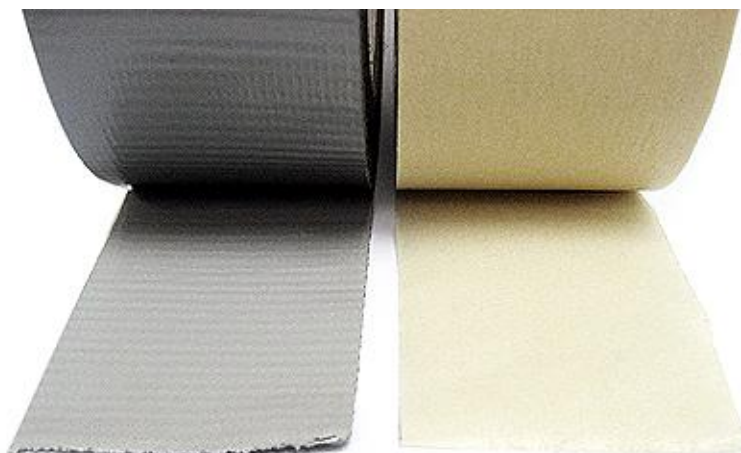


Adhesive Surface Topography
with 3D Metrology



Prepared by
Craig Leising

INTRO:

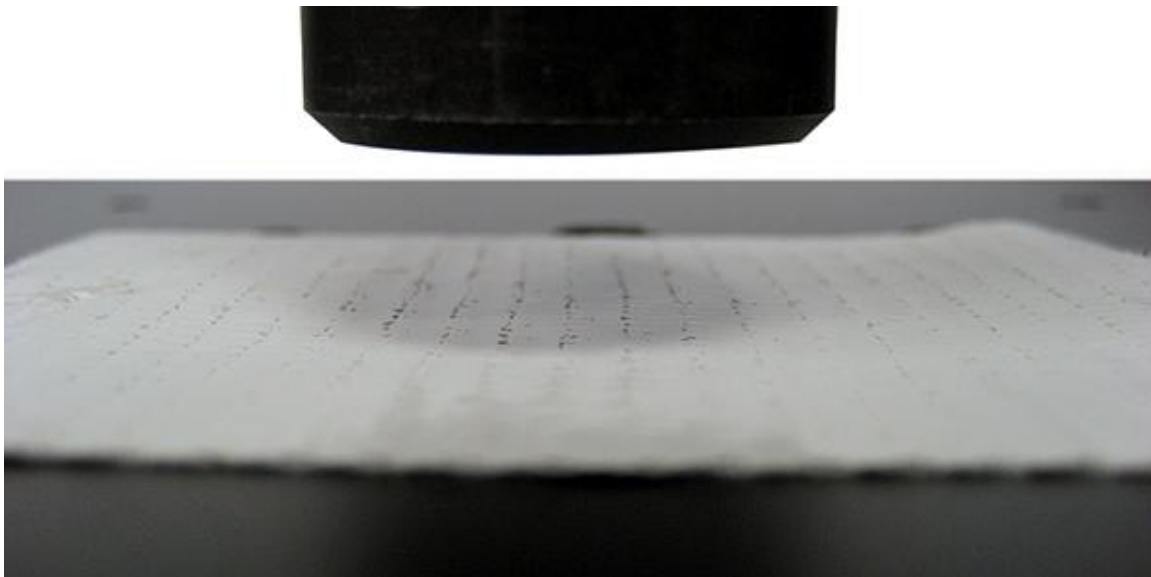
Adhesives are intended for direct contact with another surface to create varying levels of bond. These varying levels of bond, or strength, can be directly attributed to the surface area over which the two materials contact. At the nanometer level an otherwise flat appearing surface may in fact be uneven and rough altering the strength of the adhesive bond. It is for this very reason that adhesive surface topography should be closely monitored during R&D and quality control to achieve intended adhesive strength.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR R&D AND QUALITY CONTROL

Adhesive surface topography is vital to understanding and responding to the intended use and need for adhesion. To control the strength of an adhesive bond will heavily rely upon quantifiable, reproducible and reliable measurement of adhesive surface topography. Precise measurement and evaluation of an adhesive surface, on a given material or existing structure, can lead to the best selection of substrate, depositing and control measures. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unmatched capability to measure adhesive surfaces. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle and reflectivity, Nanovea Profilometers succeed.

MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface of two adhesive tapes for comparative review. Several surface parameters can automatically be calculated including the most common, Sa (average surface roughness), step height, area and many others.

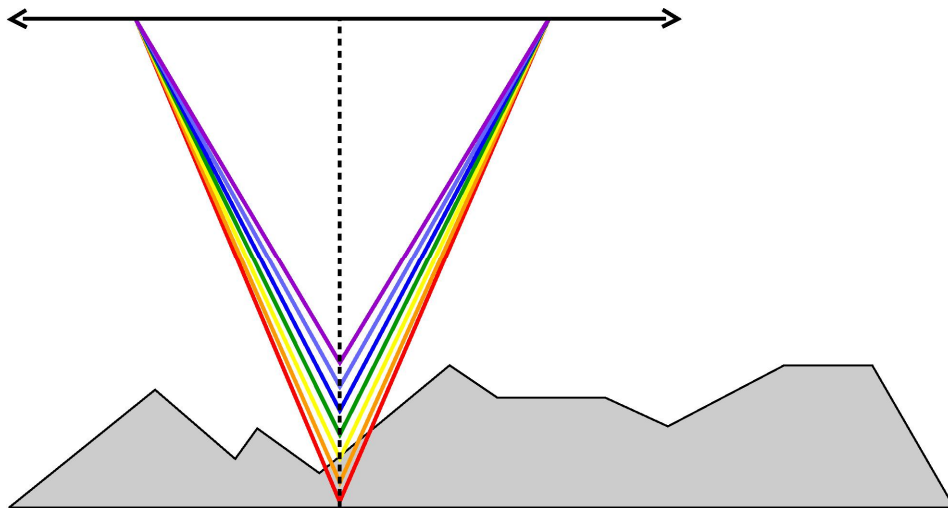


MEASUREMENT SET-UP & TIPS:

Measurements area randomly selected on the sample, drastic changes in surface topography is not an issue for Nanovea Profilometers. Small height variation down to nanometers up to 27mm of height variation can easily be measured.

MEASUREMENT PRINCIPLE:

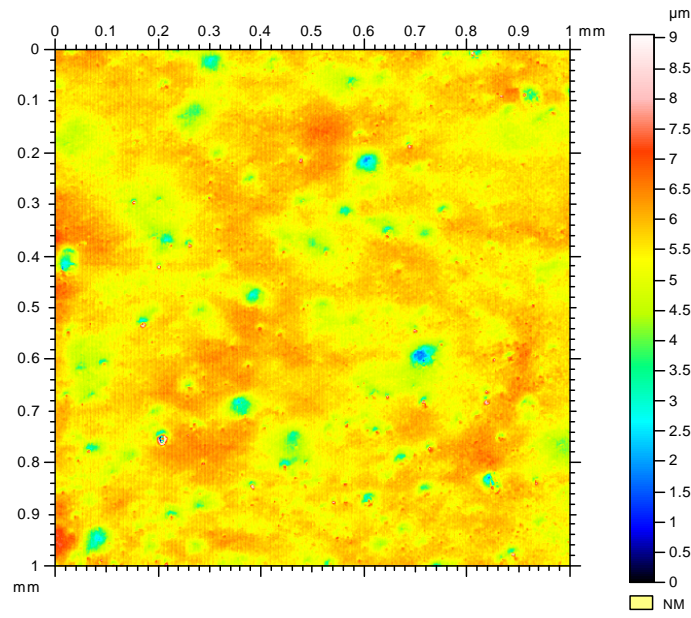
The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white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



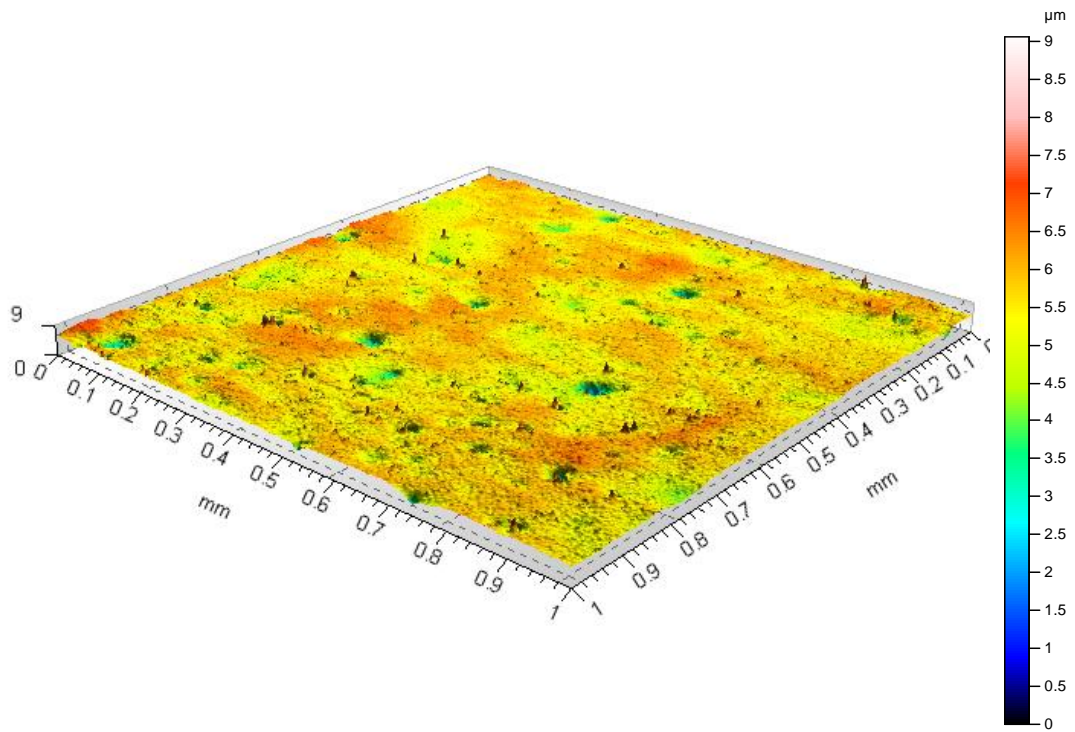
Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough.

RESULTS:

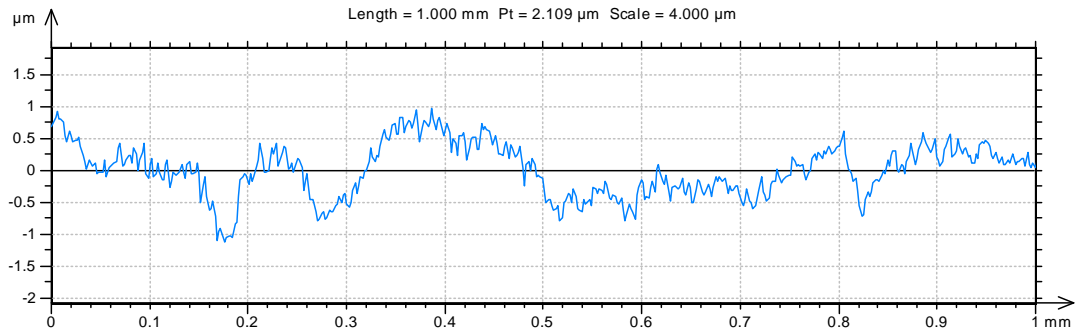
Duct Tape



Top Surface of Duct Tape

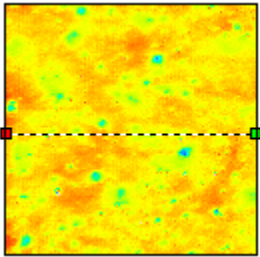


3D Image of Duct Tape Surface



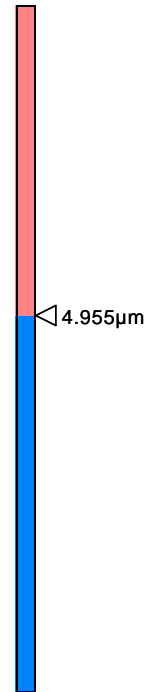
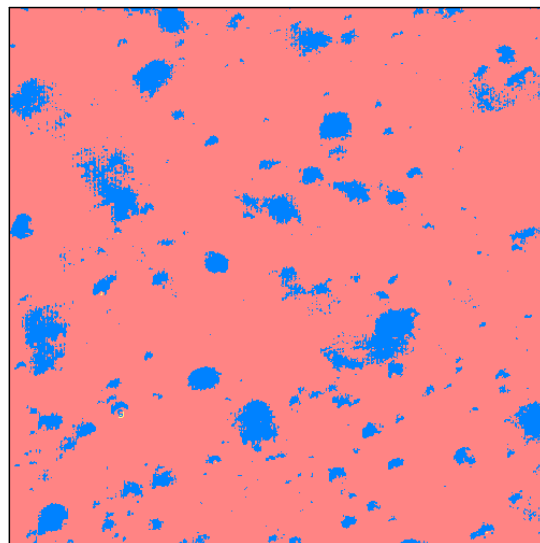
Roughness Profile Extracted From Duct Tape

Roughness Profile Extracted Surface Area Contact



ISO 25178
Height Parameters

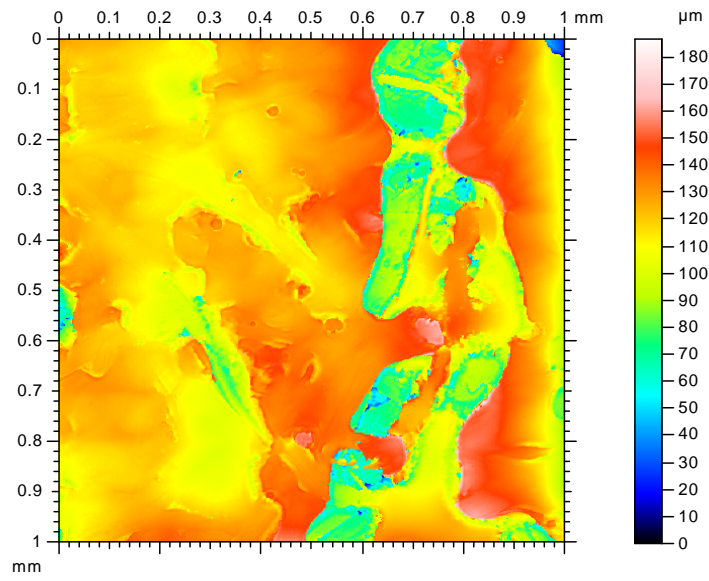
Sq 0.480 µm
 Ssk -1.231
 Sku 8.681
 Sp 3.499 µm
 Sv 5.562 µm
 Sz 9.062 µm
 Sa 0.344 µm



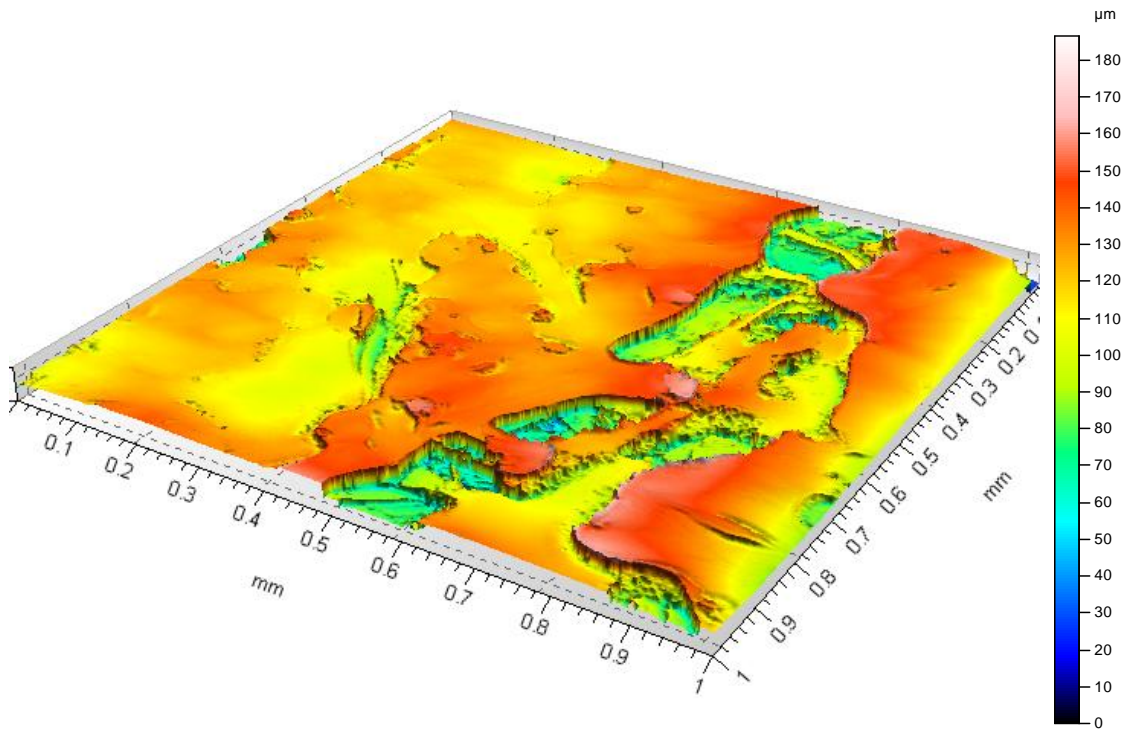
	Blue	Green	Red
Projected Area (%)	8.284	0.000	91.72
Volume of void (%)	0.7477	0.000	84.30
Volume of material (%)	99.25	0.000	15.70
Volume of void (µm.mm2/mm2)	0.03704	0.000	3.463
Volume of material (µm.mm2/mm2)	4.917	0.000	0.6447

RESULTS:

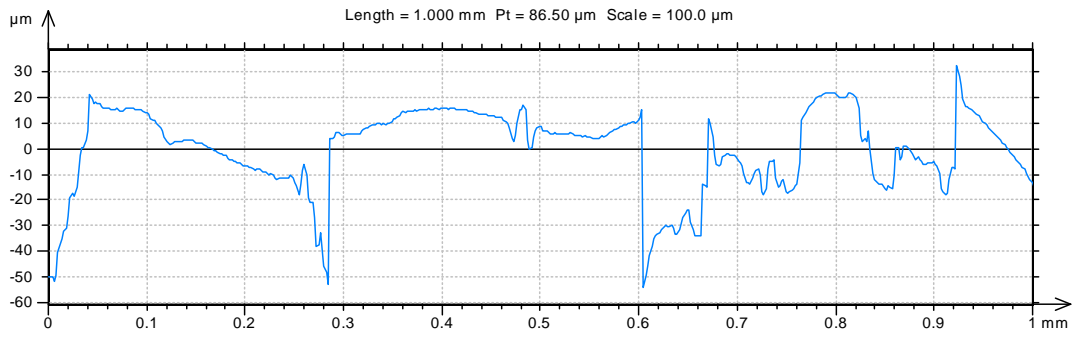
Masking Tape



Top Surface of Masking Tape

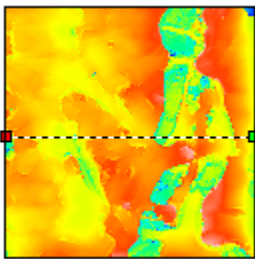


3D Image of Masking Tape Surface



Roughness Profile Extracted From Masking Tape

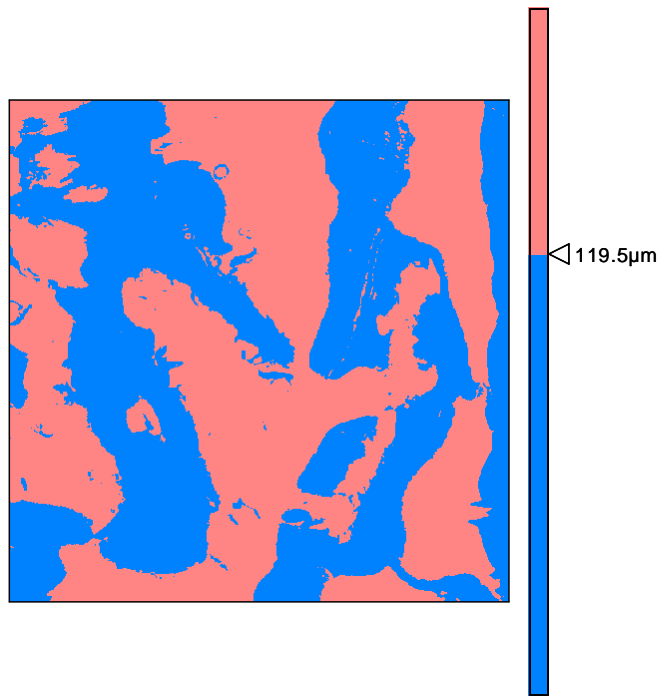
Roughness Profile Extracted



ISO 25178
Height Parameters

Sq 20.01 µm
 Ssk -0.8582
 Sku 4.289
 Sp 67.89 µm
 Sv 118.7 µm
 Sz 186.6 µm
 Sa 14.90 µm

Surface Area Contact



	Blue	Green	Red
Projected Area (%)	46.45	0.000	53.55
Volume of void (%)	6.534	0.000	89.53
Volume of material (%)	93.47	0.000	10.47
Volume of void (µm.mm2/mm2)	7.807	0.000	60.08
Volume of material (µm.mm2/mm2)	111.7	0.000	7.024

Height Parameter		Definition
Sa	Arithmetical Mean Height	<p>Mean surface roughness.</p> $Sa = \frac{1}{A} \int_A z(x, y) dx dy$
Sq	Root Mean Square Height	<p>Standard deviation of the height distribution, or RMS surface roughness.</p> $Sq = \sqrt{\frac{1}{A} \iint_A z^2(x, y) dx dy}$ <p>Computes the standard deviation for the amplitudes of the surface (RMS).</p>
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	<p>Skewness of the height distribution.</p> $Ssk = \frac{1}{Sq^3} \left[\frac{1}{A} \iint_A z^3(x, y) dx dy \right]$ <p>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.</p> <p>Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.</p>
Sku	Kurtosis	<p>Kurtosis of the height distribution.</p> $Sku = \frac{1}{Sq^4} \left[\frac{1}{A} \iint_A z^4(x, y) dx dy \right]$ <p>Kurtosis qualifies the flatness of the height distribution.</p> <p>Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.</p>

CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Profilometer can precisely characterize both the topography and the nanometer details of the adhesive surface. From the 3D image the inconsistent adhesive surfaces can clearly be identified and may or may not be an important factor for its intended purpose. With this information surface contact area can be investigated and what its effect on adhesive levels may be. To further view in detail a 2D cross section can quickly be chosen to analyze, at nanometer range, step height and planarity among others. Special areas of interest could have been further analyzed with integrated AFM module. Nanovea 3D Profilometers speeds range from 20mm/s to 1m/s for laboratory or research to the needs of hi-speed inspection; can be built with custom size, speeds, scanning capabilities, Class 1 Clean Room compliance, with Indexing Conveyor and for Inline or online Integration.