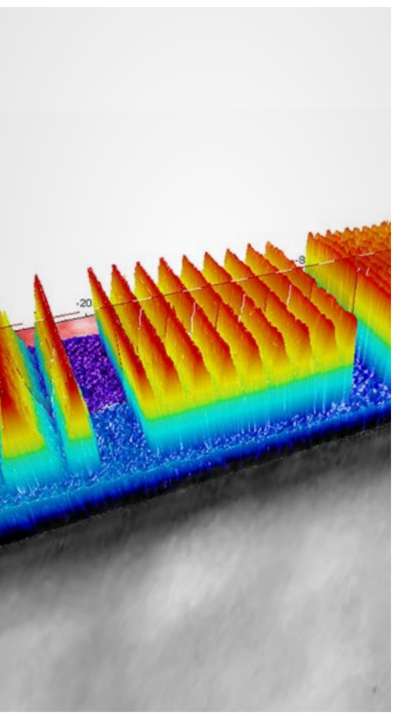
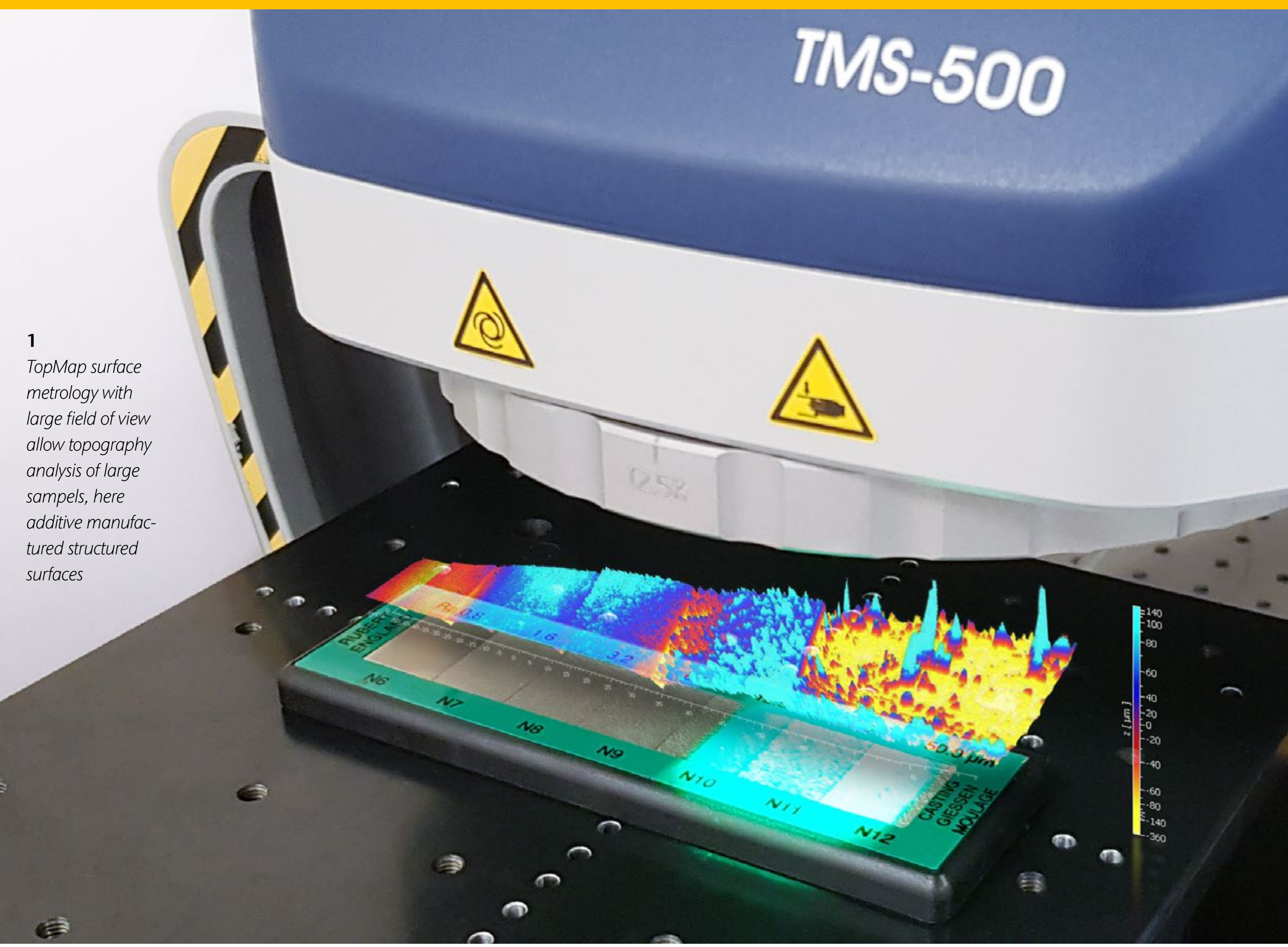


Additive manufactured surfaces

3D optical profiling of form and texture

Application note

Additive manufacturing (AM) techniques compliment current conventional subtractive manufacturing methods by providing additional new surface generation possibilities to the industry.



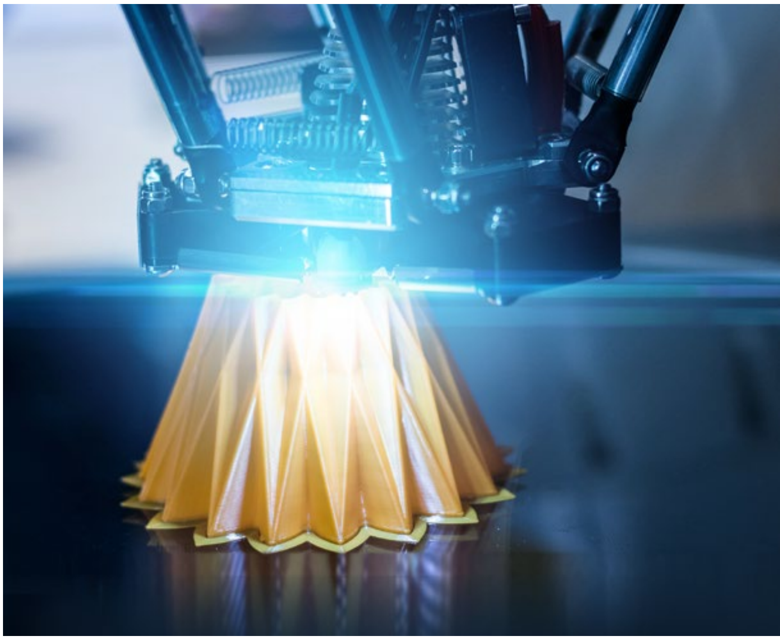
1
TopMap surface metrology with large field of view allow topography analysis of large sampels, here additive manufactured structured surfaces

Areal measuring whitelight interferometers allow scanning the topography of entire samples in a single shot and cover all details. This non-contact method of characterizing and visualizing precision surfaces in 3D dedicates to metrologists and inspection managers for the quality control of textured surfaces over large areas like that for 3D printed additive manufacturing (AM).

In many manufacturing processes, surfaces and their properties are as important as the bulk properties of the material. The surface topography has an effect on a wide range of application properties, such as friction, wear, visual appearance, bonding behaviour of paints and coatings, corrosion resistance, fatigue behaviour, sealing capacity, electrical and thermal contact resistance, etc. It is due to these properties that it is desired to induce a texture into the surface. When a texture is made into a surface, the end product is known as a textured surface. These surfaces will have particular properties designed to improve its application performance.

One clear advantage of AM is that this technique allows the creation of complex geometries and internal features that cannot be produced using conventional subtractive machining methods. However, the control of the surface generation can prove challenging to the many new manufacturing processes and steps that may require a deeper understanding improved and optimized in order to create the correctly designed surface. This can become particularly challenging when considering all the different surface rotations and angles.

Often, when using conventional tactile measurement technology, the surface evaluation is based on a simple profile by a stylus-based concact instrument. However, a stylus is at risk of being damaged when measuring rougher surfaces, might damage/scratch the surface under test, may have problems measuring recessed surfaces and it is a lot more time-consuming to process the 2D data to high-resolution 3D scans. These are all good reasons to consider an areal-based optical technology like whitelight-interferometers.

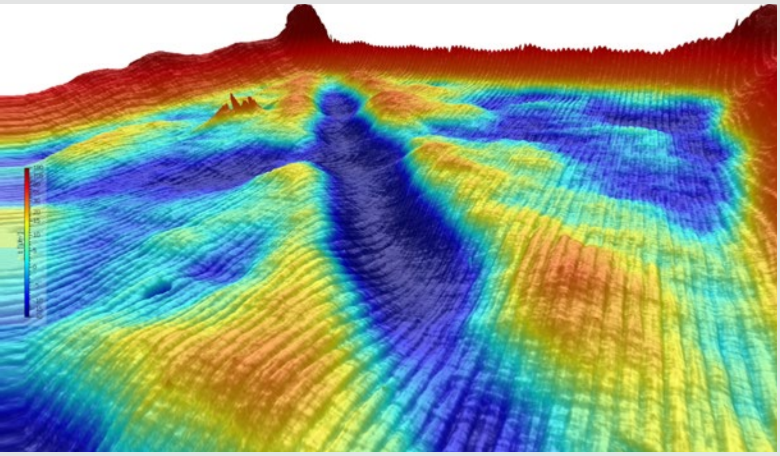


Areal 3D surface information in a single shot

The spatial frequencies (scales - surface characteristics can be complex with roughness, waviness and form components) of interest of the surface to be measured will influence the choice of measurement technology and, in general, technology will govern the metrological quality of the measurement results (for example measurement accuracy and precision). In addition to the finish produced by the manufacturing process, there is the inherent structure in the material. Very few surfaces are molecularly smooth. In metals, grain areas will produce surface irregularities that are extremely fine (small spatial frequencies), compared with the texture from the manufacturing process (large spatial frequencies).

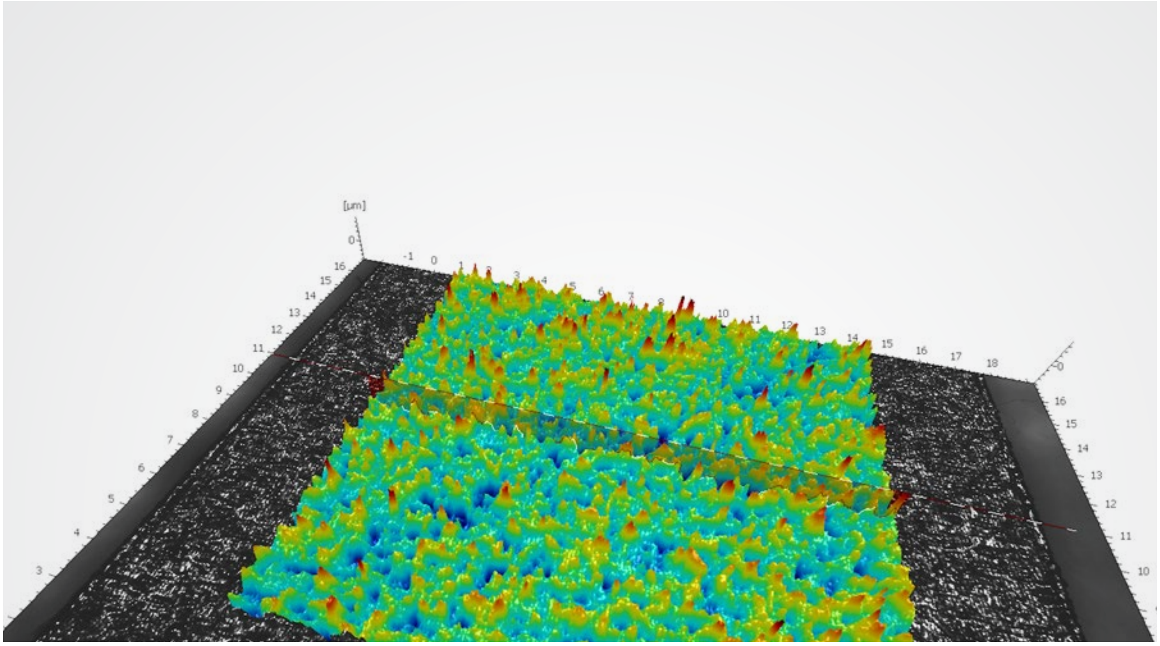
This complex texturing is the main reason why so many surface parameters have been produced to describe the many different surface features and characteristics. Care must be taken when selecting a parameter; i.e. amplitude parameters such as R_a can be applied to both a sinusoidal and stepped shaped surface but still offer a similar R_a-value. R_a would therefore be useless in describing the difference between such surface types, which is why spatial and hybrid parameters are becoming more popular.

However, if the parameter sets are correctly applied they can prove useful in describing many differences between many surface types. Parameters can be used to relate surface appearance (optical), surface energy (cleanliness, hygiene), surface resistance /conductivity (shielding), heat transfer (heat flux control), barrier (corrosion performance, permeation control), adhesion, surface topography (friction, forming behaviour, touch), compatibility with additional organic coating layers (paints, glues...) and others.



2
Additive manufactured 3D printed surface measured by TopMap Pro.Surf+, showing roughness and form together

3
TopMap Pro. Surf+ combines both the detection of large areal form deviation plus roughness evaluation



4
Measuring the whole surface allows a full understanding of its characteristic. If a surface consists of a high degree of irregularity, then the whole area, data zoom, 2D profile slices, 2D and 3D areal parameters combined help describe a surfaces properties.

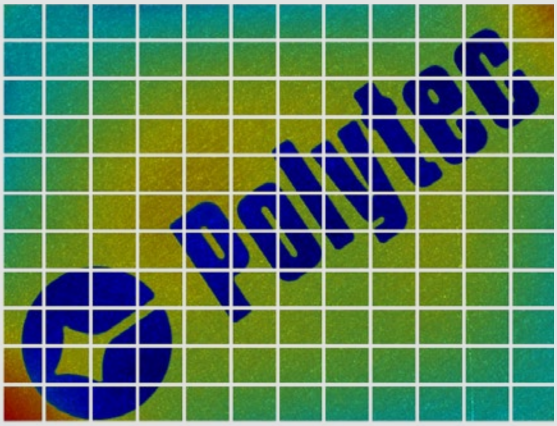
Here, the TopMap Pro.Surf+ multi-sensor system from Polytec GmbH is quickly becoming the instrument of choice for texture quality control over larger areas for AM surface types. The coherence scanning interferometry (CSI) technique is ideally suited for the measurement of textured surfaces no matter what material type – from metal over plastic and ceramic to composite. CSI can measure all these surfaces from shiny to roughwhile showing both the high resolution and large area measurement capability. This ensures both the small and large spatial frequencies associated with the wide range of surface possibilities, as generated by the AM process, can be measured and characterized numerically.

Surface results can be displayed in the form of surface texture parameters. Both 2D and 3D images, extracted profiles, localized flatness, heights and depths of structures can be expressed numerically to describe the most complex of surface types. All results can be described using the traditional R-type parameters as well as the new S-type parameters, which are employed to describe 3D surface roughness.

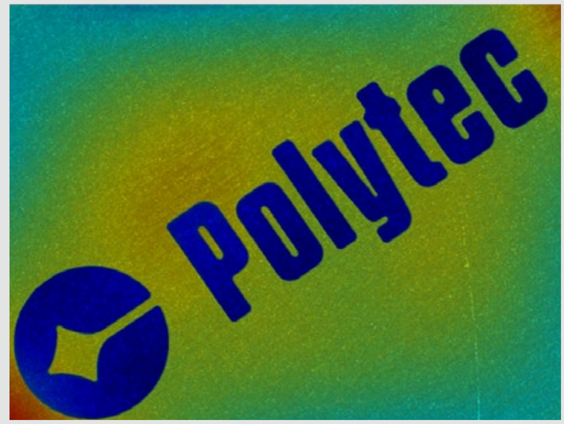
!

Note:
All parameters for the TopMap Pro.Surf+ comply with ISO 4288 and ISO 25178. The definitions used in our datasheet (and the Fair Data Sheet) are given in the new ISO 25178-600. Instruments also conform to ISO 25178-700 (calibration of areal measuring instruments) and the description is also comparable to our specifications.

5
Macroscope scanning procedure measures large areas in one shot, faster and without image stitching



Microscope needs to stitch



Macroscope gets the whole data

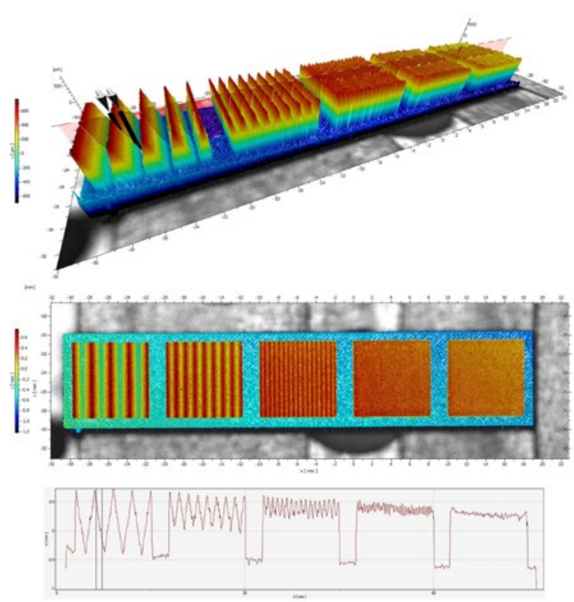
Multi-tasking surface metrology

The TopMap Pro.Surf+ optical surface metrology system is a multi-functional tool that includes large single field of view in XY of up to 44.9 mm x 33.8 mm. This is the area that can be scanned with an optical resolution in XY from 8.4 µm. The Z resolution is to the nanometer range thanks to the coherence scanning algorithm used. Optional image stitching capture areas over 200 mm in both X and Y directions, while the large Z range reaches from nanometer to 70 mm. The attached confocal roughness sensor then supports XY sample scanning from the 1 µm in XY range. This combination gauge now offers the widest of spatial frequency measurement possibilities for high accuracy and stable measurements.

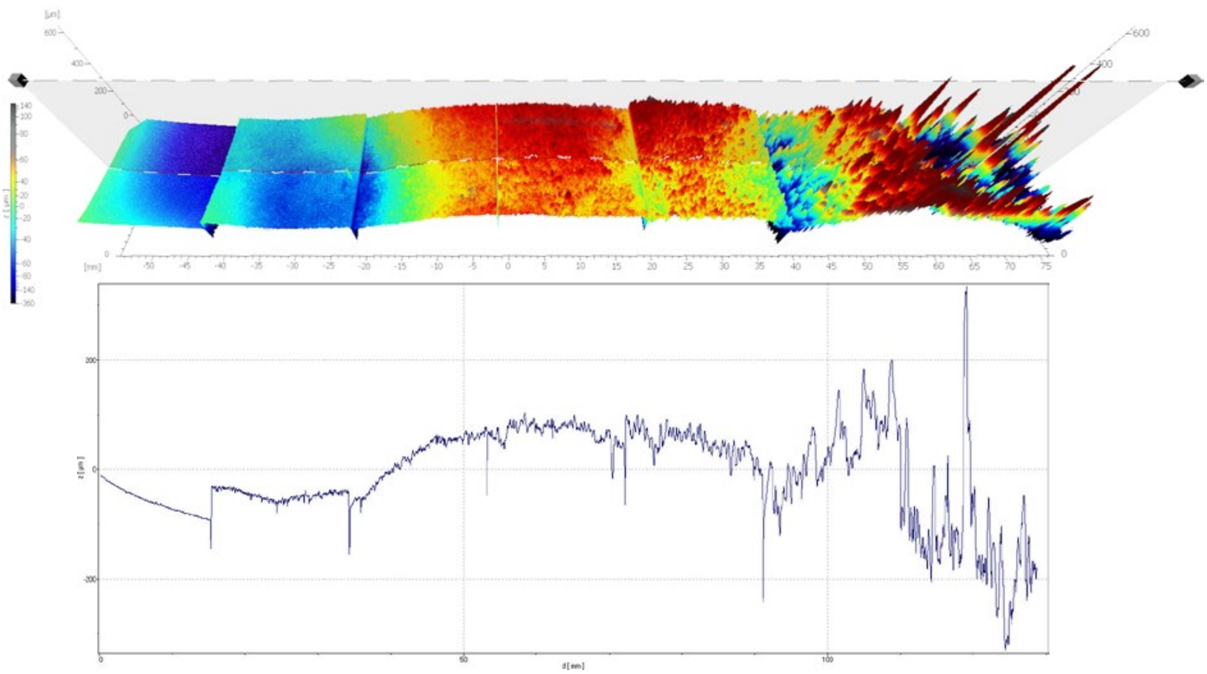
This combination of white-light interferometer and chromatic-confocal sensor technology is ideal for the evaluation of the most complex surfaces, offering a broad range of parameters over the widest spatial frequency band, which will allow a surface to be fully characterised both visually and numerically.

Advanced software

The entire system is managed by Polytec's powerful but easy to use software, ideally suited for fast-automated measurement routines. Using an interactive window display, the software presents on-screen instrument push button control, surface images, plots and data. Available data includes a high fidelity 3D images, 3D plots, 2D profiles from 3D data, and a wide range of surface roughness and contouring parameters.



Choose between different views like 3D, 2D view incl video image or 2D profile



6
ISO recommend a 12.5 mm area be scanned for rough surfaces and even 40 mm for rougher surfaces. The TopMap Pro.Surf+ can make fast measurement over large areas

Summary

The shift towards areal topography characterization is driving the adoption of optical measurement devices based on a range of multi-sensor technologies. The most utilized optical technologies for AM surfaces of metal parts may need a tactical approach to help fully characterize, combining results of profile lines and areal data. The multi-sensor system TopMap Pro.Surf+ offers 1 nm vertical resolution and 1 µm XY resolution, allowing both the measurement of small and large features over larger areas. Ideal for both small and large spatial frequency measurements, measurements are fast, accurate and stable.

The highly irregular AM surfaces can present measurement difficulties for older traditional measurement techniques such as contact-based stylus instruments, where local slope and vertical scale of high roughness can present challenges. Similarly, given the highly irregular nature of most AM generated surfaces, 2D data may not prove sufficient to fully describing the surface. The Top Map Pro.Surf+ can measure a wide variation in surface types allowing if to numerically represent the most complex of surfaces using both 2D and 3D areal ISO approved parameter sets.

!

Highlights

- High resolution XYZ measurements
- 214 mm x 214 mm XY with stitching and 70 mm Z scan range sensitive to the nm-ranger
- Fast measurement times cope with production cycle times
- Roughness and contour results displayed in one result
- Profile and areal extraction images and results

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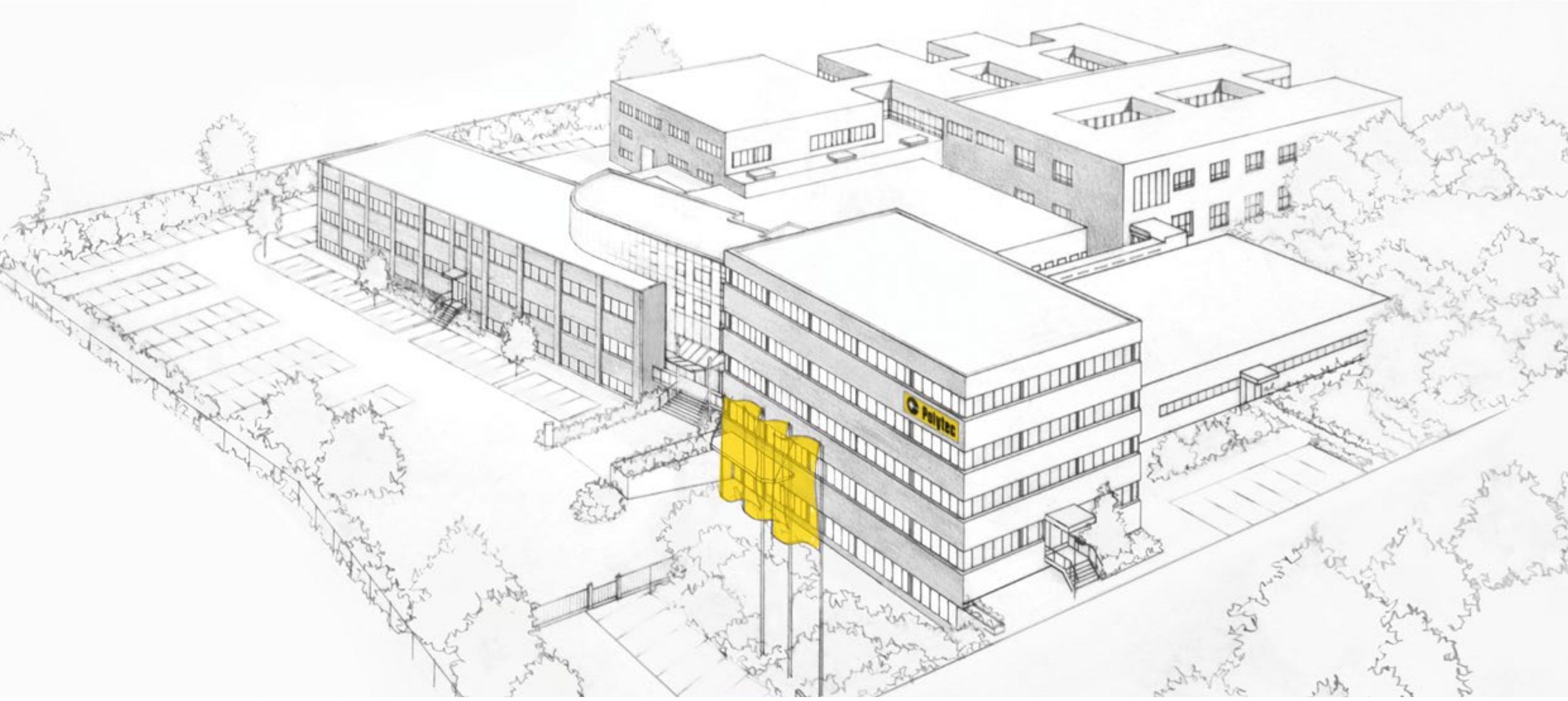

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