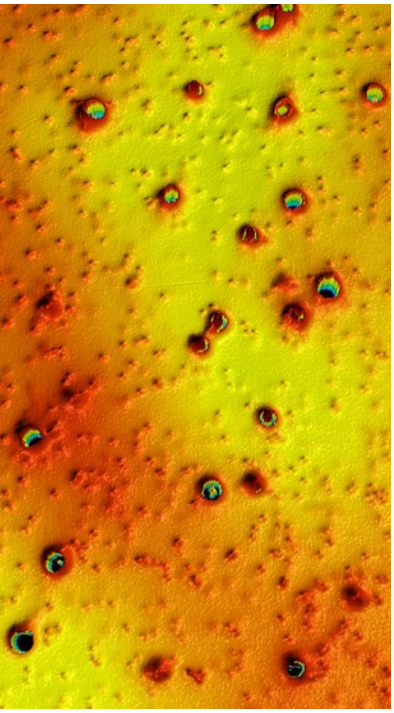


# Coating process quality

Control surface texture, layer thickness, defects and wear

Application note

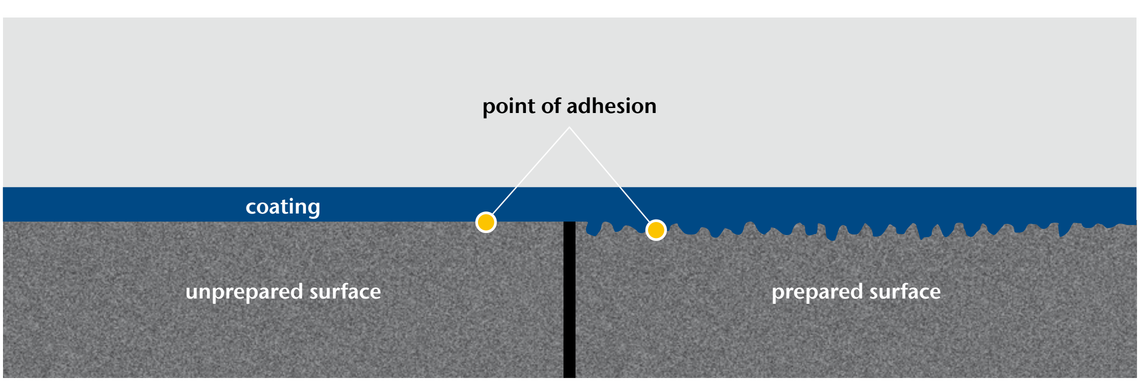
# How optical topography measurement helps surface quality control for coating processes

**Surface preparation** > **Surface coating** > **Coating quality check** > **Wear analysis**

**What is a surface coating?**

Coating is a covering or modification of near-surface structure applied to the surface of an object with the purpose of improving its look and functionality. A consideration for 'non-all-over' coatings is that control is needed as to where the coating is to be applied, as well as its quality, its consistency and life performance and durability.

Coating technologies can affect a wide range of engineering applications and disciplines. Thick layer or thin-coated surfaces all require careful preparation and controlled processing steps; from initial surface preparation, to surface coating, quality checks and wear analysis. Everything from chemistry, physical and mechanical engineering, metallurgy and materials science, all contribute to the end quality and performance of the coating surface generated.




**1**
*A coating/substrate layer or multi-layered system is designed in a manner to enhance the performance of the surfaces, at macro, micro and nano level.*

**Polytec TopMap surface metrology family**

Optical 3D surface measurements enables the detection of deviations in surface quality at an early stage with automated procedures. Polytec's range of Coherence Scanning Interferometers (CSI) covers options for both large area macro-scanning and smaller area microscope surface profiling, thus resulting in the widest range of measurement possibilities. All instruments have similar nanometer or sub nanometer Z resolution independent of the field of view and the XY sampling.

Polytec's TopMap measurement family of metrology products is redefining surface measurements. Tailored to optimize measurement throughput for applications including: 2D and 3D areal surface form, roughness, wear and transparent layer thickness measurements. Our product range now includes the new TopMap Micro.View® and Micro.View®+.

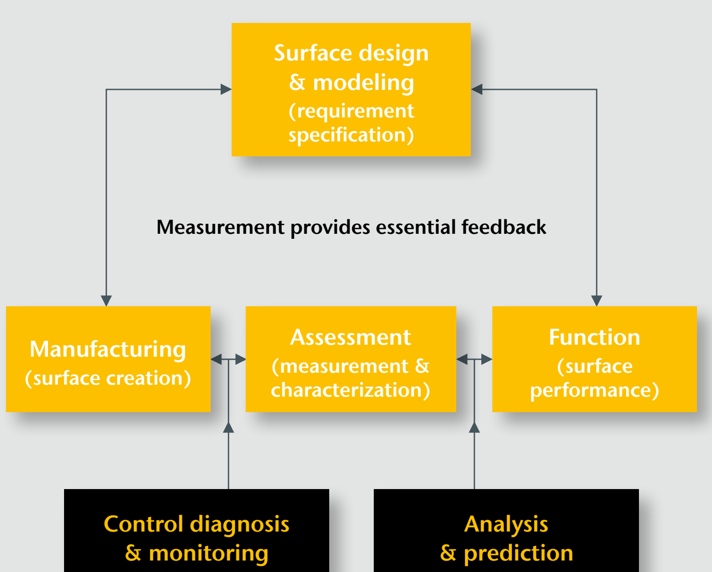
*TopMap Pro.Surf+* | *TopMap Pro.Surf* | *TopMap Micro.View®* | *TopMap Micro.View®+* | *TopMap Metro.Lab*

# TopMap Micro.View®
# table-top optical surface profiler

TopMap Micro.View® is an easy to use and compact optical profiler. Combine exceptional performance and affordability with this powerful metrology solution. With an extended 100 mm Z measurement range and the CST Continuous Scanning Technology, Micro.View® measures complex topographies at nm resolution. This convenient table-top setup features integrated electronics, with the smart focus finder simplifying and speeding up the measurement procedure.

Benefit from the optional ECT Environmental Compensation Technology, securing reliable and accurate measurement results even in noisy and challenging production environments. Micro.View® is the cost-effective quality control instrument for inspecting precision engineered surfaces in the field of manufacturing and research.

Users achieve internationally traceable ISO 4287 and ISO 25178 measurement results that combine high XYZ resolution, high repeatability and high accuracy with numerical results and fast data capture.


Quality problems often start with the initial action of the substrate machining and initial surface preparation: Instability of the machining of a material, errors in tool guideways, deformations to stress patterns of component microstructure of the material, all have an effect on the surface quality. After initial machining – a surface may need
finishing and further preparation before coating, such as a super finishing, removing defects or cleaning surface contaminations away.

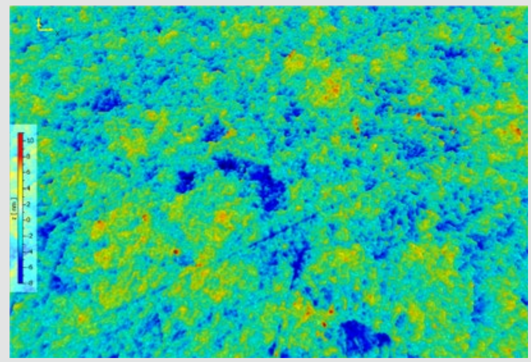
The surface topography really does have an effect on a wide range of the surface properties, such as formability, friction, wear, visual appearance, bonding behaviour of paints and coatings, corrosion resistance, fatigue behaviour, sealing capacity, electrical and thermal contact resistance, etc. Therefore, different surfaces, different functions, different performance – all surface features need to be measured, monitored and controlled.

## Texture control

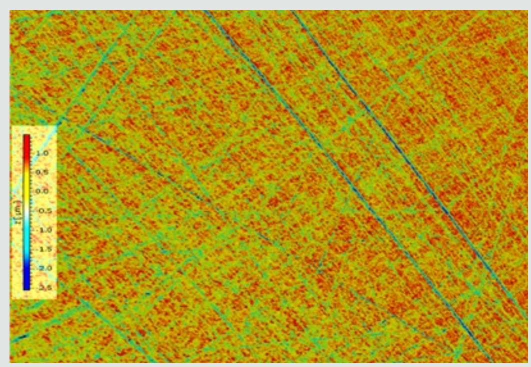
Surface texture metrology can be used as means of gaining insight into the physical phenomena taking place during a manufacturing process. Thus, surface texture parameters can be used as a method for manufacturing control. If the surface texture values change, this indicates the underlying process has changed. Surface parameters can also help verify compliance to specific surface design requirements. Also, examining surface parameters enables process improvement, process efficiency and constant monitoring of quality control.

Etching, peening, polishing and lapping: Before a surface can be coated, it may need preparation dependent upon its function. Effects of the surface substrate texture will ripple through to the top surface from the coating process and will have an effect on the top surface and its final texture.

The smoothness of coatings is important to help optimize the coatings performance. By using the TopMap Micro.View®, it is now possible to measure many different surface types from very rough to super-smooth films with RMS (root mean square) roughness values below 1nm. This non-con-tact CSI measurement technology with exceptional sub nanometer vertical resolution is ideally suited to demanding coating metrology tasks when accurate low noise texture measurements are required for stable process control.



**2**
*Polished glass substrate*
*$S_a$ = 1.17 nm, $S_q$ 1.49 nm*



**3**
*Lapped metal substrate*
*$S_a$ = 0.32 µm, $S_q$ 0.44 µm*

### "S" parameter set

**Height parameters**
- Root mean square deviation
- Skewness
- Kurtosis
- Maximum peak height
- Maximum valley height
- Maximum height of texture surface
- Arithmetical mean height

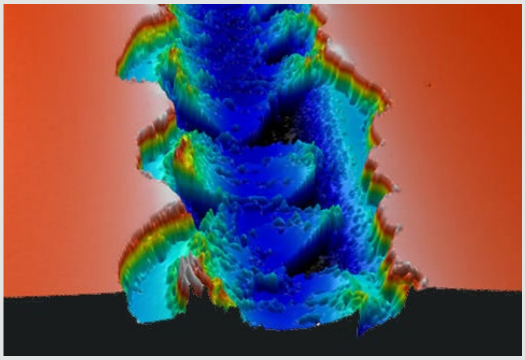
**Spartial parameters**
- Fastest decay auto-correlation length
- Texture aspect ratio

**Hybrid parameters**
- Root mean square slope of the assessed texture surface
- Developed interfacial area ratio

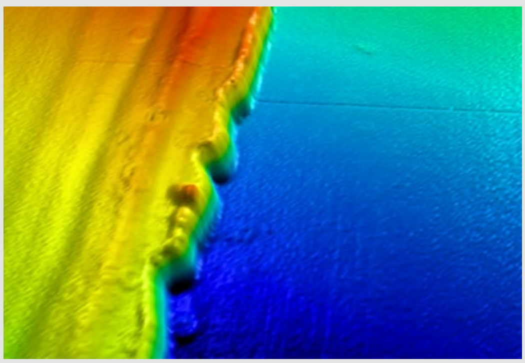
**Miscellaneous parameters**
- Texture direction of the texture surface

*Both 2D "R" parameters and 3D "S" areal parameters are available. Different parameters describe different surface features and functions. Areal characterization is increasingly gaining acceptance for obtaining quantitative information about the 3D topography of a surface, especially complex surfaces.*

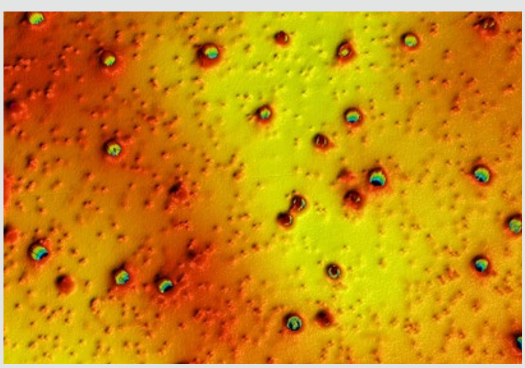
**4**
*Scratch test, 1.96 µm thick coating*



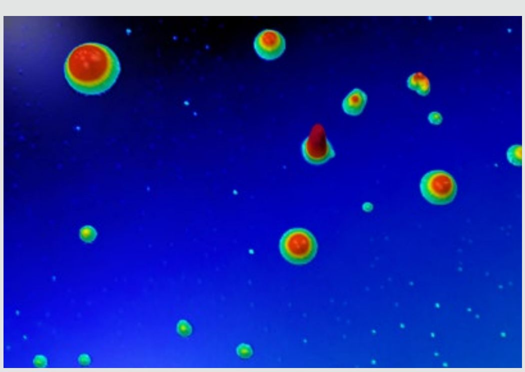
**5**
*Step edge test, 75.2 nm thick coating*



**6**
*Coating defects can be visuzalized, 10 µm wide, 2 µm deep*



**7**
*The size of droplets can be sorted, measured and qualified, 1.5 µm high*



## Thickness control

Another major consideration for most coating processes is that the coating should be applied at controlled thicknesses. There are many different coating technologies and methods available, the choice of method depends on the needs of the end application and the type of surface material being worked upon. Coating technologies include: Composite coatings, nano coatings and ultra-thin films, deposition (plasma and ion-based vacuum), epitaxial film growth, sputter technologies, dip, flow and spin coatings, spraying, painting and rolling, electroplating and electroless plating, and or surface modification.

In order to measure depth or thickness, the scratch test is a common method. The scratch test is a popular adhesion test for thin, hard and well-adhering coatings such as TiC (titanium carbide) on steel or cemented carbide substrates. Coating thickness measurement can also be measured at the edge of a coating. Layer thicknesses from a few µm upwards can be detected on transparent coatings at any position.

## Defect measurements

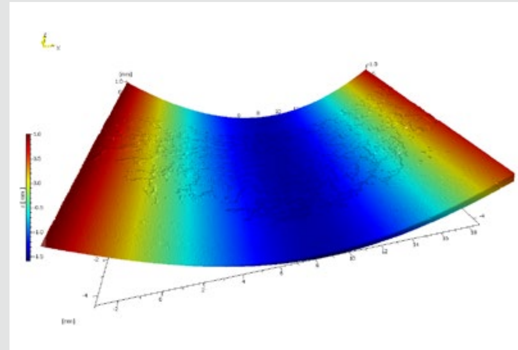
A wide variety of surface defects in coating and metallizing can be measured, qualified and catalogued, including voids, streaks, chatter, droplets, spots, dimples, holes, scratches, coating disturbances, contaminants, orange peel, and visual texture appearance. Defects can be quickly visualized, measured and the information used to help identify its cause, so that process cures can be quickly implemented, then monitored to show the improvements in end coated surface quality control.

Defects can be measured and qualified on a coating to help identify the cause.

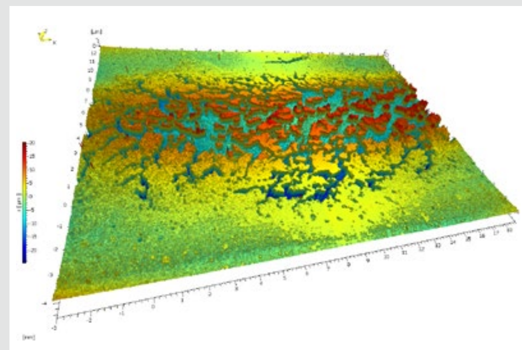
### Wear analysis

Monitoring and controlling problems that relate to surface wear are critical to developing an effective surface coating. For this reason, understanding how a surface changes and behaves due to wear mechanisms is critical to the development of new coatings and the optimization of tried and tested coatings. Wear analysis helps to ensure that these coatings have both good performance and long life durability.

With the large area measurement a fuller view of the wear scar is possible, on the right is a 20 mm XY area on a measured curved roller bearing surface. Figure 8 is as the surface was measured including original form, then the surface is flattened with a form removal to show the effect of wear on the coverall surface texture. The coating brake down can now easily be seen on this roller bearing surface in Figure 9.



**8**
*Roller bearing surface raw data with form, overall Z scale 2.5 mm*



**9**
*Roller bearing surface with removed form, overall Z scale 50 µm*

*As well as a variety of surface texture parameters, other parameters such as volume, area and depth can all be provided to describe a surface defect. Different parameters describe different surface features and functions. Areal characterization is increasingly gaining acceptance for obtaining quantitative information about the 3D topography of a surface, especially complex surfaces. "S" and "V" are areal surface parameters, extending the respective "R" method, which evaluates a line profile.*

**"V" parameter set**

**Areal parameters**
- Core roughness depth
- Reduce peak height/ valley depths
- Peak/valley material portion
- Slope of the plateau/ valley region
- Relative material ratio at the plateauto the valley intersection

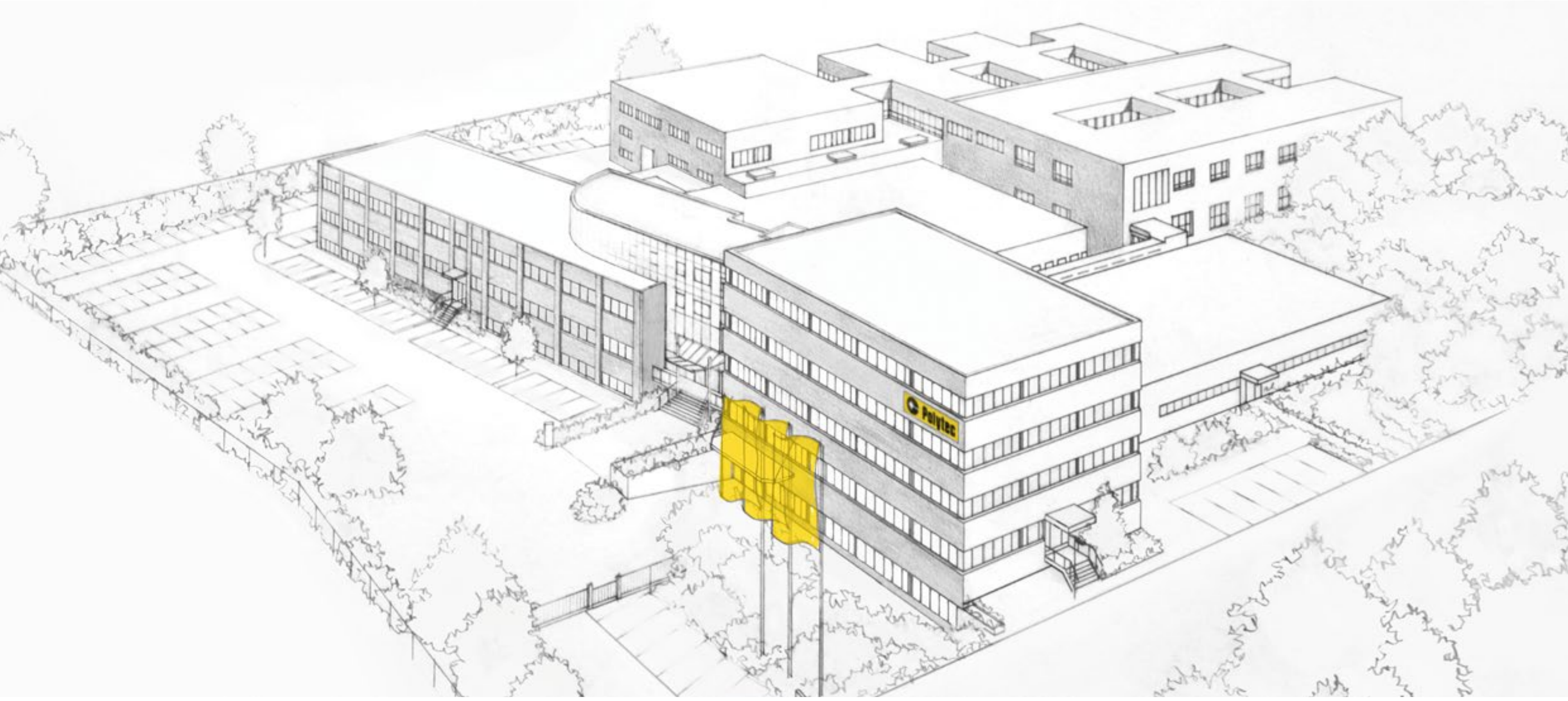
**Void volume**
- Dale void volume of the texture surface
- Void core volume of the texture surface

**Material volume**
- Material volume of the texture surface
- Core material volume of the texture surface

**Other**
- Peak extreme height

### Summary

Coherence Scanning Interferometry (CSI) was developed for general-purpose surface topography measurement on both smooth and rough surface types. Maximum fringe contrast occurs at the best focus position for each point on the sample measured. Polytec's correlogram algorithm precisely maps the height of each point on the surface with sub-nanometer resolution independent upon the lens used. This CSI technology is available on all of Polytec's TopMap surface metrology systems, allowing for for both large area and small area measurements to be performed on most surface types. This non-contact measurement technology makes the TopMap family of optical profiling instruments an ideal metrology option for the measurement tasks in the coating industry.



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