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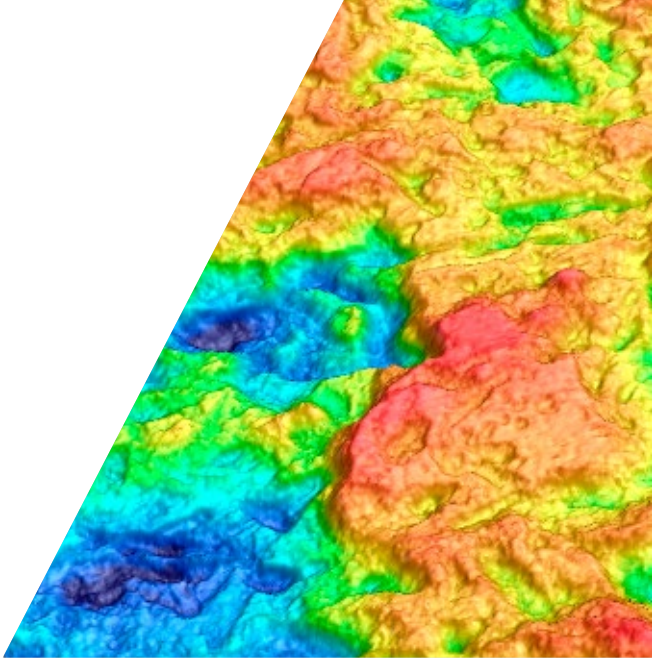
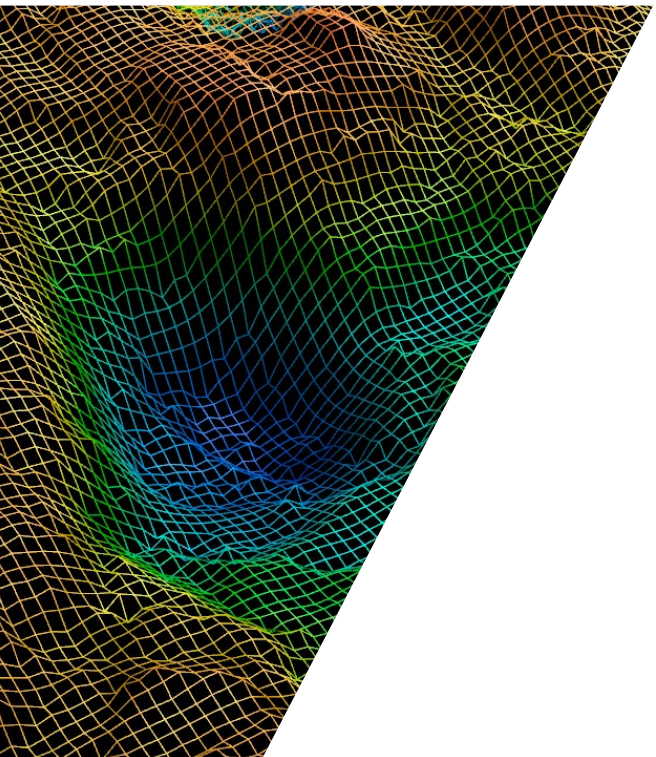


Compare and Understand

Selecting a Roughness Measuring Instrument



3D Surface Profiler VK-X Series

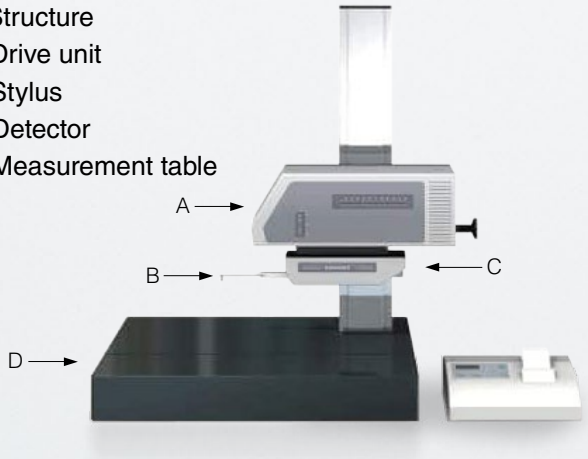
Differences Between Contact and Non-Contact Measurement Systems

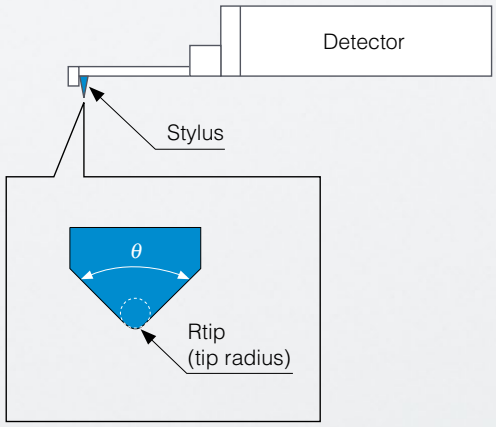
Roughness greatly affects product quality including the amount of wear, airtightness, texture, and the wettability of coating surfaces. Contact-type stylus profilometers have conventionally been widely used for roughness measurement, but the move toward smaller and more sophisticated products has increased the necessity of non-contact roughness measurement. This guide introduces the problems of conventional contact-type stylus profilometers and examples of solving such problems through the use of a 3D Surface Profiler that can perform non-contact roughness measurements.

Contact-type stylus profilometer

This instrument measures and records surface roughness according to the data obtained when the surface of a target is traced with a stylus.

■ Structure
A: Drive unit
B: Stylus
C: Detector
D: Measurement table





To perform highly accurate measurements of microscopic shapes and roughness, it is necessary to make the tip radius of the stylus as small as possible and to reduce the contact pressure. Typical tip radii of styluses, which are made of sapphire or diamond, are 2 µm, 5 µm, or 10 µm. The ideal taper angle of the circular cone at the tip is 60 degrees.

Characteristics of contact-type stylus profilometers and laser microscopes

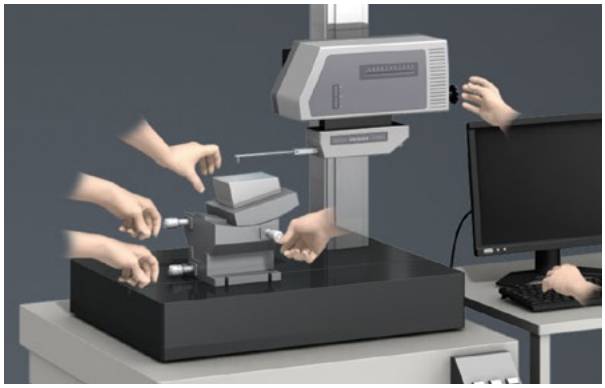
The following table compares the typical characteristics of these instruments.

Method	Contact type	Non-contact type
Measuring instrument	Stylus profilometer	Laser microscope
Measurement resolution	1 nm	0.1 nm
Measurement range (Z axis)	1 mm 0.04"	7 mm 0.28"
Measurement range (X axis)	100 mm 3.94"	100 mm 3.94"
Stylus radius (laser spot radius)	2 µm	0.2 µm
Measurement point confirmation	Visual	Built-in optical camera
Line roughness measurement	Possible	Possible
Surface roughness measurement	Impossible	Possible
Sample damage	Common	None

Stylus Profilometer Problems

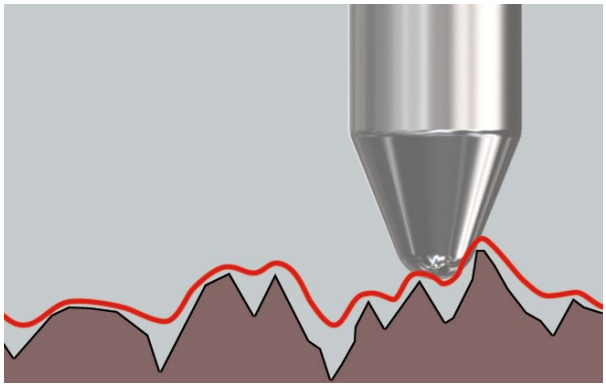
Problem 1

It is difficult to determine where to place the probe.



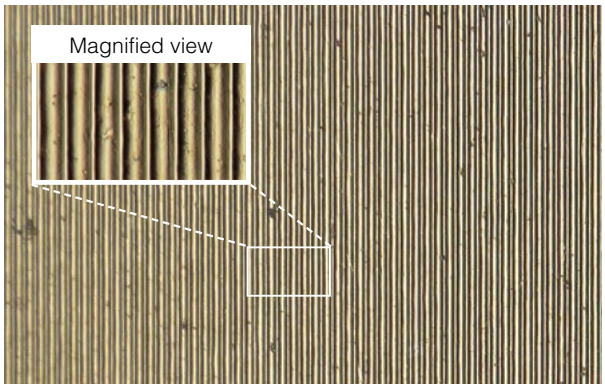
Problem 2

Grooves smaller than the tip radius of the stylus cannot be measured.



Problem 3

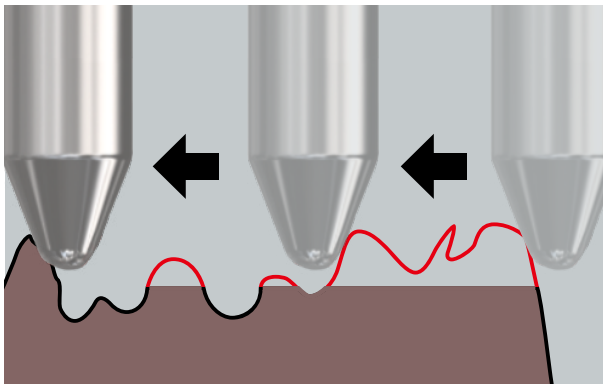
The sample surface may be scratched due to the measuring force.



Aluminum surface (200×)

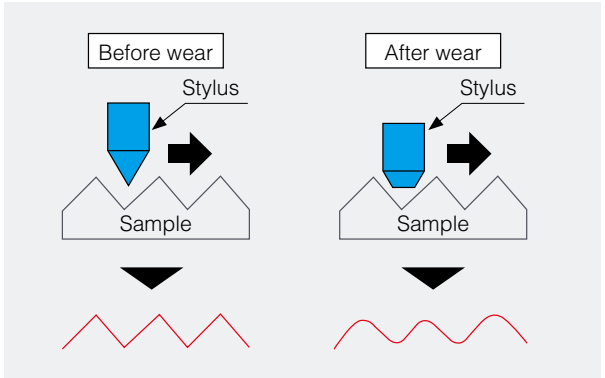
Problem 4

Soft samples cannot be measured accurately.



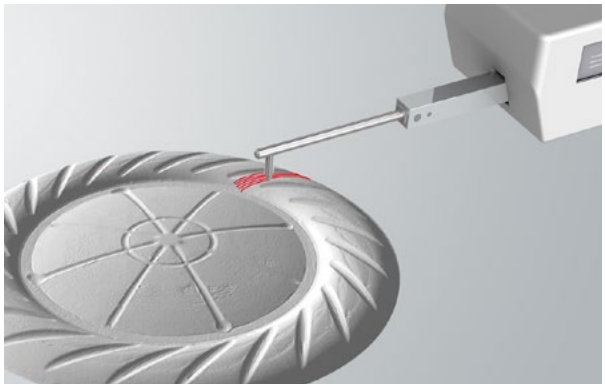
Problem 5

The stylus wears out.



Problem 6

Surface roughness cannot be measured.



Solving Problems with a 3D Surface Profiler

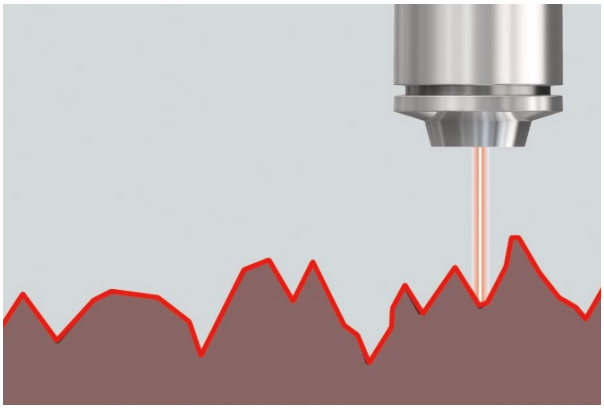
VK-X Series 3D Surface Profiler

Solution 1

Just place a target on the stage and press the Start Measurement button to measure automatically. No measurement adjustment is necessary thanks to the built-in AI-SCAN function.

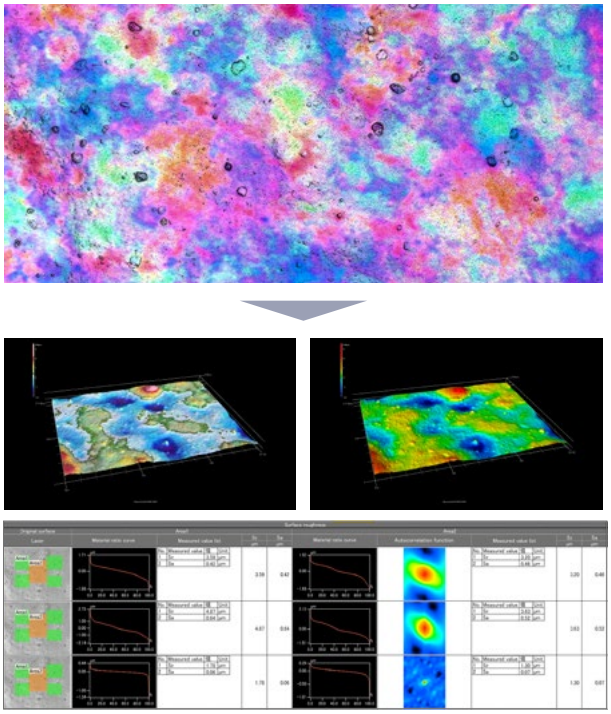
Solution 2

A laser beam with a spot diameter of 0.4 µm scans the surface, enabling measurement even of microscopic roughness that cannot be measured with conventional stylus profilometers.



Solution 3

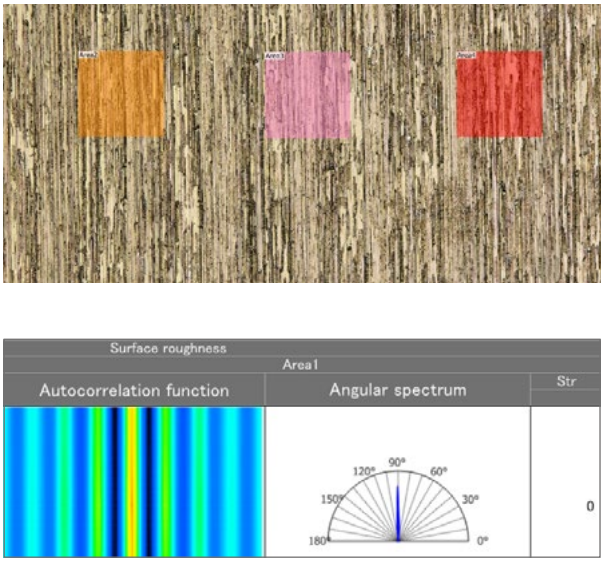
The roughness of a given area can be measured in a non-destructive, non-contact manner. No damage occurs to the sample.



Film surface (3000×)

Solution 4

Surface roughness measurement compliant with ISO 25178 is possible.

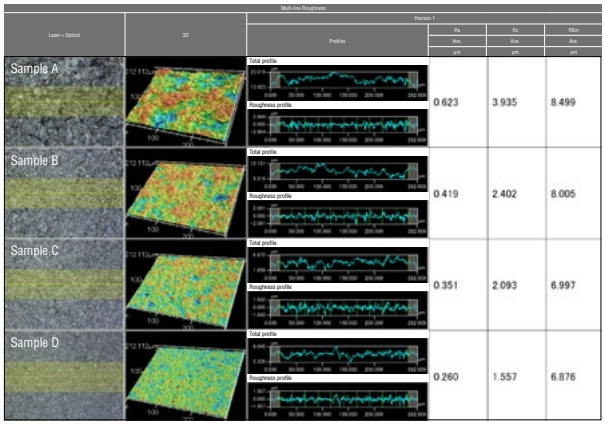


Processed metal surface (400×)

Advantageous Features of the 3D Surface Profiler

Advantage 1

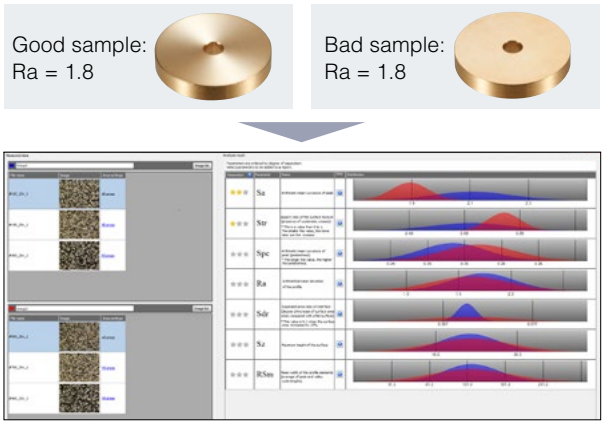
The batch analysis function enables simultaneous processing of all roughness data in a single operation.



Roughness measurement of a blasted surface (1000×)

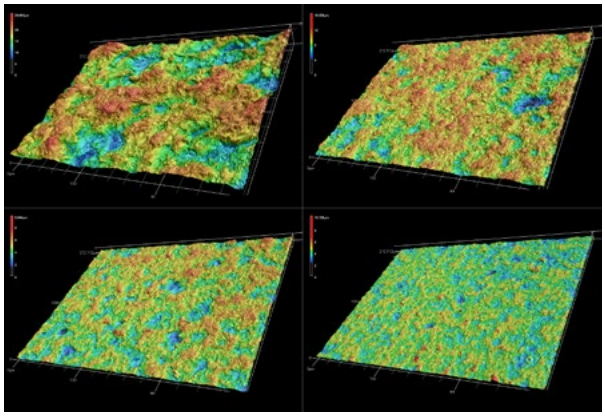
Advantage 2

The parameter suggestion function automatically analyzes the roughness differences between samples. Parameters suitable for roughness comparison can be extracted automatically from 42 different parameters.



Advantage 3

The 3D list display function allows for visual comparison of roughness differences.



Corrosion evaluation of a blasted surface (1000×)

Useful Roughness Parameters

The VK-X Series offers measurement using 42 different roughness parameters. This section introduces typical roughness parameters and application examples.

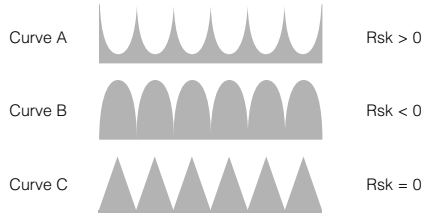
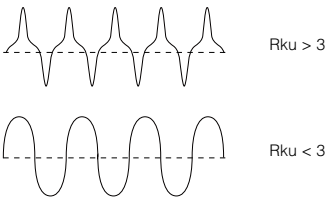
Roughness parameter categories

The parameters used for roughness measurement are broadly divided into three groups. Commonly used parameters Ra and Rz are categorized as height parameters.

Category	Typical roughness parameter	Name
Height parameters	Ra	Arithmetic mean height
	Rz	Maximum height
	Rsk	Skewness
	Rku	Kurtosis
Horizontal parameters	Rsm	Mean width of profile elements
Hybrid parameters (both height and horizontal elements are evaluated)	Rmr (c)	Load length ratio

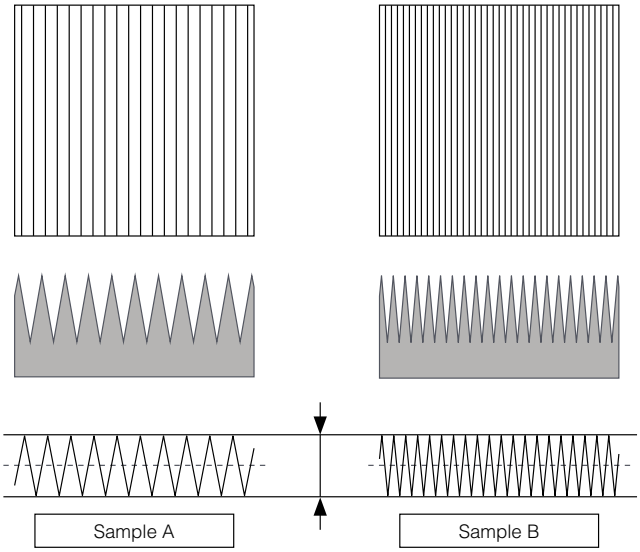
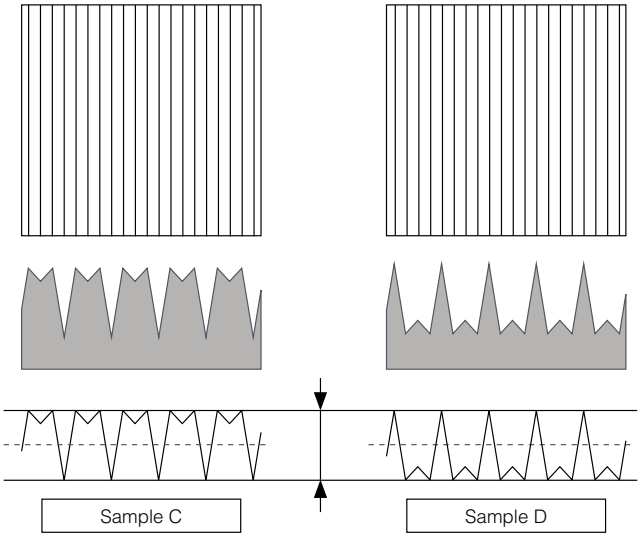
Rsk and Rku

Among the height parameters, Rsk (skewness) and Rku (kurtosis) are most frequently used after Ra and Rz. The following table shows application examples of these parameters.

Roughness parameter	Description	Application example
Rsk	This parameter represents the deviation of the peaks and valleys (unevenness) on the surface with reference to the mean line of a profile curve. Rsk = 0 shows the condition where peaks and valleys are symmetrical (Curve C). Rsk > 0 shows the condition where the distribution of peaks and valleys is skewed below the mean line (Curve A). Rsk < 0 shows the condition where the distribution is skewed above the mean line (Curve B).  Profile curves	The sliding parts of actual machines have a shape similar to Curve B. This parameter is used for the evaluation of oil sumps for lubricants and the abrasion of sliding surfaces. Sliding parts of a machine 
Rku	This parameter represents the sharpness of the peaks and valleys (unevenness) on the surface. Rku = 3 represents average sharpness. Rku < 3 represents a surface that has been worn, or does not have sharp peaks and valleys, such as for a polished surface. Rku > 3 shows the condition where there are sharp peaks and valleys. 	This parameter is used for the evaluation of gloss, polish, or appearance.

Rsm and Rmr (c)

Even when height parameters show no roughness difference, evaluation may be possible with Rsm (mean width of profile elements) or Rmr (c) (load length ratio).

Roughness parameter	Description	Application example
Rsm	When products used for evaporation or adhesion are evaluated with Ra or Rz, the resulting values may be the same, resulting in even defective products being considered non-defective, as in the case of samples A and B below. In reality, these samples have different textures that can be recognized clearly. In this case, it is effective to use Rsm, which can evaluate roughness in the horizontal direction. 	This parameter is used for the evaluation of airtightness or texture.
Rmr (c)	When samples C and D, products used on high-speed sliding surfaces, are compared, sample C provides higher wear resistance. When Ra or Rz is used for this evaluation, the sample C and D values are the same, making it impossible to determine that sample D is defective. In this case, it is effective to use Rmr (c), which can evaluate roughness in the vertical and horizontal directions. 	As in the case of Rsk (skewness), this parameter is used for the evaluation of abrasion and oil sumps.

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