KEYENCE

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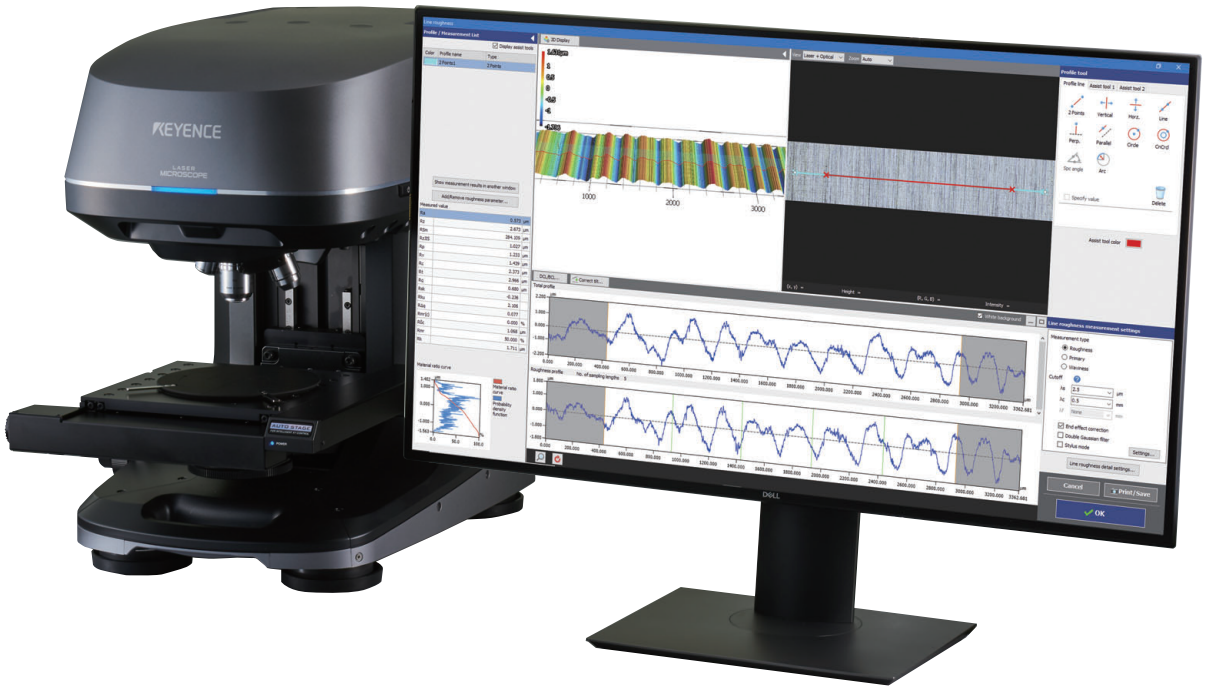


3D Surface Profiler

Quick Start Guide

- Surface Roughness Measurement -

KEYENCE CORPORATION

Introduction

Thank you for your purchase of the VK-X3000 Series 3D Surface Profiler.
First, we will introduce basic operation. You can understand basic operation using a common object such as a coin.

This manual describes line, multiline, and surface roughness measurement of 3D data gathered by the VK-X3000 Series.

The VK measures surface roughness according to ISO standards.

Contents

Chapter 1

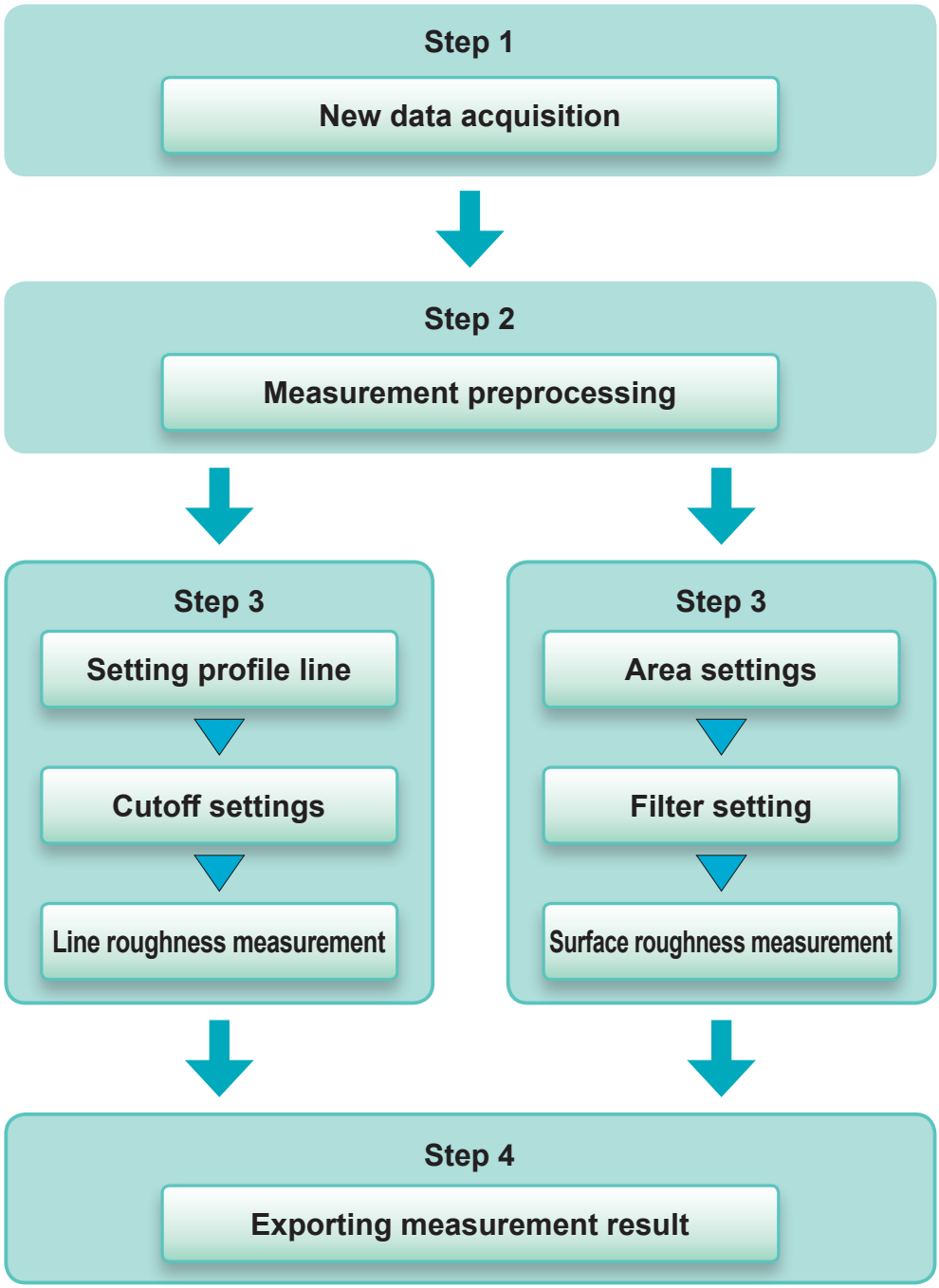
Before Starting Operation

1-1 Understanding the Operation Flow

See the general flow for roughness measurement below.

Step 1: New data acquisition → Obtain a 3D image by measuring a sample
Step 2: Measurement preprocessing → Remove the tilt and noise of the obtained 3D image
Step 3: Use the measurement function → Measure preprocessed data using various functions
Step 4: Export measurement result → Output a measurement result to a report or Excel

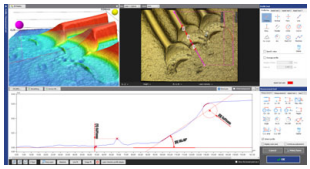
This manual describes Step 3 and Step 4.

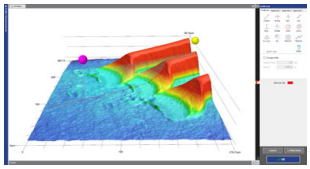


● **New data acquisition**
Measure an object and obtain a 3D image including color information.
For details, see 📖 "Quick Start Guide: Gathering New Data using Focus Variation/White Light Interferometer", and 📖 "Quick Start Guide: Gathering New Data using Laser Confocal".

● **Measurement preprocessing**
For details, see 📖 "Quick Start Guide: Image Processing".

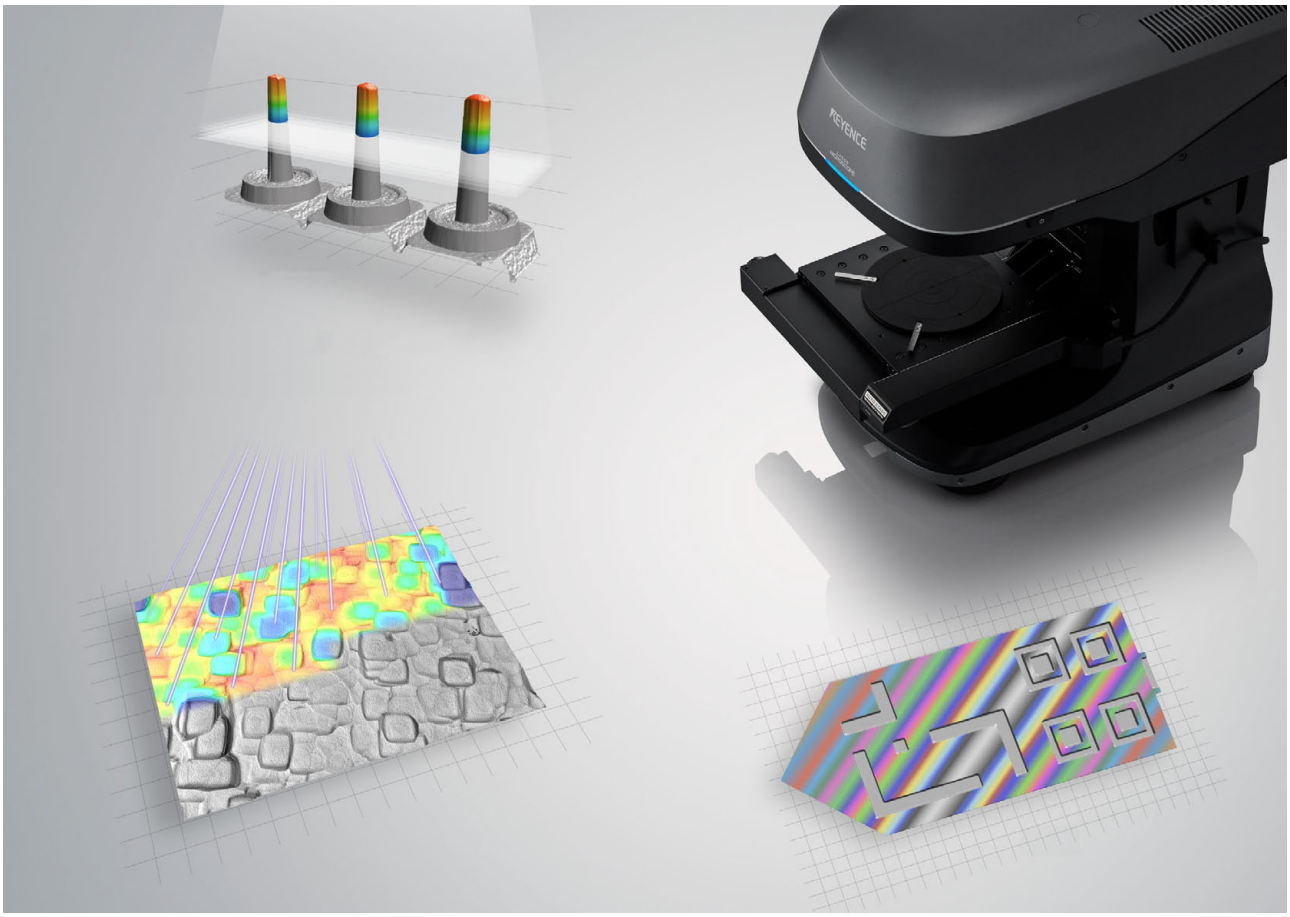
● **Using the measurement function**
Perform various measurements from an obtained 3D image.
- Cross section shape measurement
- Roughness measurement
- Comparison of two types of data
- Film thickness measurement





Chapter 2

Conducting Line Roughness Measurement



2-1 Flow of Line Roughness Measurements

This manual assumes that the 3D image is already open in the Multifile Analyzer.

This section describes operating procedures for line roughness measurement.
The flow of line roughness measurements is as follows:

Displaying the line roughness measurement window

Display the line roughness measurement window to perform measurement.

Setting profile line

Draw a profile line at the measurement position on the image displayed in the line roughness measurement window.

Setting measurement type

Specify the measurement type (Roughness, Primary, Waviness).

Stylus mode setting

When applicable, set the stylus mode.

Setting cutoff value

Set a cutoff value.

Setting Evaluation Length

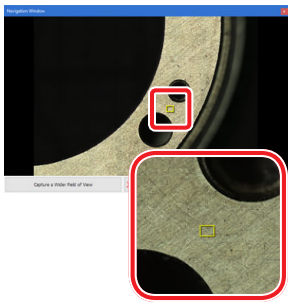
As needed, set segments on the total profile graph, and obtain values for each segment.

Exporting measurement result

Output the measurement results to Excel as a report.

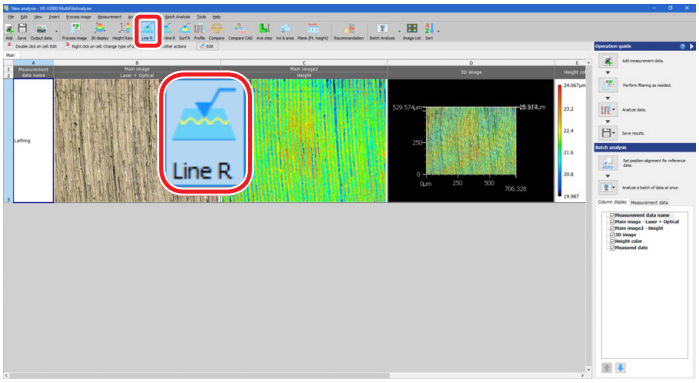
- **Multi-line roughness measurement**
  Multi-line roughness is a helpful tool to reduce measurement variation. A single roughness line may skew results based on the specified location. This tool will set multiple parallel lines to measure roughness over a larger area. Click the [Multi-line R] button on the toolbar. Alternatively, select [Multi-line roughness measurement] from the [Measurement] menu.

- **About the sample**
  The operation manual uses the results of measuring a part of a metal.



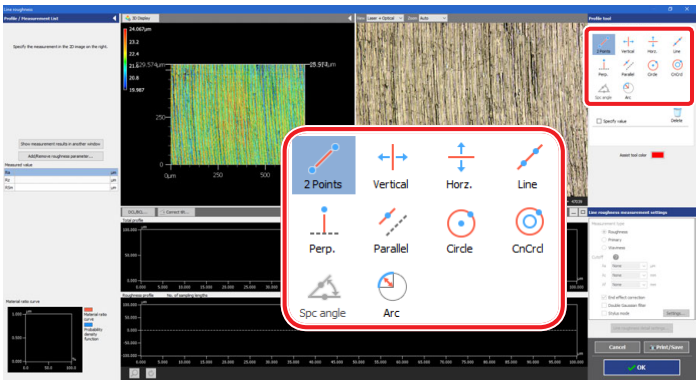
1. Select measurement data and click the [Line R] button.

Click the [Line R] button on the toolbar. Alternatively, select [Line roughness measurement] from the [Measurement] menu.



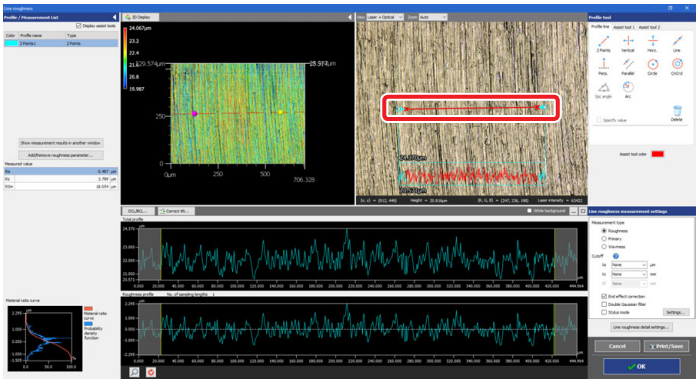
2. Click [2 Points] in [Profile tool].

There are 10 types of profile tools available at the top right corner of the screen.
In this case, select the 2 points function.



3. Identify an area of interest and click twice to draw a measurement line.

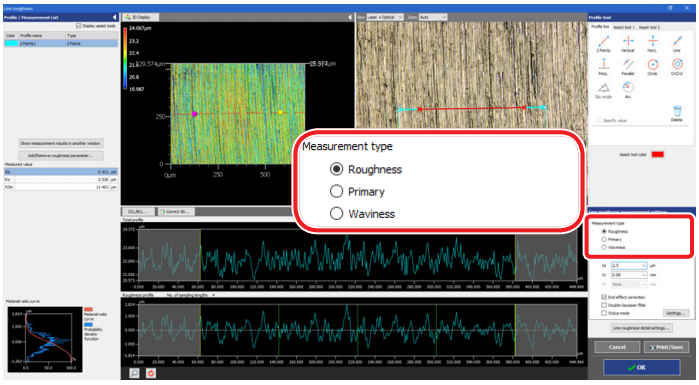
On the top right of the screen, place the cursor over the area where you want to create the total profile, then click it.
In the lower half of the screen, the total profile and profile curve are displayed.



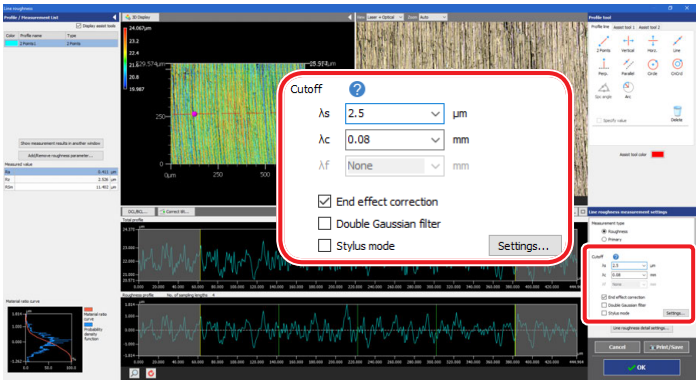
2-3 Setting Line Roughness Measurement

The line roughness measurement settings can set filter processing and calculation conditions that affect the calculation of the line roughness measurement, such as the measurement line type (roughness, cross section, and waviness) and cutoff.

1. Select the [Roughness] radio button from [Measurement type] of [Line roughness measurement settings].



2. Set the cutoff or stylus mode as needed.



Set the cutoff to the value indicated in the drawing or the product technical information requirements, if instructed. However, when no specific instructions are given or the surface roughness is not known, set the cutoff according to the following values.

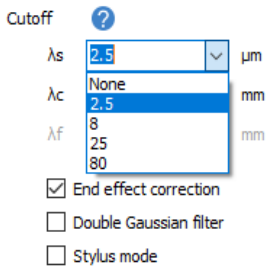
Setting cutoff λs

Set following values to cutoff.

Lens magnification	Cutoff λs
Objective lens 20x	2.5 μm
Objective lens 50x	0.8 μm
Objective lens 100x	0.8 μm
Objective lens 150x	0.8 μm

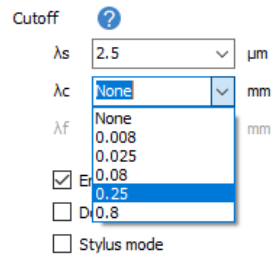
● **Measurement type**
By default, the [Roughness] radio button is selected.
If applicable, “Primary” or “Waviness” can be selected using the appropriate radio button.

● **Cutoff λs**



For the cutoff λs, ISO standard values can be selected from a pull-down in the text box. Additionally, a desired number can be freely input.

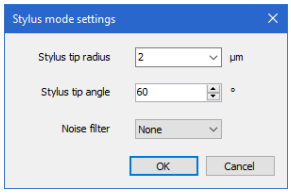
● **Cutoff λc**



For the cutoff λc, ISO standard values can be selected from a pull-down in the text box. Additionally, a desired number can be freely input.

● **Stylus mode**

The stylus mode is a function to interpolate the roughness profile after the cutoff filtering so that it can be correlated with the value of the contact-type surface roughness meter.
Use this to evaluate the correlation with the measurement results of the contact-type surface roughness meter.



Point

The "None" or "Weak" setting is appropriate for the objective lens with 50x or more, and "Medium" or "Strong" for the lens with 20x or less.

Setting cutoff λc (for a periodic roughness profile)

Set a cutoff λc as the same value as the sampling length.
For a sample with a periodic roughness profile, the parameter RSm is estimated from the total profile and the cutoff is set by referring to the following table.
When the RSm of the measurement result after the calculation is out of range of the estimated RSm, change it to the appropriate RSm cutoff.

RSm (mm)	Sampling length of the roughness profile (mm)	Evaluation length of the roughness profile (mm)
0.013 < RSm ≤ 0.04	0.08	0.4
0.04 < RSm ≤ 0.13	0.25	1.25
0.13 < RSm ≤ 0.4	0.8	4
0.4 < RSm ≤ 1.3	2.5	12.5
1.3 < RSm ≤ 4	8	40

Table 1: Reference lengths for the measurement of periodic roughness profile parameters, and RSm measurement of periodic/aperiodic profile curve

Setting cutoff λc (for an aperiodic roughness profile)

Set a cutoff λc as the same value as the sampling length.
For a sample with an aperiodic roughness profile, estimate the unknown parameter Ra, Rz, or RSm from the total profile, and determine each corresponding cutoff value from any of the tables in the tables 1 to 3.

Ra (mm)	Sampling length of the roughness profile (mm)	Evaluation length of the roughness profile (mm)
(0.006) < Ra ≤ 0.02	0.08	0.4
0.02 < Ra ≤ 0.1	0.25	1.25
0.1 < Ra ≤ 2	0.8	4
2 < Ra ≤ 10	2.5	12.5
10 < Ra ≤ 80	8	40

Table 2: The aperiodic profile curve roughness parameters Ra, Rq, Rsk, Rku and RΔq, as well as the material ratio curve BAC and probability density function ADF, and their related sampling lengths of the parameters.

Rz (mm)	Sampling length of the roughness profile (mm)	Evaluation length of the roughness profile (mm)
(0.025) < Rz ≤ 0.1	0.08	0.4
0.1 < Rz ≤ 0.5	0.25	1.25
0.5 < Rz ≤ 10	0.8	4
10 < Rz ≤ 50	2.5	12.5
50 < Ra ≤ 200	8	40

Table 3: Sampling lengths for the roughness parameters Rz, Rv, Rc and Rt of the aperiodic profile curves

Setting cutoff λf

The cutoff λf is set when “waviness” is measured.
Set the value of n times of λc instructed in the drawing or the product technical information requirements.

Stylus mode setting

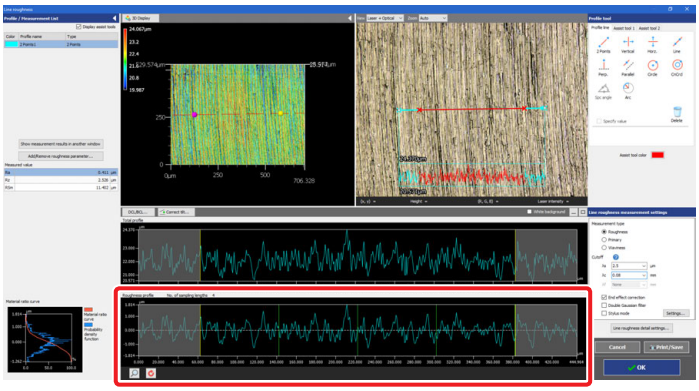
When correlation with the data from a stylus type roughness meter is measured, set the stylus mode according to the diameter and angle of the stylus tip of your roughness meter.

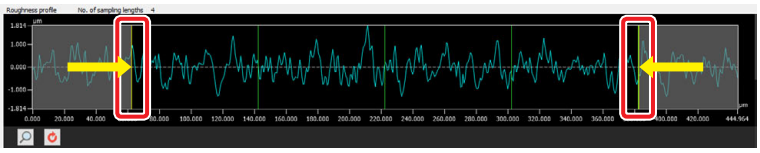
Range of Ra (μm)		Range of Rz (μm)		Radius of the stylus tip	Angle of the stylus tip	
More than	Equal or less than	More than	Equal or less than		Year 2001	Year 1994
0.006	0.02	0.025	0.1	2 μm	60 degrees when instructed, 90 degrees	60 degrees or, 90 degrees
0.02	0.1	0.1	0.5	2 μm		
0.1	2	0.5	10	2 μm		
2	10	10	50	5 μm		
10	80	50	200	10 μm		

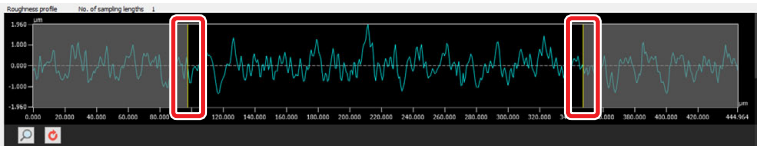
As needed, set the evaluation length on the total profile.

1. You can set an evaluation length by dragging two yellow vertical cursors that are displayed on the profile graph.

The cursor positions are shared between the roughness/primary/waviness profiles and total profile.

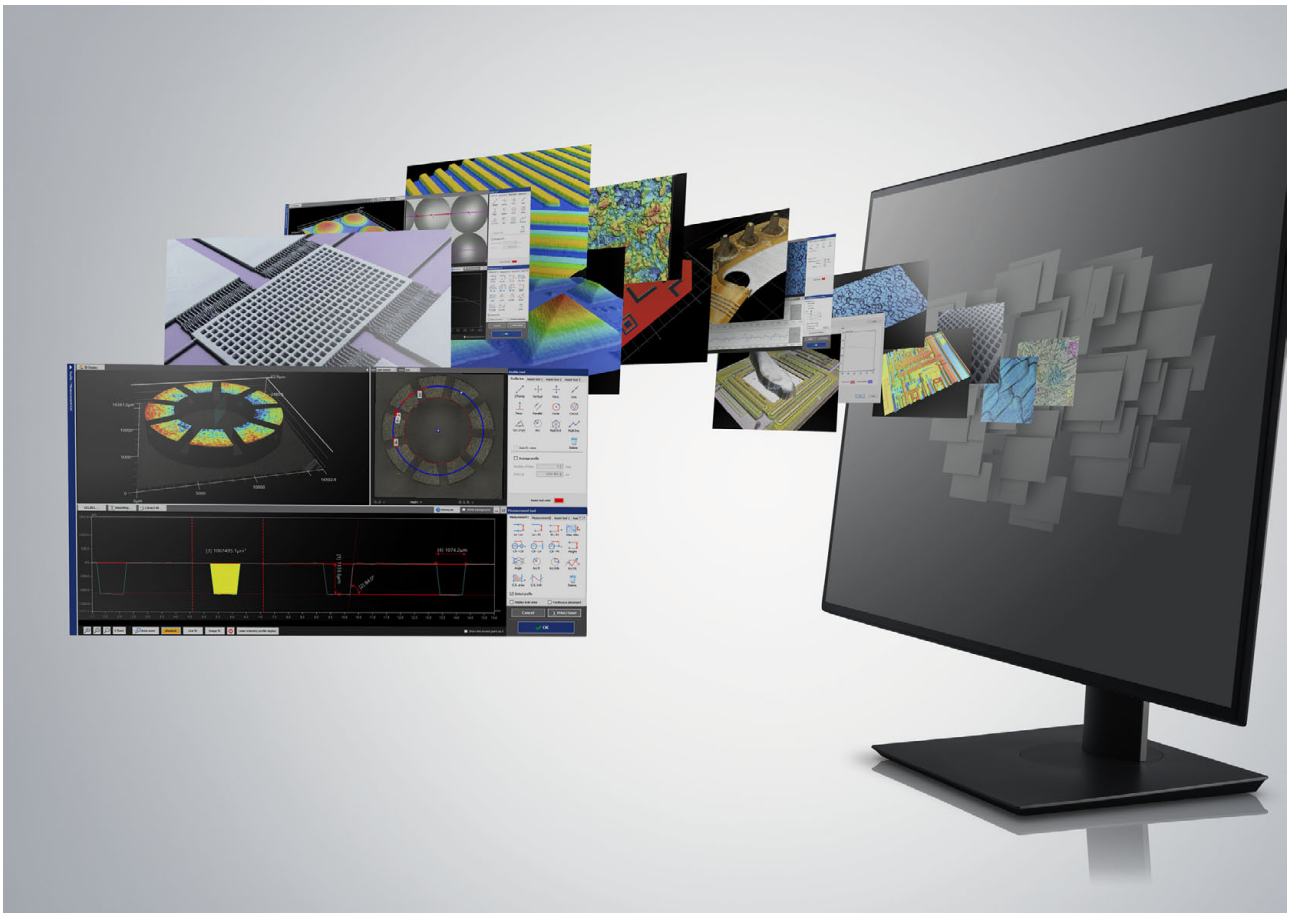






Chapter 3

Conducting Surface Roughness Measurement



3-1 Flow of Surface Roughness Measurement

This manual assumes that the 3D image is already open in the Multifile Analyzer.

This section describes operating procedures for line roughness measurement.
The flow of surface roughness measurement is as follows:

Displaying the surface roughness measurement window

Display the surface roughness measurement window to perform measurement.

Setting measurement area

Draw a profile line at the measurement position on the image displayed in the surface roughness measurement window.

Setting measurement type

Specify areas in the image display area.

Performing filter

Set filters to calculate the surface of measurement target.

Surface roughness measurement detail settings

When measuring the following parameters, set the threshold values for areal material ratio, etc.

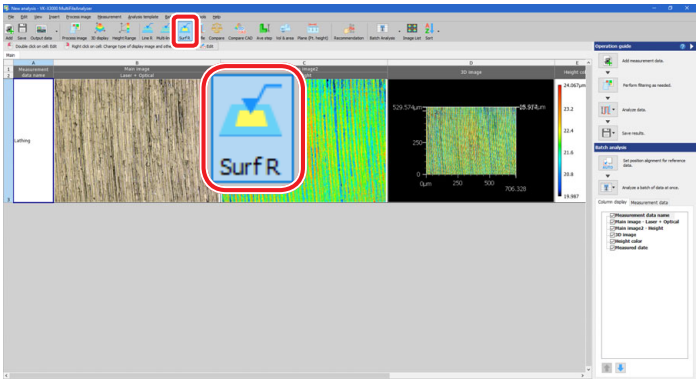
- Volume parameters
- Peak extreme height
- Spatial parameters

Exporting measurement result

Output the measurement result to Excel file to create a report.

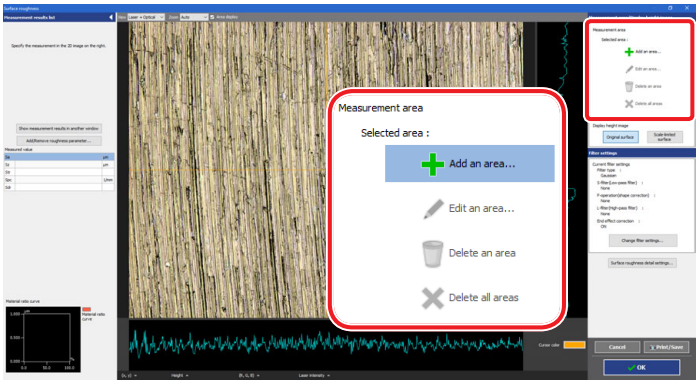
1. Select measurement data and click the [Surf R] button.

Click the [Surf R] button on the toolbar. Alternatively, select [Surface roughness measurement] from the [Measurement] menu.



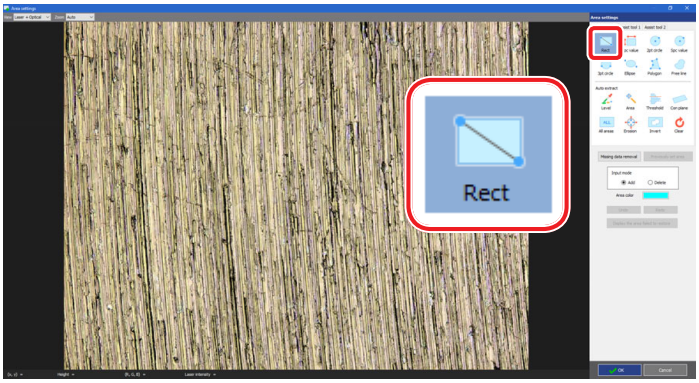
2. Select the area settings.

Click the [Add an area] button.



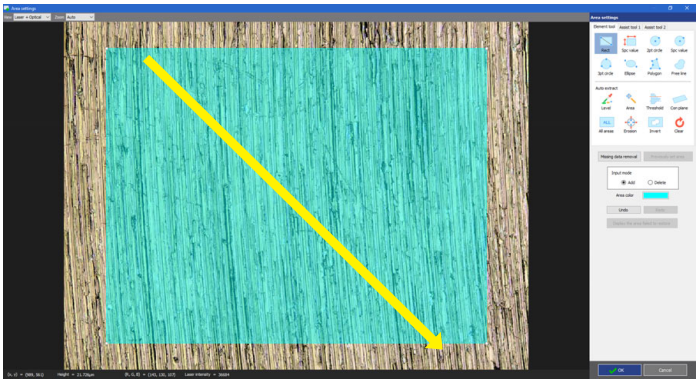
3. Click the [Rect] button from [Element tool].

Click the [Rect] button from [Element tool] on the top right of the screen.



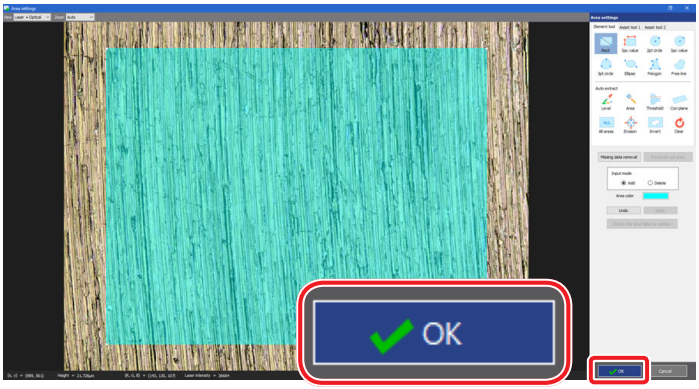
4. Select the range you want to select in the measurement data screen.

Click the top left (start point) of the range you want to select, move the cursor, and click the bottom right (end point) in the measurement data screen.



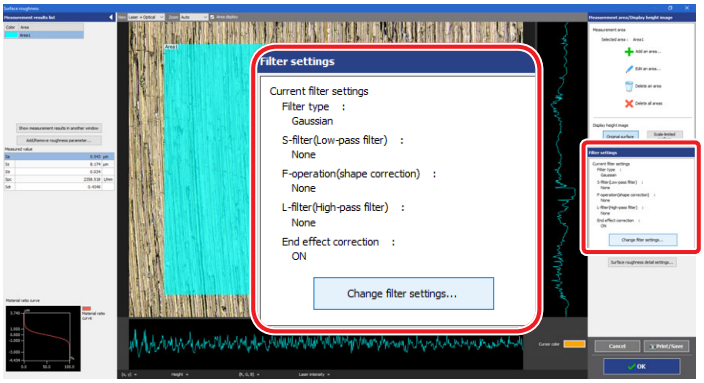
5. Click the [OK] button.

Click the [OK] button to set the area.

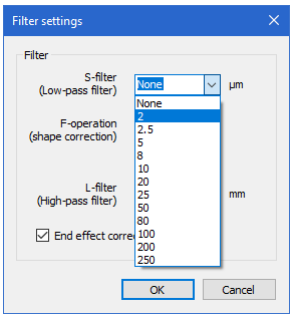


Set the filter to remove unneeded noise and waviness components.
Note that description is provided on the premise that [Filter type] is [Gaussian].

1. Click the [Change filter settings] button of the [Filter settings].

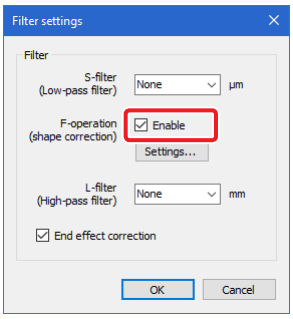


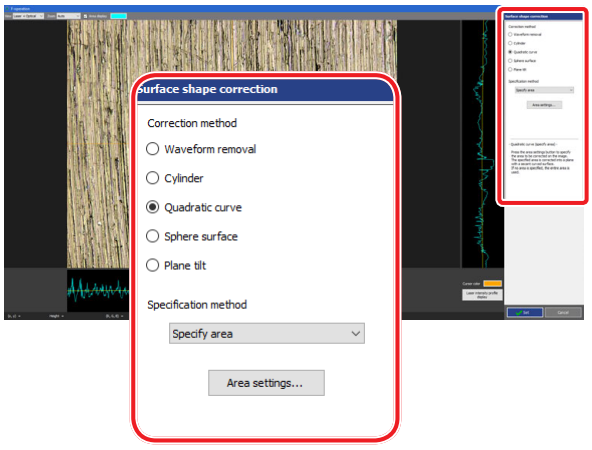
2. Select the filter setting value for [S-filter] of [Filter settings].



3. To remove the shape of curvature etc., select the [Enable] checkbox for [F-operation] of [Filter settings].

The [F-operation] window appears. Select the correction method, such as waveform removal.
For details of the correction method, see "VK-X3000 Series Multifile Analyzer Reference Manual, Chapter 5 Measurement Preprocessing".

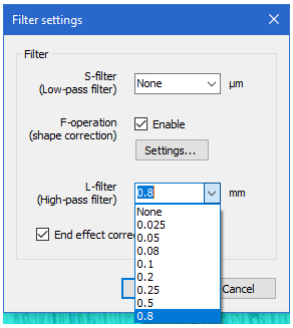




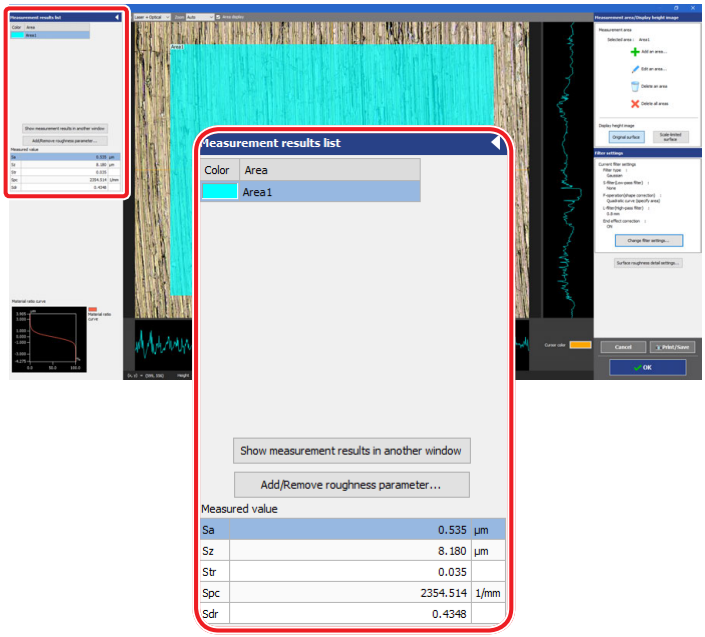
- **End effect correction**
  When Gaussian filter or Double gaussian filter is selected, selecting [End effect correction] checkbox can correct the circumference of the surface so it is not distorted.

- **S-filter**
  The ISO 25178 standard defines the S-filter setting value as a value that is at least three times of the XY calibration value.

4. **Select the filter setting value for [L-filter] of [Filter settings], and click the [OK] button.**



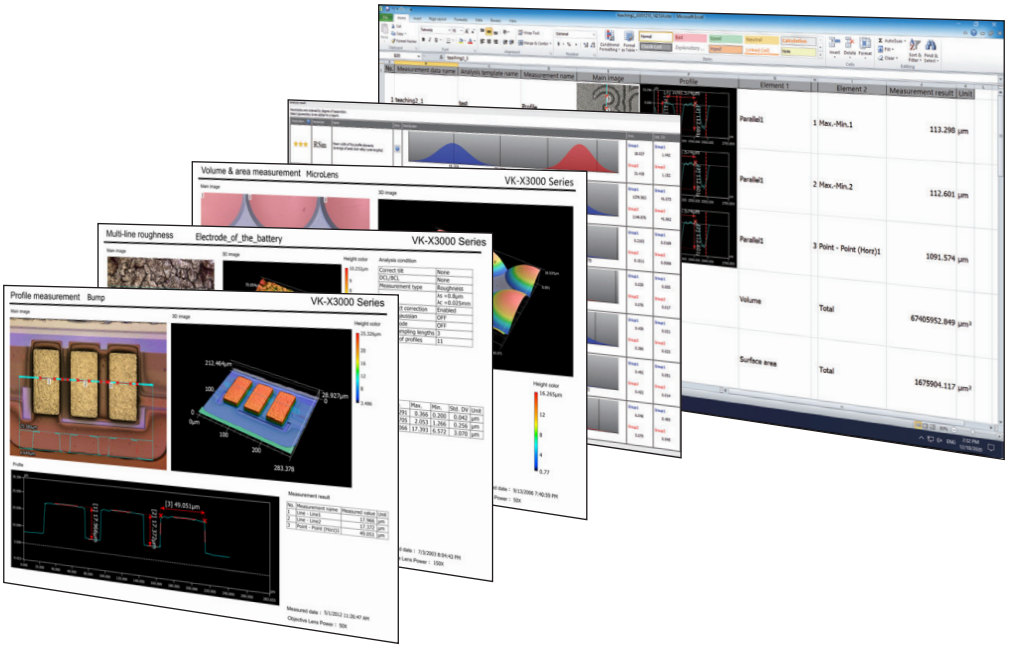
The measurement results will be displayed.



● **L-filter**
The ISO 25178 standard defines the L-filter setting value as a value that is five times of the cycle length of the waviness component you want to remove.

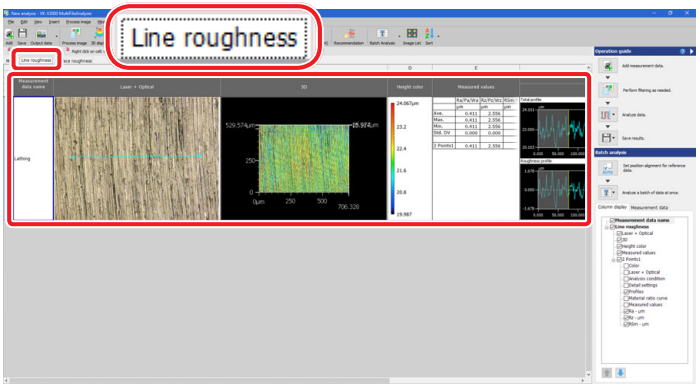
Chapter 4

Exporting Measurement Result



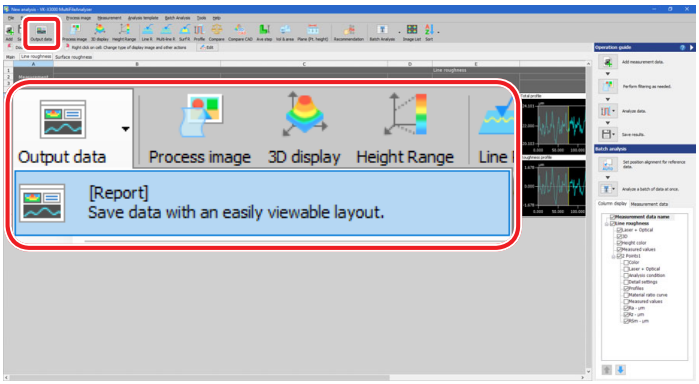
You can display a report of measurement results by the Multifile Analyzer in another window. For the report, its layout can be edited and file can be output.

1. Select the grid sheet including the measurement result you wish to display in report.

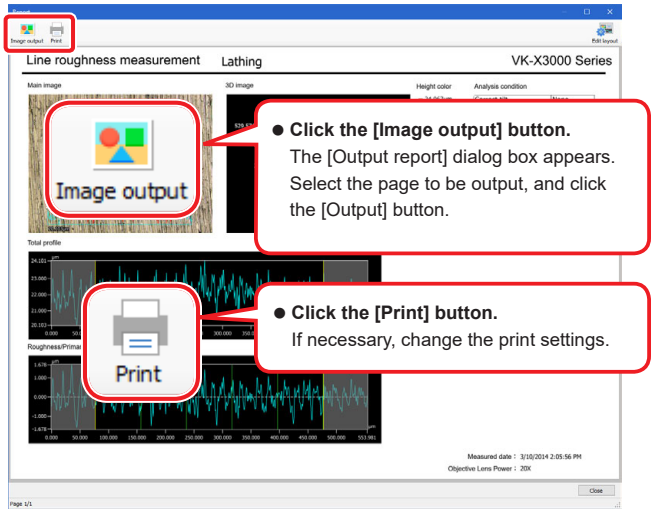


2. Select [Report] from the [Output data] button on the toolbar.

The report screen appears.



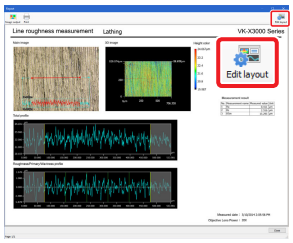
3. Save it as an image file by clicking the [Image output] button on the toolbar. Click the [Print] button to print.



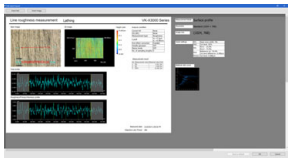
4. Click the [Close] button to close the screen.

● **Edit the report layout**

Clicking the [Edit layout] button displays the [Edit report layout] screen.



The report layout can be edited.



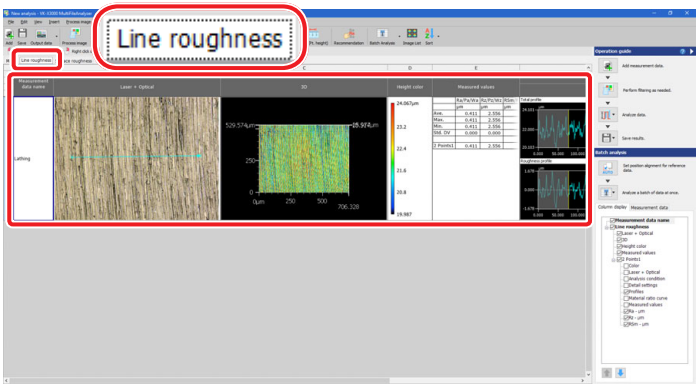
- Click the [Insert text] button to insert the text box.
- Select an image and right click it, a menu related to layout editing will appear.
- Click the [Insert image] button to insert the image.
- Click the [Back to default] button to return to default.

Exporting to Excel file

For the result measured by the Multifile Analyzer, the content of the grid view area is output to Excel file in unaltered form.

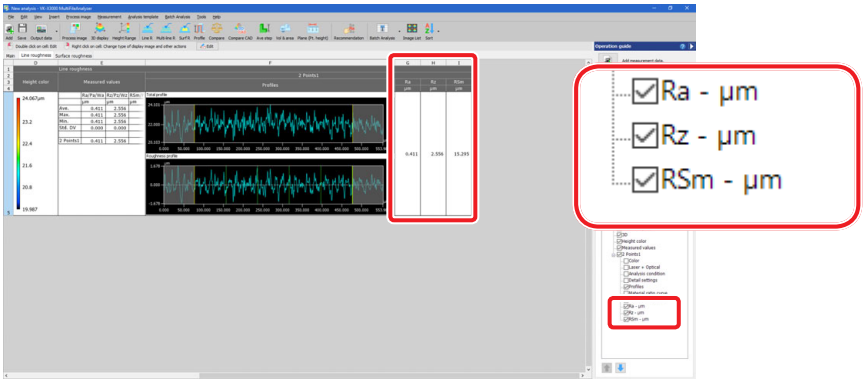
- The file is saved as an Excel workbook (*.xlsx). This extension is the standard file format for Excel 2007 and later.
- When you export to an Excel file, images, graphs, tables within cells and all other content of the grid sheet is output in unaltered form. Before performing the output, adjust the size of the grid sheet.

1. Select the grid sheet including the measurement result you wish to output in an Excel file.



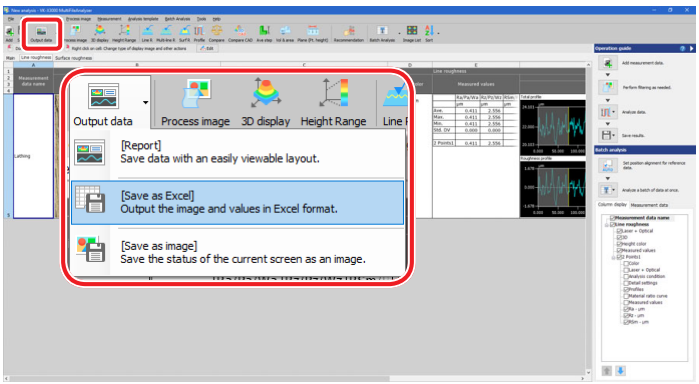
2. Select the measurement results you wish to output to cells in the Excel worksheet from the checkbox of the [Column display] tab.

Selecting the [Column display] tab adds the each result of the measurement items to each cell of the measurement results.



3. Select [Save Excel] from the [Output data] button on the toolbar.

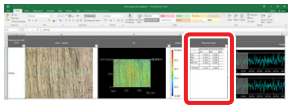
The [Save as Excel] dialog box appears.



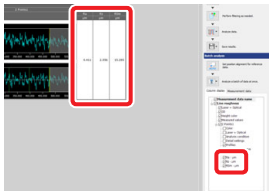
● **About the grid sheet layout and the cell of the Excel output**

The layout of the grid sheet is applied on the Excel sheet as it is.

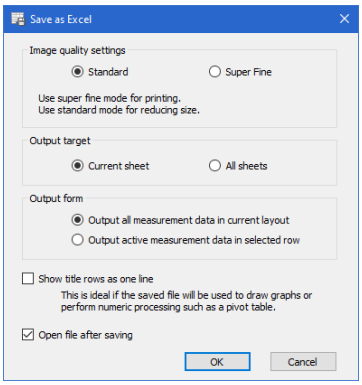
- The measurement results displayed in the [Measurement value list] checkbox of the [Column display] tab are output as images on the Excel sheet.



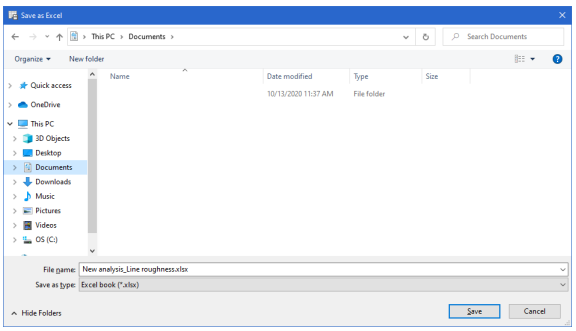
- The measurement results displayed individually in the [Column display] tab are output as numeric values to each cell on the Excel sheet.



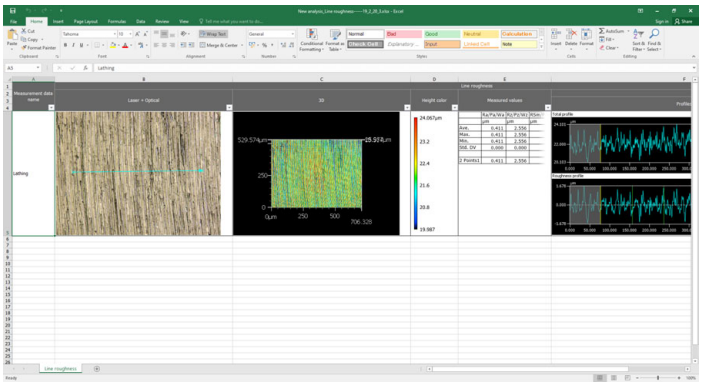
4. Change items as needed, and click [OK].



5. Select a destination folder in which to save the Excel file. Enter the file name, and click the [Save] button.



If Microsoft Office or Microsoft Excel is installed on your PC, the output file is displayed automatically.



Even if Microsoft Office or Microsoft Excel is not installed on your PC, the measurement results can be saved as an Excel format file.
In this case, use the output file with another PC.

- Microsoft Office, Microsoft Excel and Excel are registered trademarks of Microsoft Corporation.
- It is necessary to prepare Microsoft Office and Microsoft Excel separately when KEYENCE delivers the PC.

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Specifications are subject to change without notice.

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