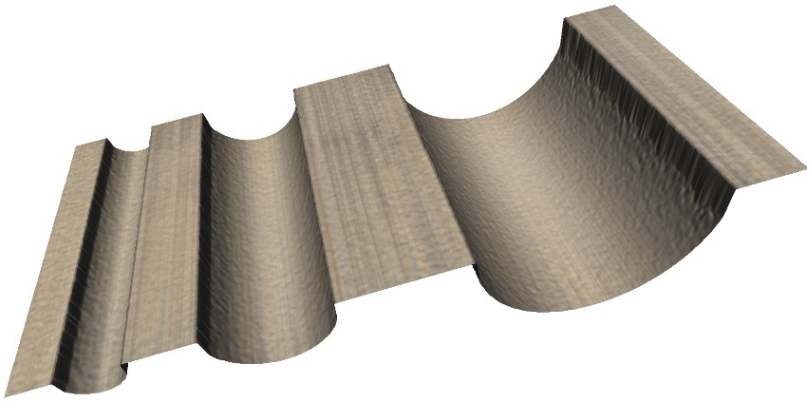
Application Note:

Bruker alicona

Application: Measurement of Micro Channels



Bruker Alicona is a leading global supplier of optical metrology solutions based on the principle of Focus Variation.

Focus Variation works on the basis of moving a focal plane over a surface and collecting robust 3D data which can then be used to measure geometric form and surface finish from a single optical sensor.

Measurement processes can be fully automated and provide GD&T measurement capabilities across all industrial & medical sectors.

The systems are in use in Industry, Industrial Research, Universities and production facilities globally.

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Micro Channel Measurement

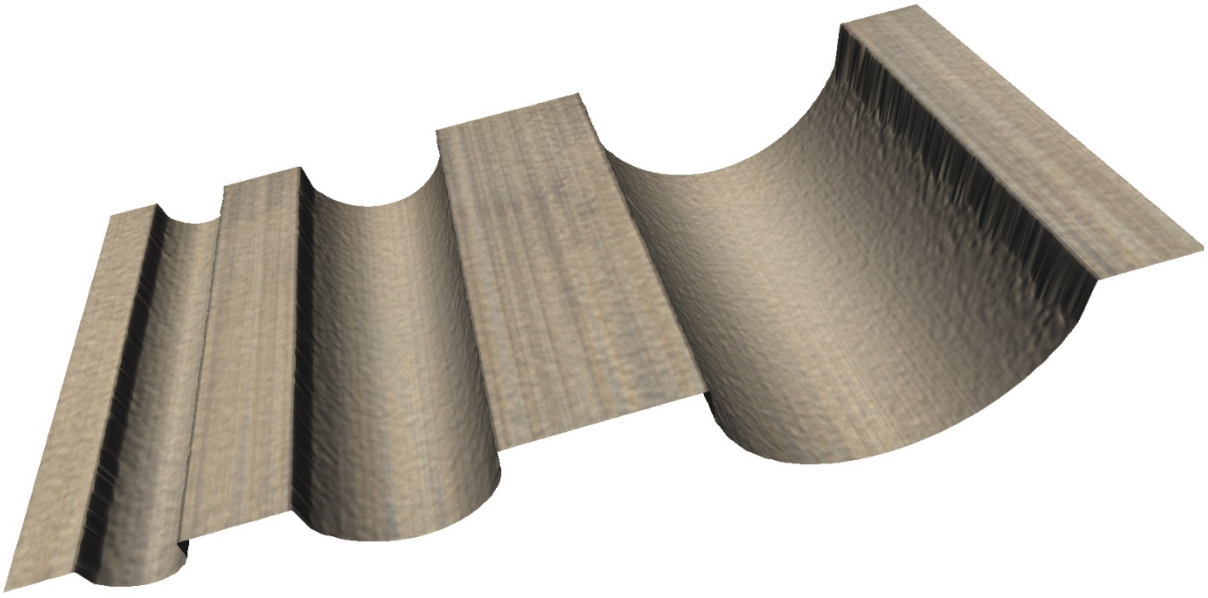
In this application note we describe the use of the Bruker Alicona measurement systems to measure micro channels which are difficult or impossible to measure using a conventional CMM. The system used for this measurement was an InfiniteFocusG5 system as shown in the appendix. The measurements can also be made using a cobot measuring system when quick automation and interface to 3rd party devices are needed; this is also illustrated in the appendix.

The size and finish of these micro channels are critical and are used in many application areas, such as microfluidic devices used in the medical industry and heat exchangers used in fuel cells and other generation devices.

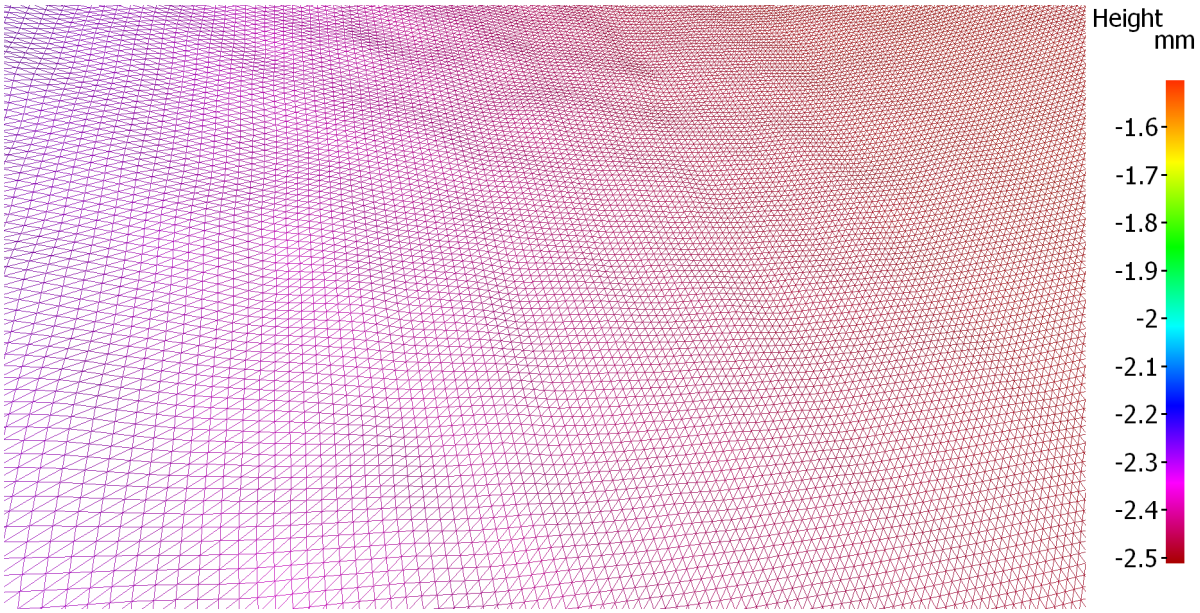
The unique nature of the Focus Variation principle, used in the InfiniteFocus systems, allows these micro features to be both imaged and measured in high resolution. As each data set contains several million data points it allows accurate measurement of these features which is not possible with single point probing.

Also, the principle of Focus Variation allows the quick and easy measurement without the need for sophisticated holding devices or extensive program writing.

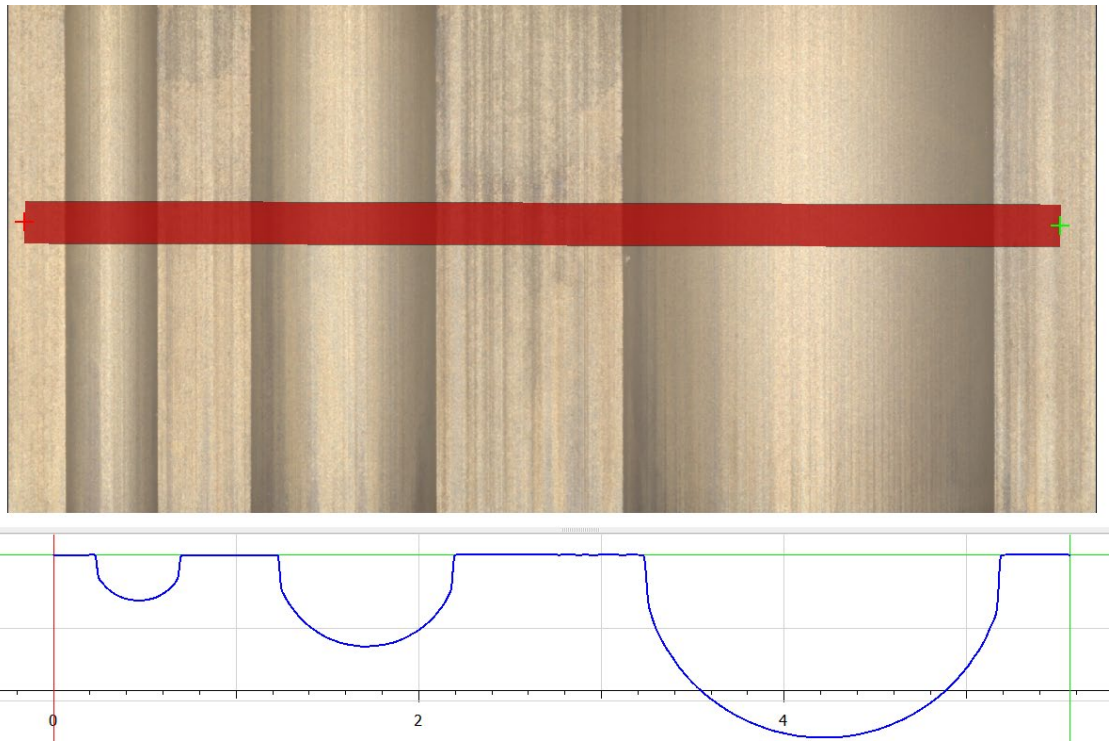
In this case the object to be measured is simply placed on the measurement table of the InfiniteFocus system, this allows X Y scanning up to 200 x 200 mm and a 3D model is produced as shown below.



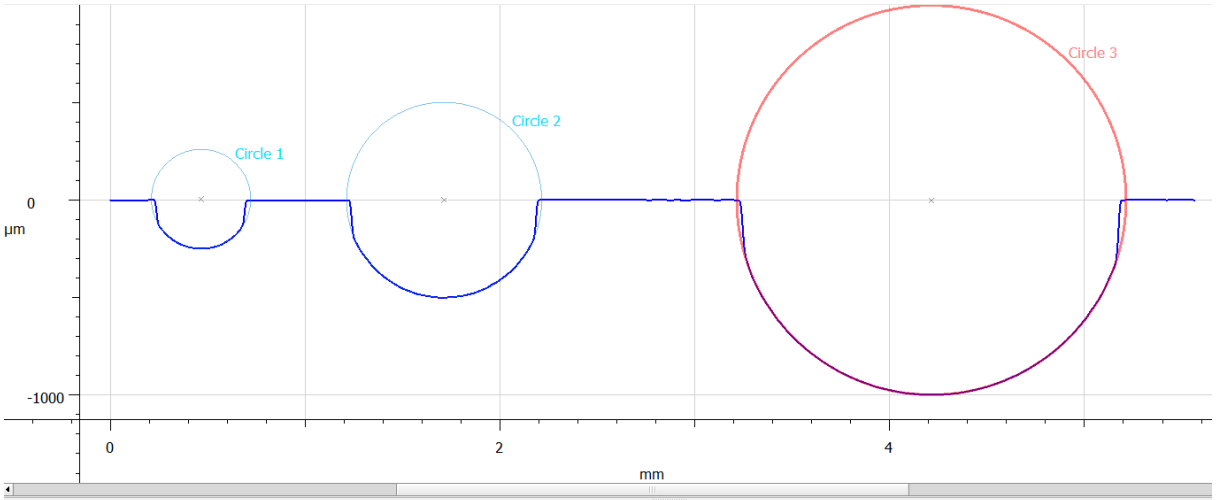
The zoomed image shown below shows the very high density of the data that has been collected and it is on this data that measurements are made. The area displayed is approximately 400 x 200 microns.



The data set is then placed in the profile measurement module and a profile line extracted across the surface as shown below, the profile line width here has been expanded to a width of 30 microns to reduce variation.



Using circle fitting, or points as appropriate it is now possible to accurately measure the 3 channels as shown below. It shows the 3 radii as 255, 501 and 999 µm. With a very high accuracy and repeatability.

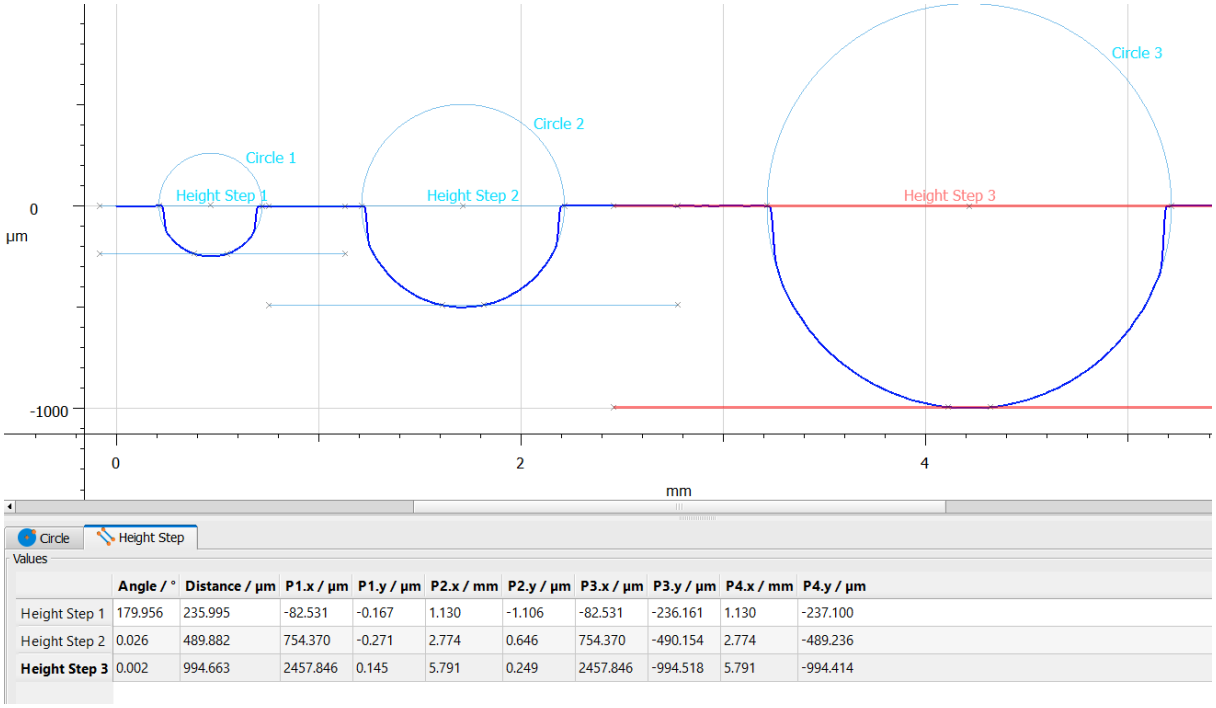


Circle

Values

	Radius / µm	C.x / µm	C.y / µm	mean Deviation / µm	min. Deviation / µm	max. Deviation / µm	Circumference / mm	Area / µm²
Circle 1	255.112	464.751	5.317	0.251	-0.716	1.174	1.603	204462.151
Circle 2	501.286	1712.837	0.692	0.471	-1.550	1.463	3.150	789442.842
Circle 3	999.581	4215.500	-0.367	0.574	-3.447	1.704	6.281	3138957.619

Using height step measurement, it is also now possible to measure the maximum depth of each channel as can be seen below.



Circle | Height Step

Values

	Angle / °	Distance / µm	P1.x / µm	P1.y / µm	P2.x / mm	P2.y / µm	P3.x / µm	P3.y / µm	P4.x / mm	P4.y / µm
Height Step 1	179.956	235.995	-82.531	-0.167	1.130	-1.106	-82.531	-236.161	1.130	-237.100
Height Step 2	0.026	489.882	754.370	-0.271	2.774	0.646	754.370	-490.154	2.774	-489.236
Height Step 3	0.002	994.663	2457.846	0.145	5.791	0.249	2457.846	-994.518	5.791	-994.414

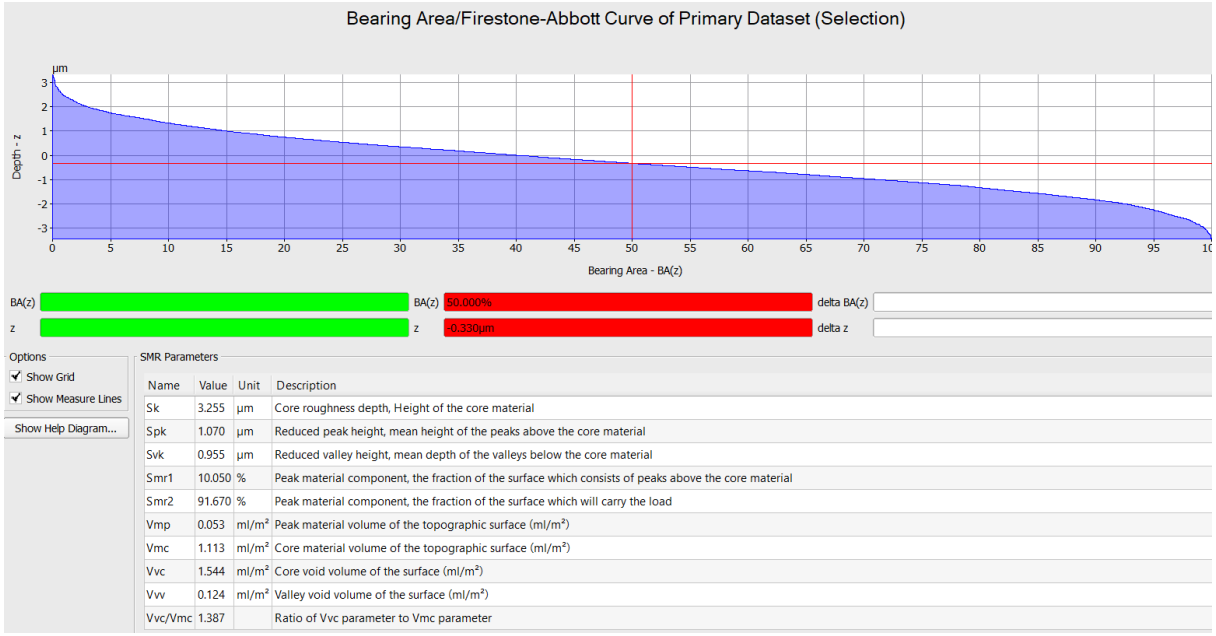
It is also now possible to measure the surface finish on the bottom of the channel using surface texture measurement. The region to me measured is firstly selected as shown below, this is the smallest channel. The size of the selection is 74µm x 2.7mm and contains 9400 measurement points providing robust data.

This provides measurement data as shown below according to the ISO 25178 standard.

Parameters

Name	Value	Unit	Description
Sa	1.006	µm	Average height of selected area
Sq	1.236	µm	Root-Mean-Square height of selected area
Sp	3.314	µm	Maximum peak height of selected area
Sv	3.436	µm	Maximum valley depth of selected area
Sz	6.750	µm	Maximum height of selected area
S10z	0.000	µm	Ten point height of selected area
Ssk	-0.577		Skewness of selected area
Sku	2.593		Kurtosis of selected area
Sdq	0.072		Root mean square gradient
Sdr	0.467	%	Developed interfacial area ratio
FLTt	6.750	µm	Flatness using least squares reference plane

Also available are functional surface parameters as illustrated below.



Name	Value	Unit	Description
Sk	3.255	µm	Core roughness depth, Height of the core material
Spk	1.070	µm	Reduced peak height, mean height of the peaks above the core material
Svk	0.955	µm	Reduced valley height, mean depth of the valleys below the core material
Smr1	10.050	%	Peak material component, the fraction of the surface which consists of peaks above the core material
Smr2	91.670	%	Peak material component, the fraction of the surface which will carry the load
Vmp	0.053	ml/m²	Peak material volume of the topographic surface (ml/m²)
Vmc	1.113	ml/m²	Core material volume of the topographic surface (ml/m²)
Vvc	1.544	ml/m²	Core void volume of the surface (ml/m²)
Vvv	0.124	ml/m²	Valley void volume of the surface (ml/m²)
Vvc/Vmc	1.387		Ratio of Vvc parameter to Vmc parameter

Summary:

It can be seen in this application note that it is easily possible to measure the geometry of micro channels with high levels of accuracy with the InfiniteFocus system. These measurements would be very difficult to measure with a CMM, also, due to the very limited number of measurement points that could be made with a touch probe the accuracy and repeatability of the measurement would be questionable. In addition, the surface measurement capability with the same sensor and 3D data set provides a complete solution for the characterisation of these channels.

This is made possible by the very high data point density achieved with the Focus Variation technique making even sub-micron measurements easily obtainable.

Appendix

Products used for this application:

InfiniteFocusG5plus

InfiniteFocus is a highly accurate and flexible optical 3D measurement system based on the Focus Variation technology. Using only one sensor, users verify dimensional accuracy surface finish of their components. By means of Vertical Focus Probing, an extension of Focus Variation vertical surfaces can be probed laterally. Components in high accuracy, with a high vertical resolution and in high repeatability. The robust measurement principle of Focus Variation in combination with a vibration-isolating hardware allows the systems to be used in a manufacturing environment. With an **automation interface**, InfiniteFocus can also be used for fully automatic measurements in production.

Compact Cobot Measuring System

Our Cobot's combine a collaborative 6-axis robot arm and a robust optical 3D measurement sensor to deliver traceable and repeatable high-resolution measurements. They require no prior knowledge of metrology and make handling, programming and executing a measurement series easy. This is made possible by intuitive hand-guided controls for the teach-in of measurement series, automatic measurement evaluation, and a no-enclosures safety concept.

As a result, Cobot measuring systems are ideal for verifying the surface state, dimensional accuracy and features of work pieces in existing production environments. Users benefit from the high mobility and flexibility of collaborative systems, as Cabot's can be positioned as required due to their mobile design. This allows users to measure their components directly in the machine tool and easily interface to 3rd party systems.