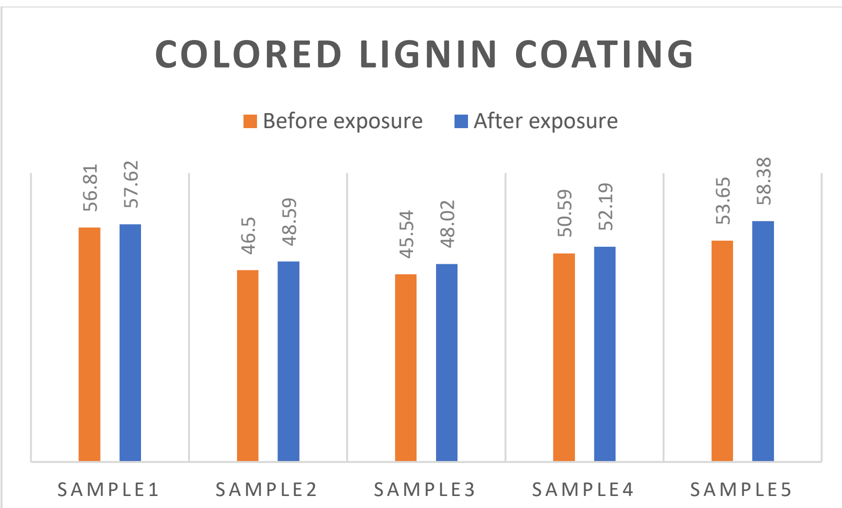


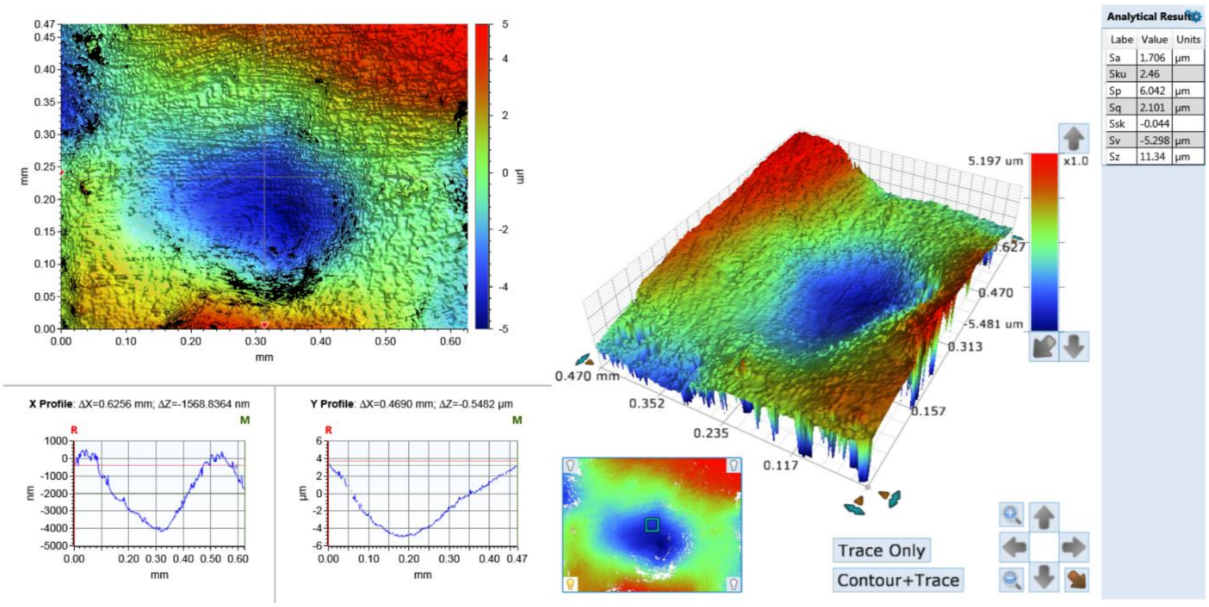
Figure 2- The change in hardness of wooden samples with Colored Lignin coating

2.3.Surface profile:

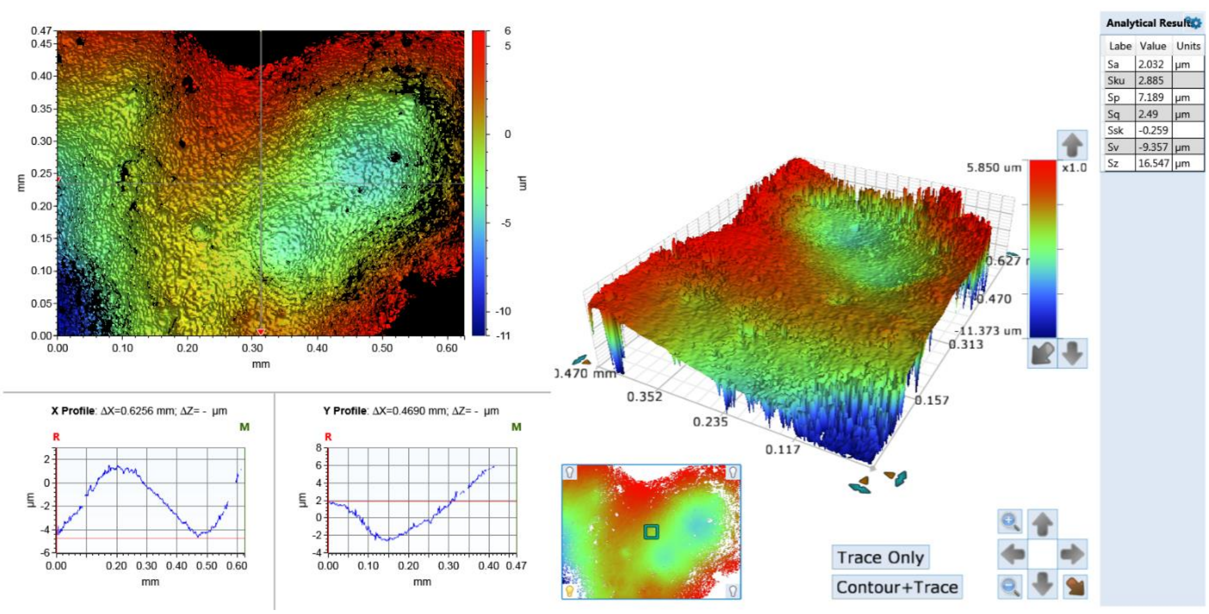
Testing the surface profile of Lignin-Alumina coatings with WLI tester was not possible. Thus, these tests, just have been performed on the colored- Lignin coated samples. First, for each sample the WLI test has been performed on two or three different random points and then the test repeated for the same point after exposure. The fully detailed results of the performed tests are provided in the next pages

Sample 1- first point :

Before Exposure :

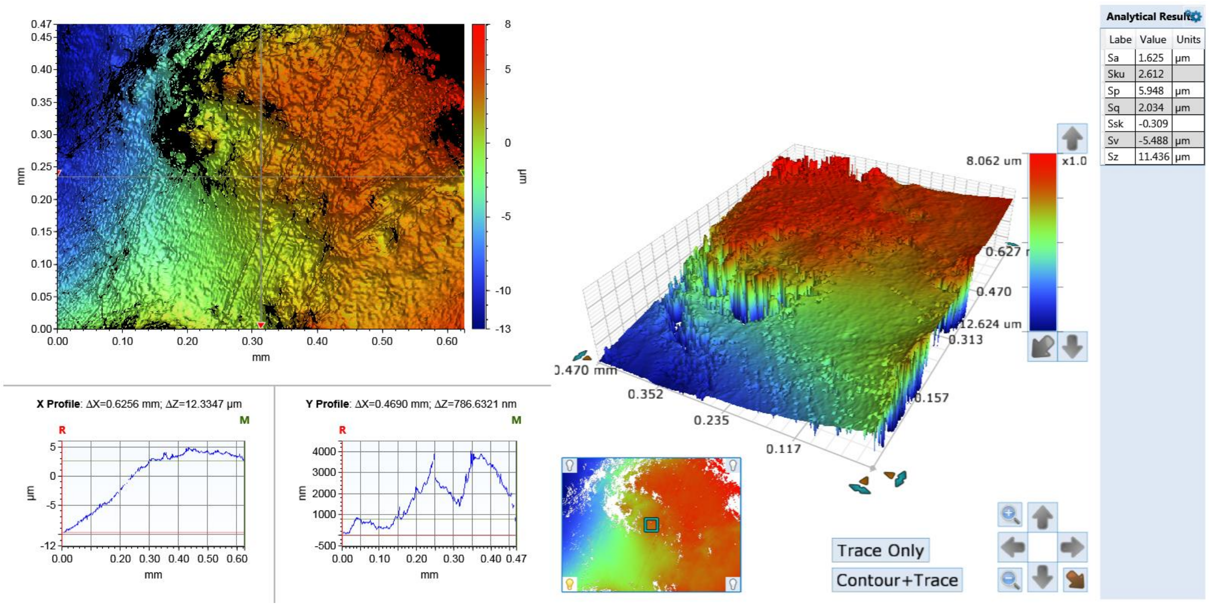


After Exposure:

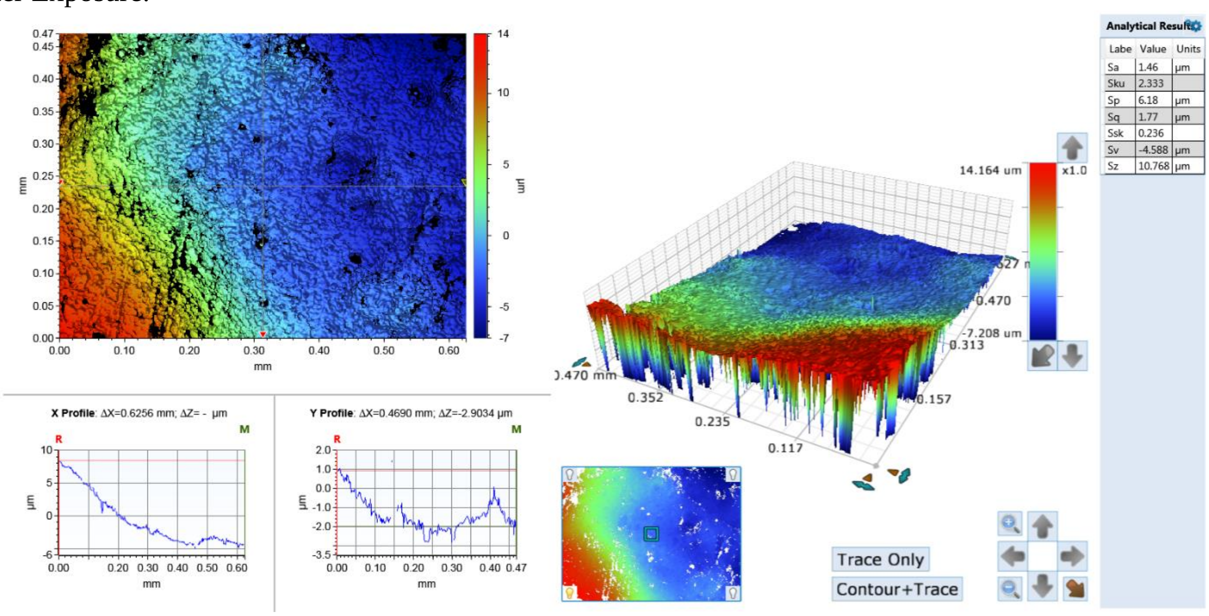


Sample 1- Second point :

Before Exposure :

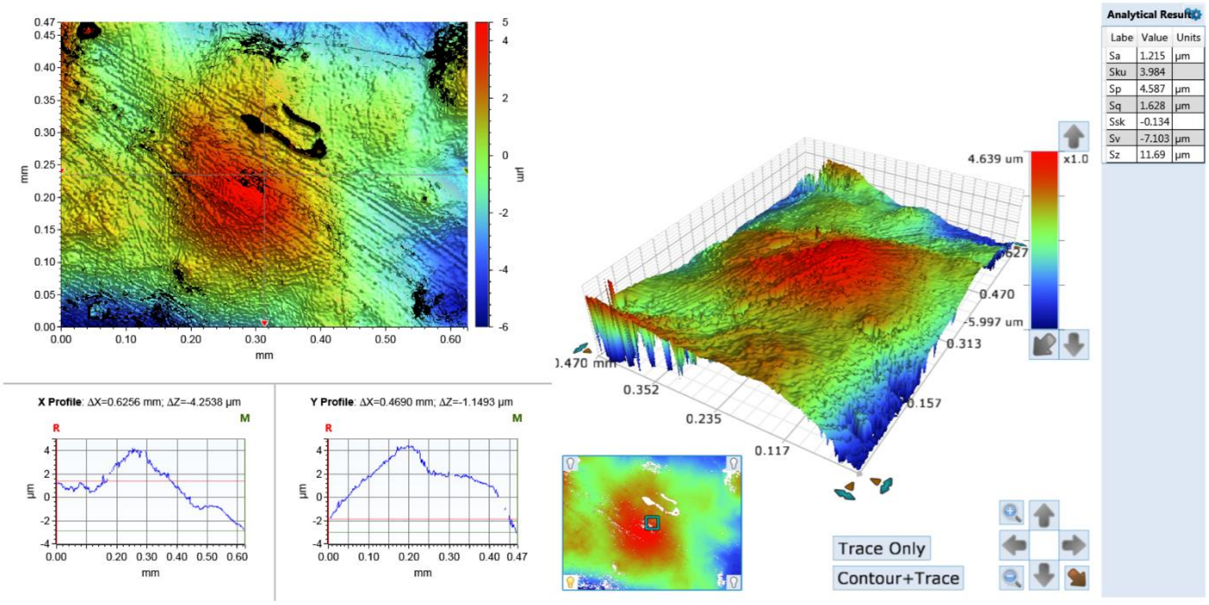


After Exposure:

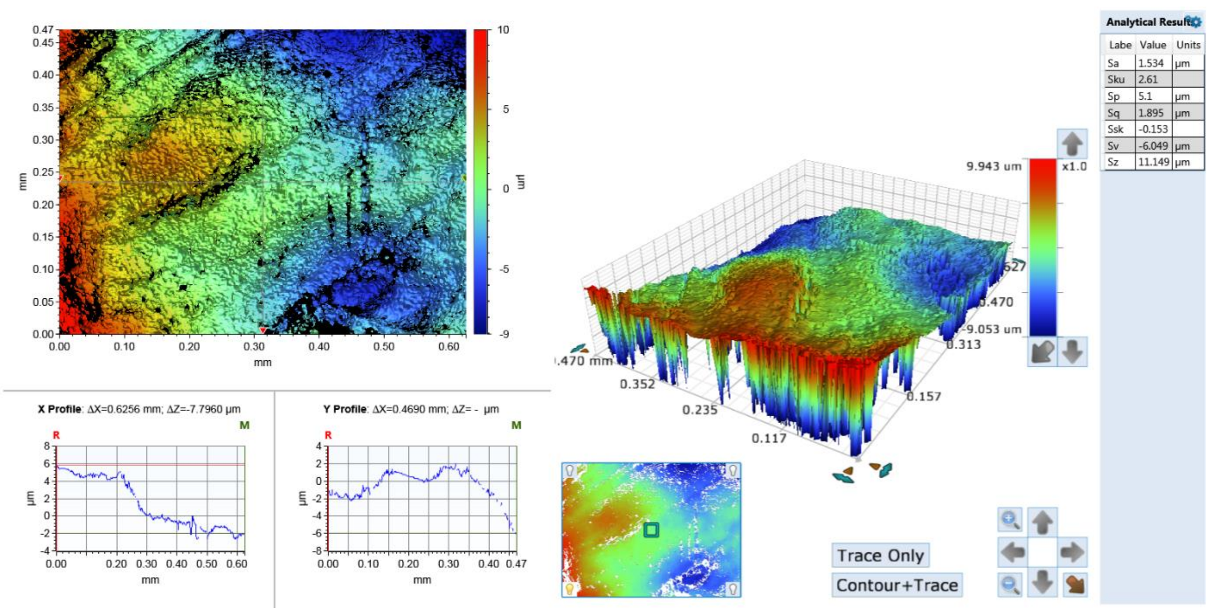


Sample 2- First point :

Before Exposure :

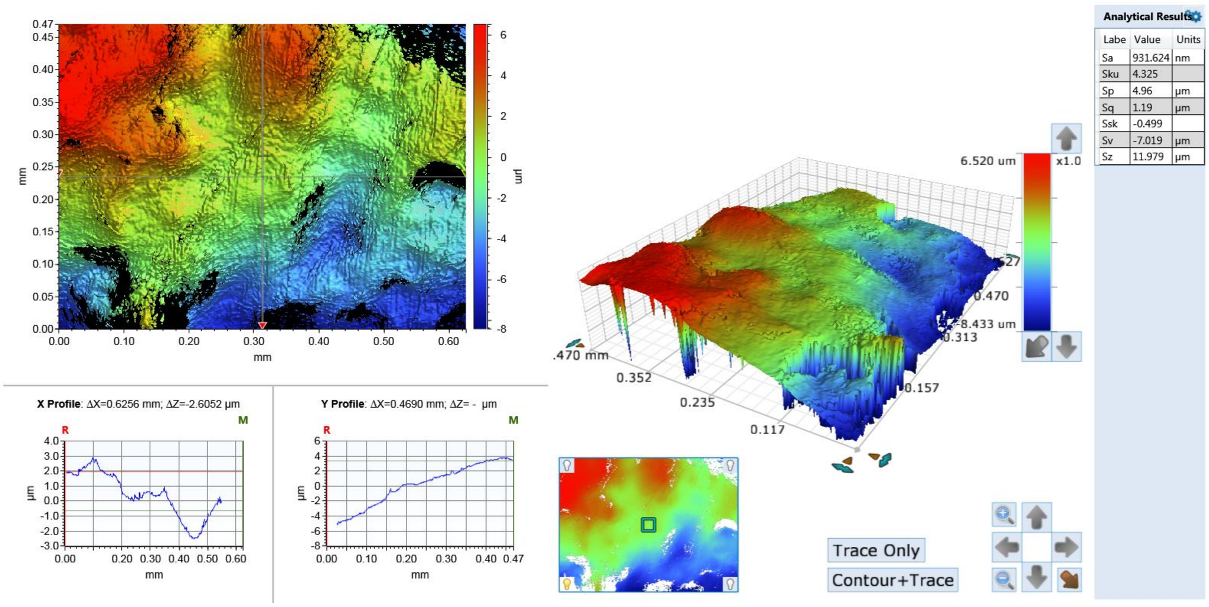


After Exposure:

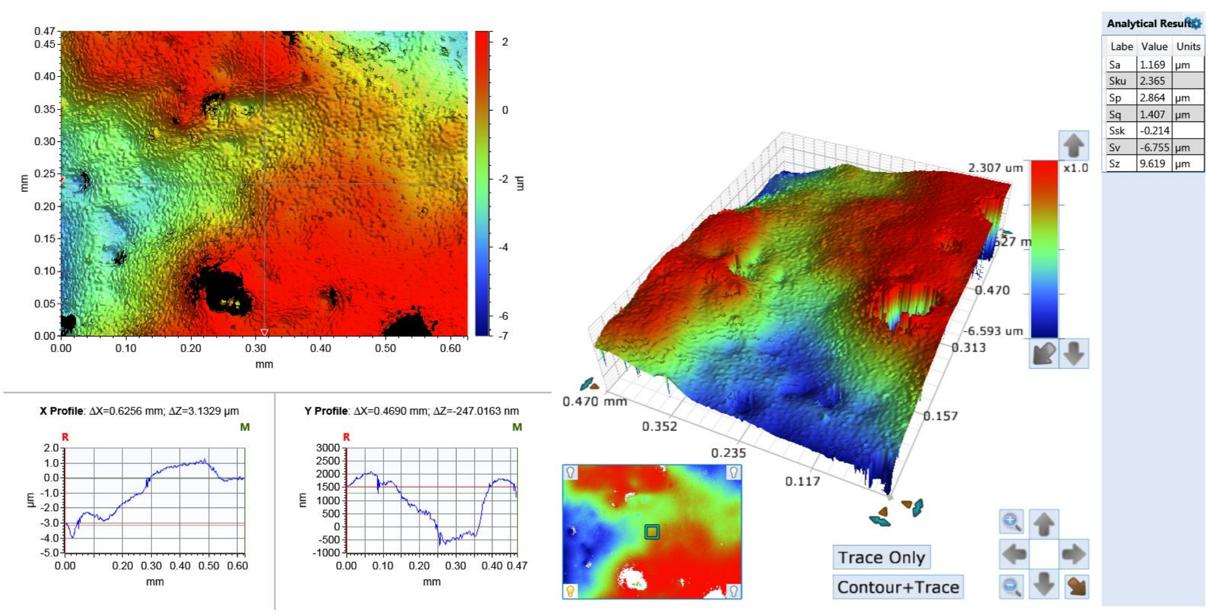


Sample 2- Second point :

Before Exposure :

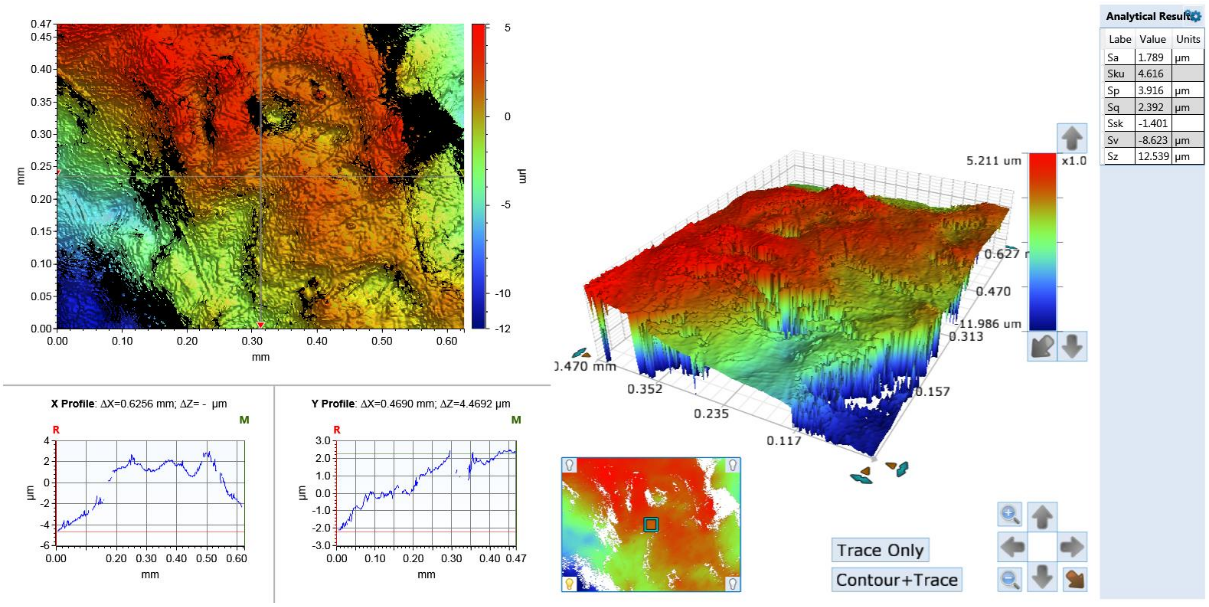


After Exposure:

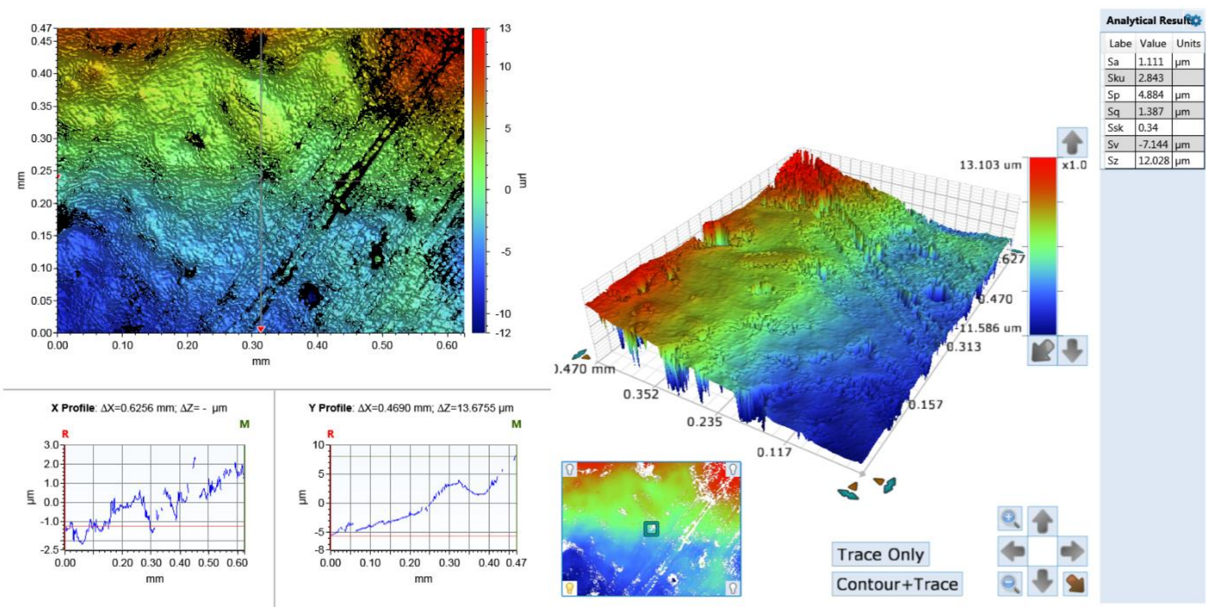


Sample 2- Third point :

Before Exposure :

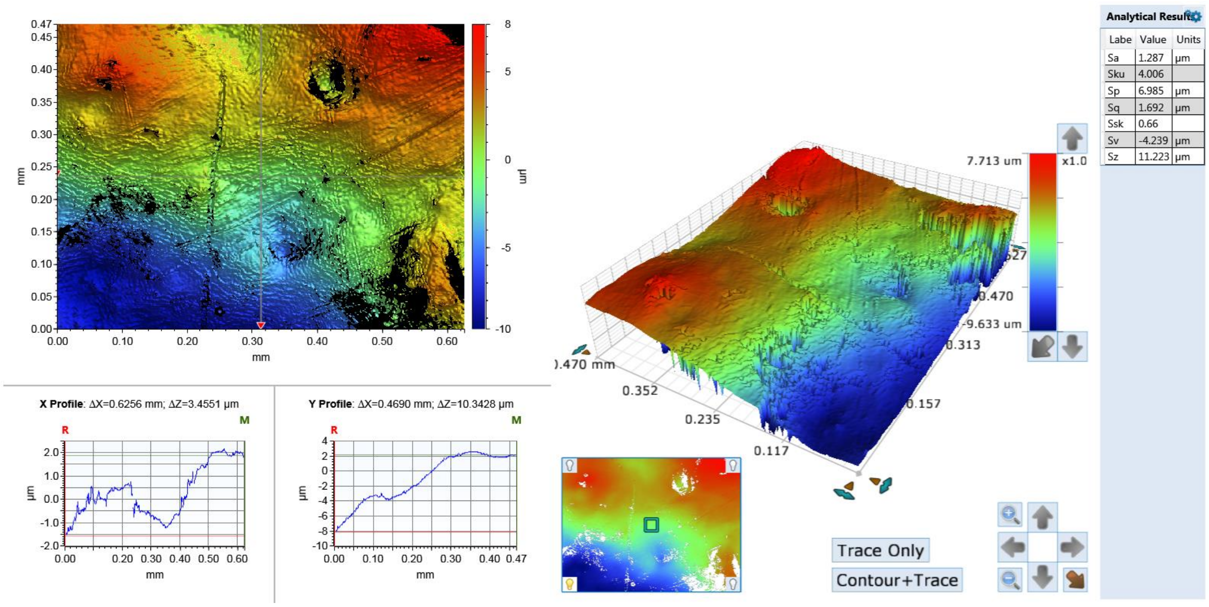


After Exposure:



Sample 3- First point :

Before Exposure :



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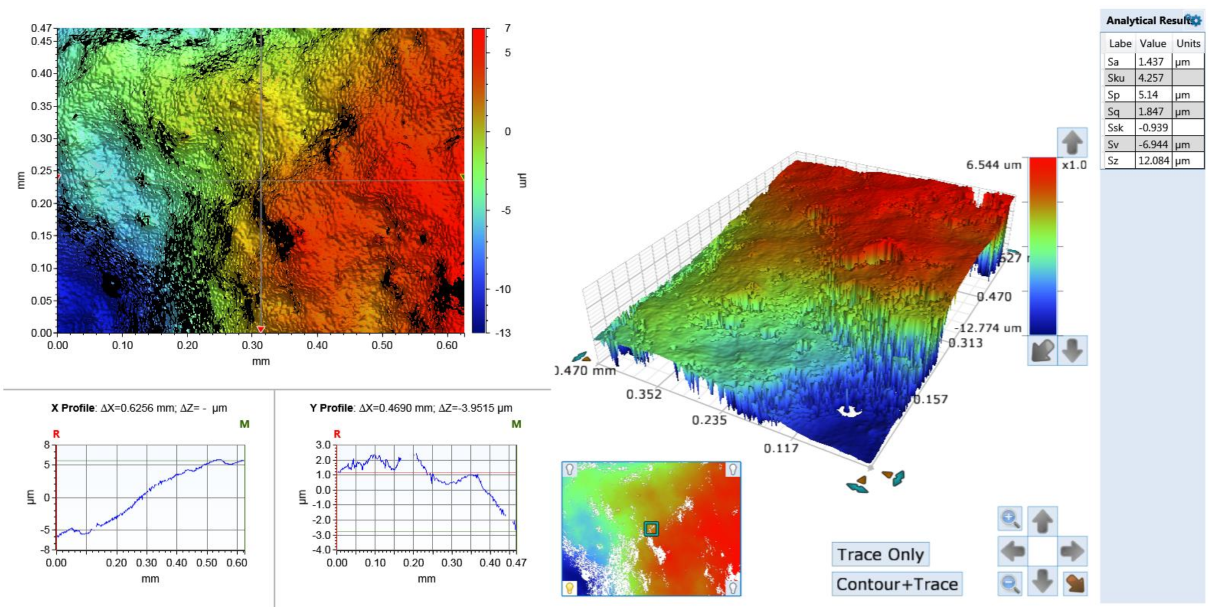
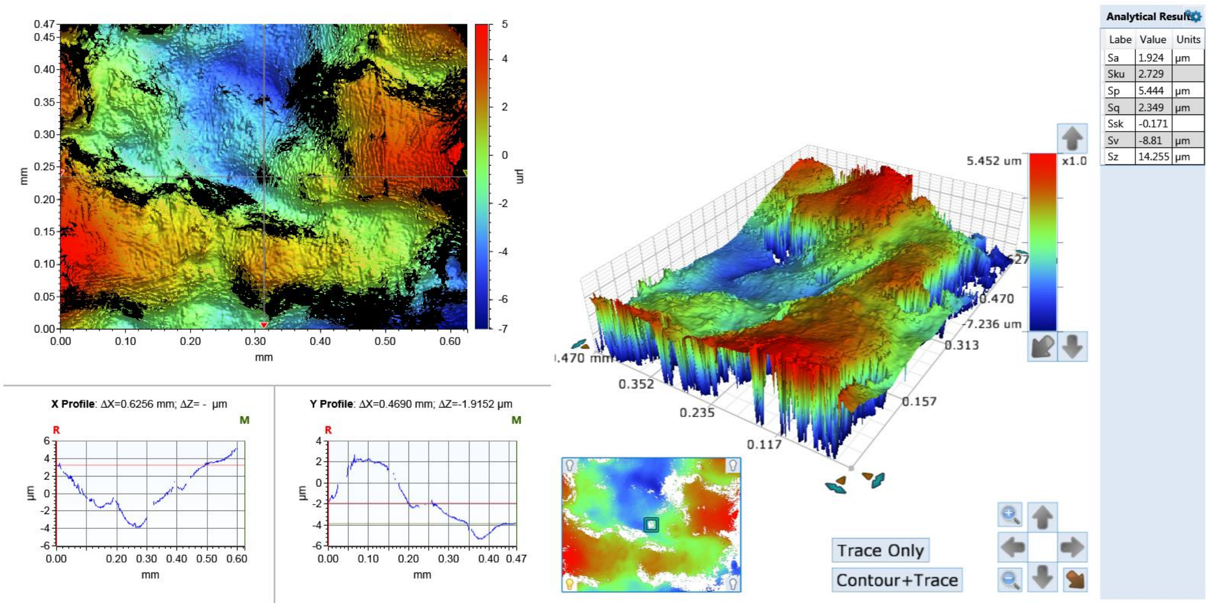


Sample 3- Second point :

Before Exposure :



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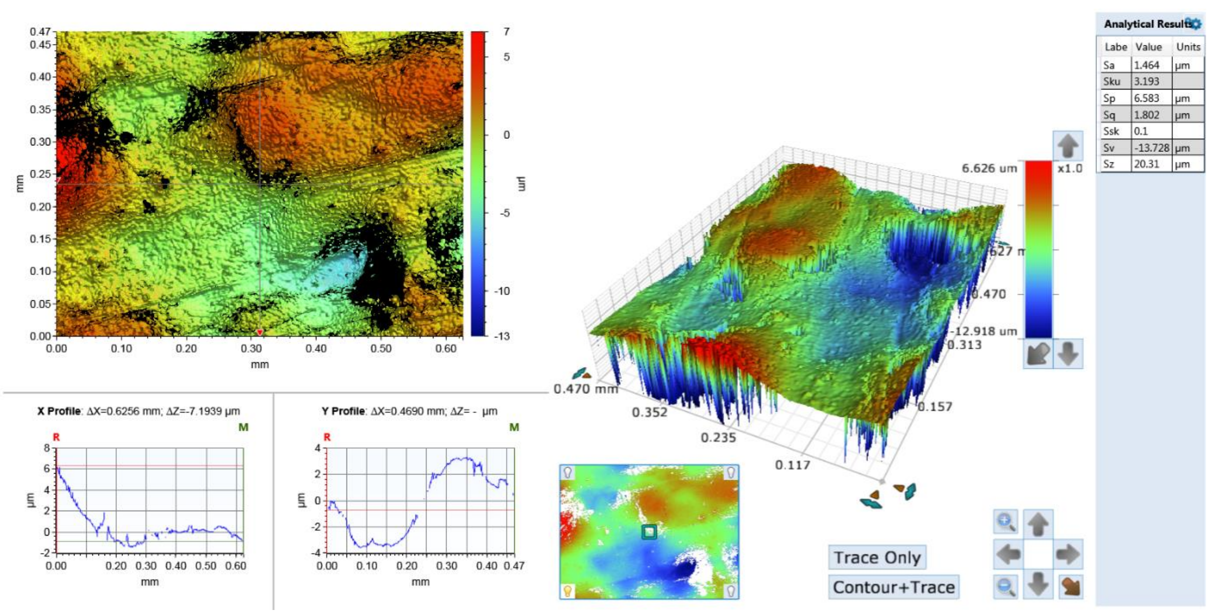
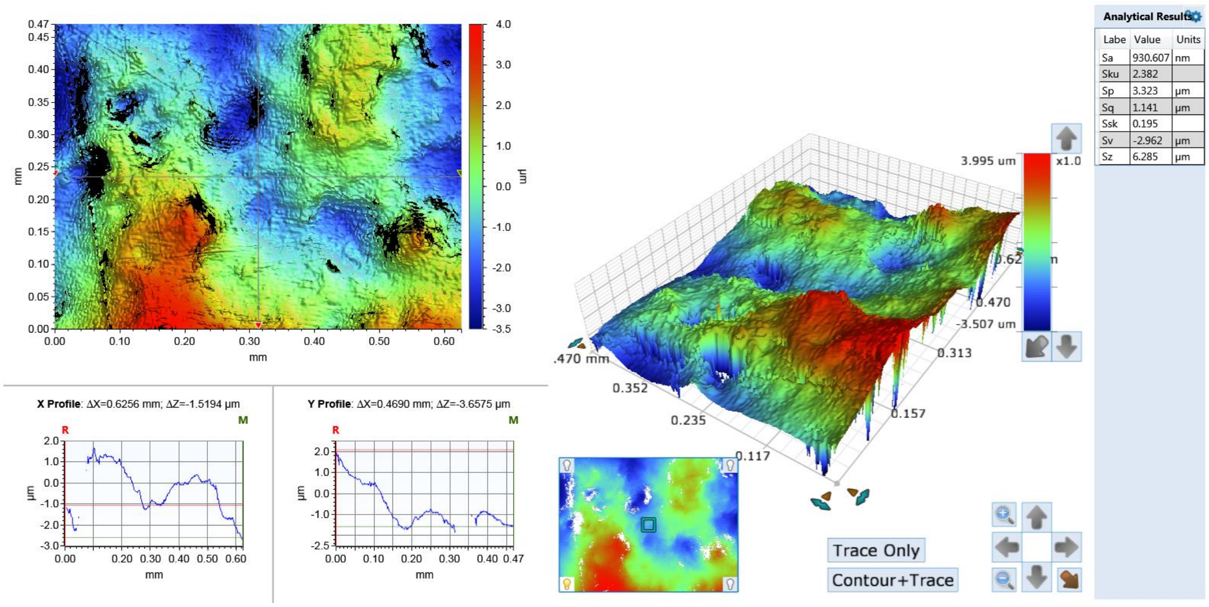


Sample 4- First Point:

Before Exposure:



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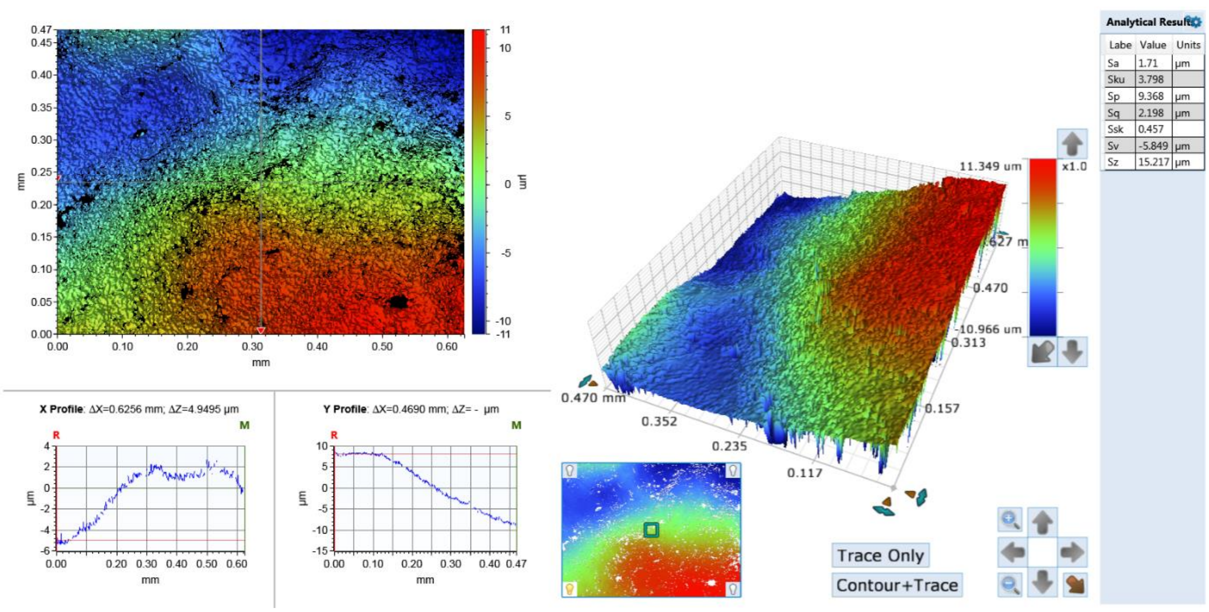
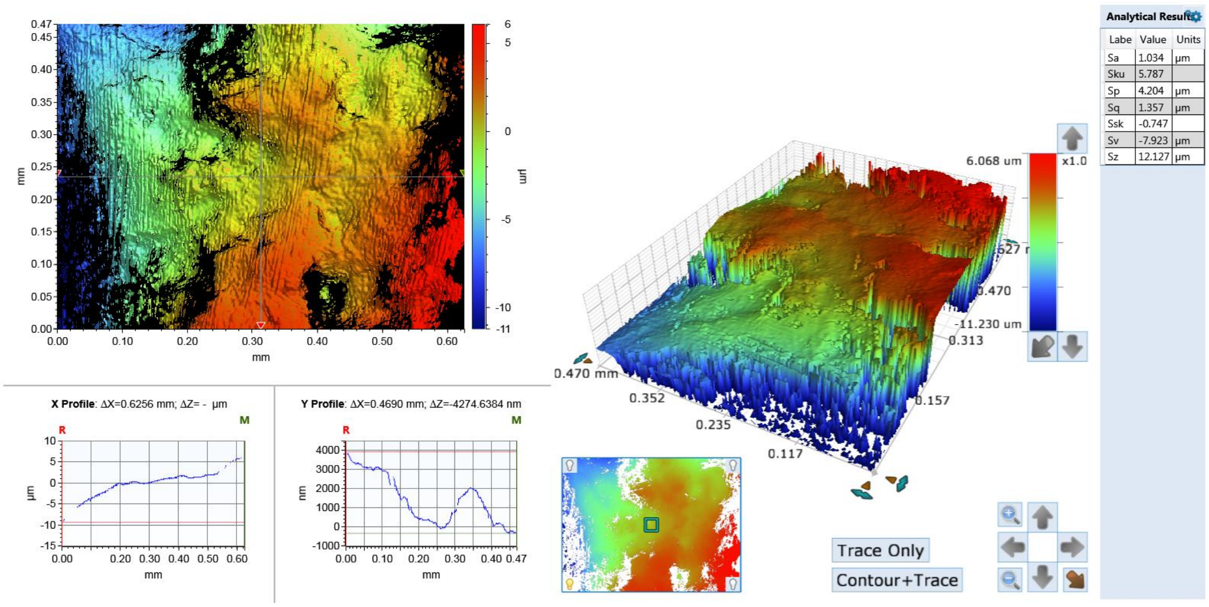
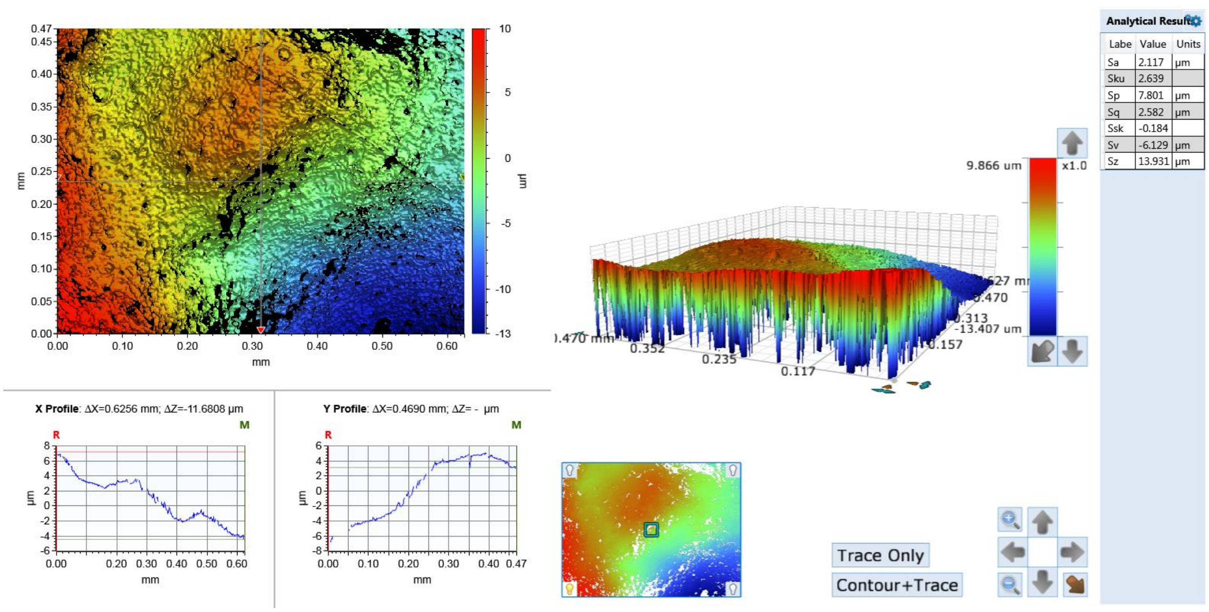


Sample 4- Second Point:

Before Exposure:

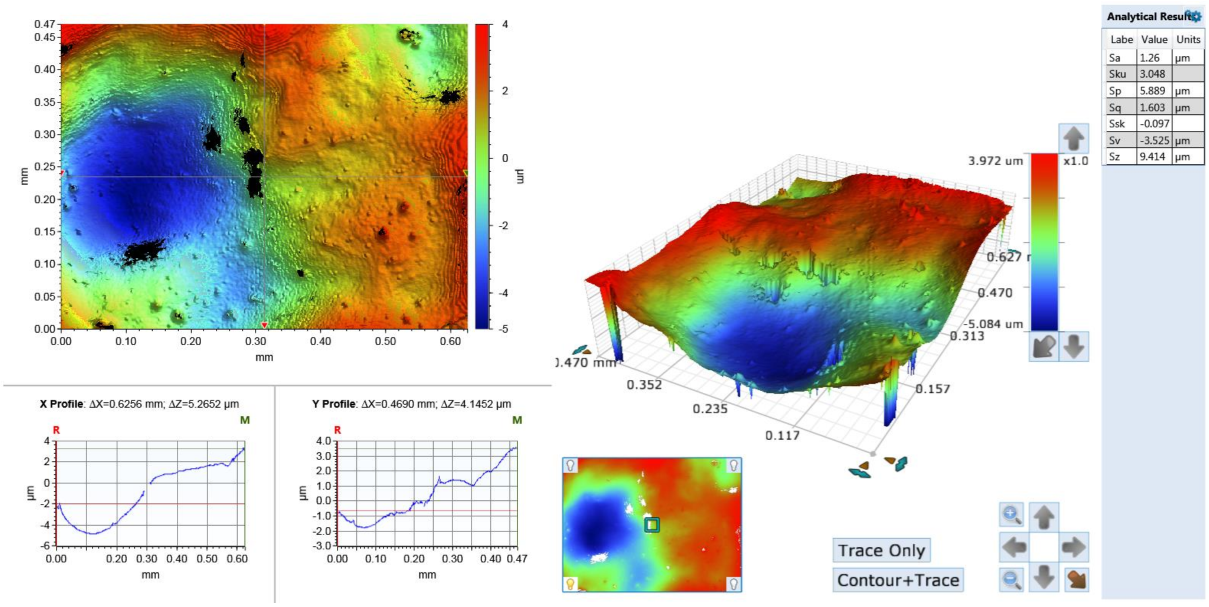


After Exposure:



Sample 4- Third Point:

Before Exposure:



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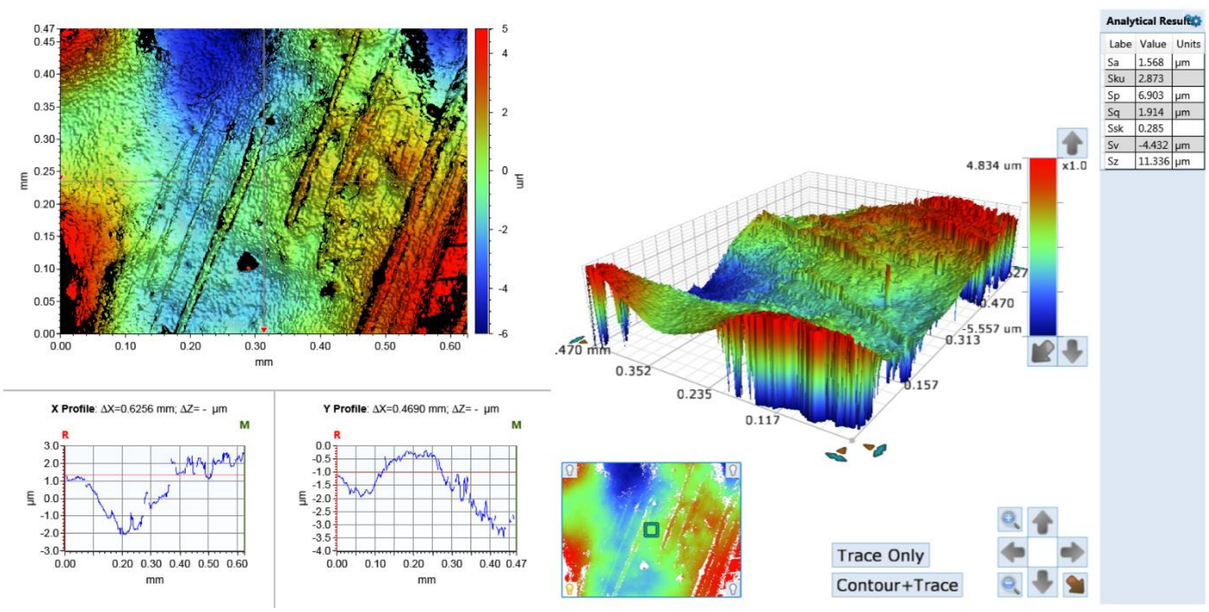
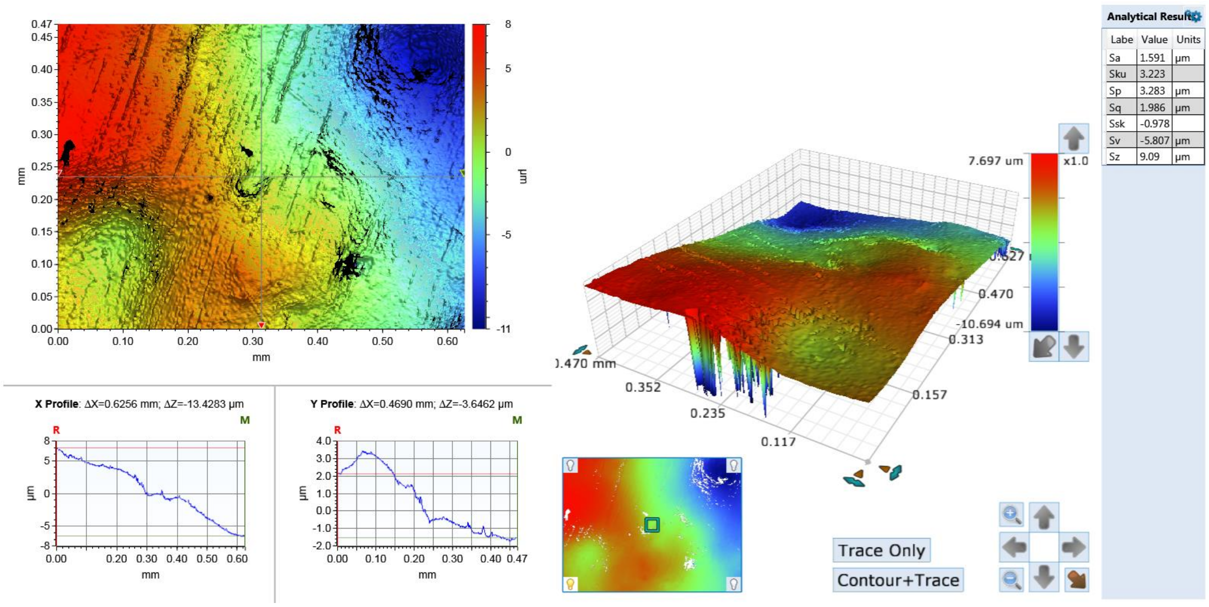


Sample 5- First Point:

Before Exposure:



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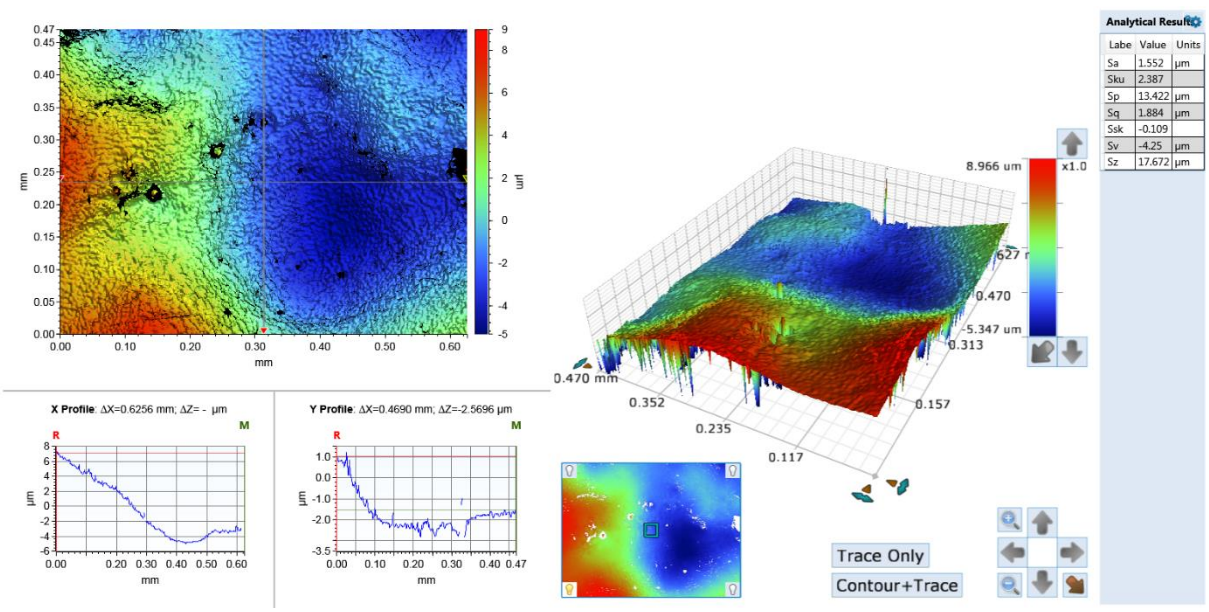
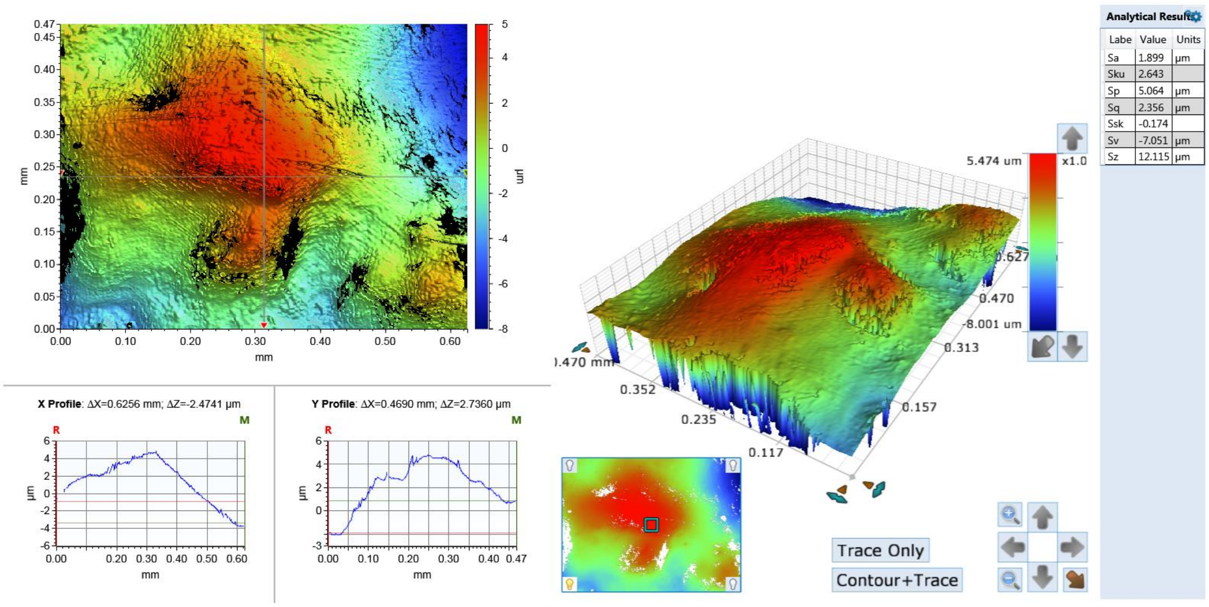
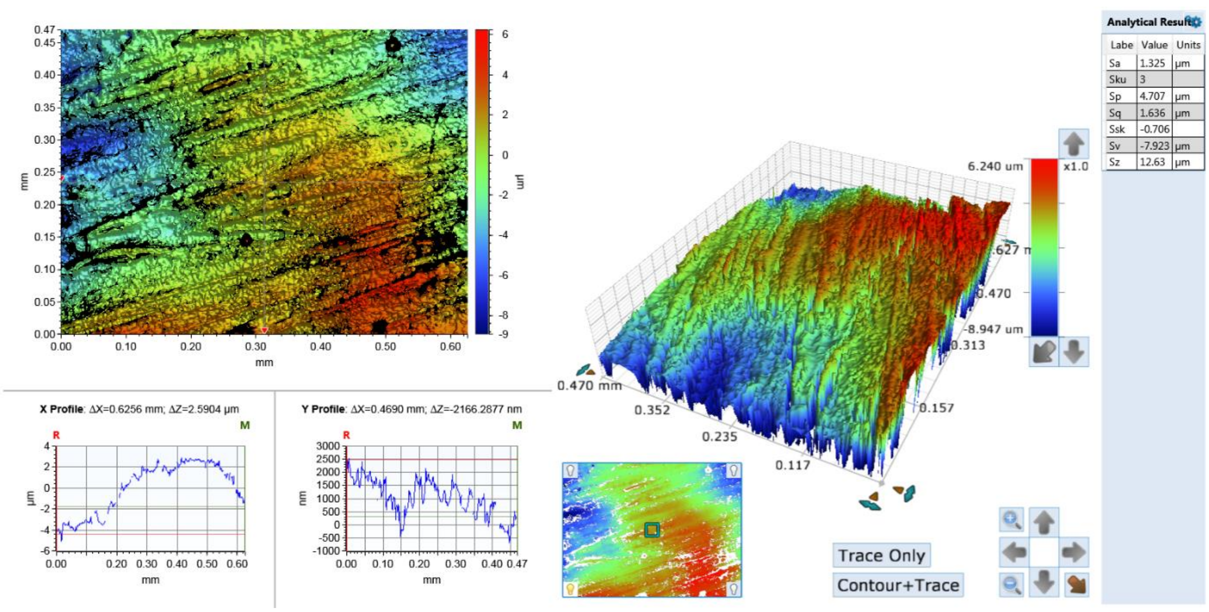


Sample 5- Second Point:

Before Exposure:

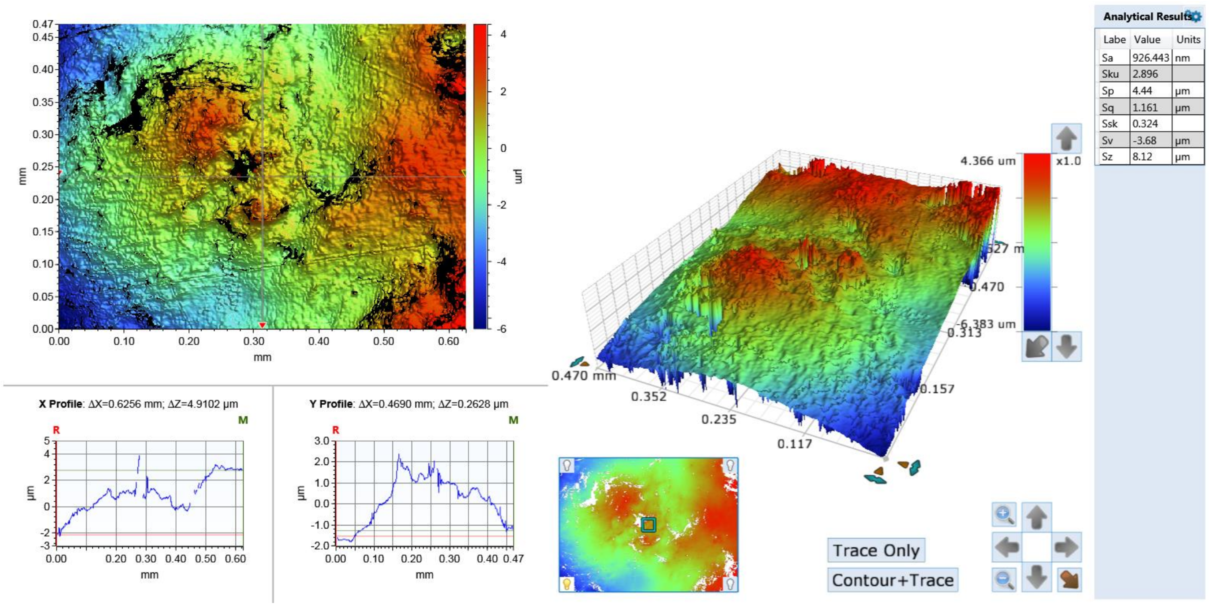


After Exposure:



Sample 5- Third Point:

Before Exposure:



After Exposure: