OptiSense

EN Version 2.1

User manual
OS Manager

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1. OptiSense OS Manager License Agreement

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2. Introduction

The OS Manager is a PC software to control and operate Optisense PaintChecker coating thickness measurement devices via a graphical user interface. With the OS Manager and one of the supported PaintChecker devices, coating thickness measurements can be taken and visualized, and measurement data stored in the device can be saved on a PC. This simplifies data acquisition, analysis and archiving, reduces the risk of reading errors and allows measu-

rement data to be collected, structured and displayed in Microsoft Office or other third-party software.

The OS Manager is also used to identify and optimize the measurement parameters for special combinations of coating material and substrate and to store, load, transfer and organize these as so-called applications.

3. OptiSense Support

OptiSense will be happy to support you in working with the PaintChecker and OS Manager.

The Infothek on our website https://optisense.com/ has various explanation videos on how to use our products at your disposal. There you will also find the latest brochures, data sheets and success stories.

If you have any questions or suggestions, please contact our service hotline:

Phone +49 2364 50882-22 | Mon-Fri 8 am - 3 pm
Mail service@optisense.com

Or simply use our contact form at
https://optisense.com/en/contact.html

4. OS Manager Features

When connecting the PC running the OS Manager software to an OptiSense PaintChecker via a USB cable, the following functions are available:

• Coating thickness measurement and easy-to-read indication of the measured value on the PC

• Displaying the measured data as a line chart

• Indication and evaluation of setpoint and tolerance bands

• Statistical evaluation of a measurement batch

• Archiving and resuming of measurement batches

• Transfer of measurement batches between measuring device and PC

• Creating applications for special material combinations

5. Installation

This section describes how to install the OS Manager on a PC. It also applies if an older version of the software is to be updated.

5.1 System Requirements

5.1.1 Software

- Operating system: Windows 7 SP1, 8.1, 10 and higher in 32- or 64-bit version

- Runtime environment: Microsoft.NET Framework 4.0

- Offline data analysis: Microsoft Office Excel 2007 or higher

5.1.2 Hardware

- Processor: 1 GHz or faster, x86 or x64 architecture

- Display: 1280 × 960 or higher recommended

- RAM: min. 2 GB

- Hard disk space: min. 512 MB + space for data

- Interface: 1 x USB 2.0 or higher

5.2 OS Manager Installation

The OS Manager installation files can be found on the USB stick that comes with the PaintChecker. The latest version can also be downloaded from our Infothek at https://optisense.com/en/publications.html in the *Paint-Checker OS Manager Software* tab.

Important: Administrator rights are required to install the OS Manager.

First unzip the installation folder. Copy the *OSManagerInstall.exe* file to the PC desktop, right-click on the file and select *Extract All*. You will get a folder containing the OS-Manager *Install file*.

Start the installation by double-clicking on this file and confirm the Windows User Account Control notification. The rest of the installation process is performed automatically.

After installation is complete, the OS Manager can be found in the OptiSense program group of the Windows Start menu.

5.3 Update and Uninstall

The OS Manager can be removed from the PC using Windows settings. This operation should also be performed prior to updating an existing installation:

- Open *Settings* in the Windows start menu

- In *Apps* you will find a list of installed programs

- Click on OS Manager in the *list* and then *Uninstall*

- Confirm the uninstall and the Windows User Account Control notification.

An Installer window will open. By clicking *Remove all components* and *Next*, the OS Manager will be removed from the PC.

After finishing the uninstall process, a new OS Manager version can be installed.

6. Overview

6.1 File Types

6.1.1 Measurement batches (file extension .osm)

In the OS Manager, measured values are organized as measurement batches. A batch consists of a number of measurements with the coating thickness and the time of measurement as well as additional information such as the application used, job number, coating materials and properties.

Measurement batches can be imported from a PaintChecker measurement device or created with the OS Manager. The measurement view of the OS Manager features the graphical presentation and statistical evaluation of a measurement batch as well as the storage and archiving as a file on the PC. With the OS Manager, these files can be loaded, edited and continued at a later time.

6.1.2 Applications (file extension .opt)

The PaintChecker measuring systems use the non-contact photothermal measuring method to determine the thickness of coatings on a wide variety of substrates. The coating thickness is not measured directly, but calculated based on temperature behavior. Therefore, the individual thermal properties of coating material and substrate have to be taken into account. Similar to photography, it is important to adjust the strength of the light source and the measurement time to the respective situation in order to obtain accurate and reproducible measurement results.

Another aspect arises when measuring freshly applied powder or wet films. Here, it is not the actual thickness of the raw material that is to be measured, but rather the final thickness after baking or drying that is to be predicted. For this purpose, the instrument includes the expected coating material shrinkage during curing into the measurement.

These material properties of coating and substrate are combined into one data set – the application. The PaintChecker devices are already factory equipped with applications for particular combinations of substrates and coatings.

With the OS Manager, these applications can be loaded, archived, edited and stored on the device. Furthermore, you can also create completely new applications with the OS Manager.

6.2 Typical Usage

The OS Manager supports you in the typical workflows of quality assurance in a coating company:

- Saving and archiving of measurement batches from coating thickness measurement during production

- Measurement, graphical visualization and analysis of coating thicknesses in the QA laboratory

- Creation and optimization of measurement parameters (applications) for new substrate coating material combinations

Most users launch the OS Manager, connect a PaintChecker Mobile device, take measurements and analyze the displayed measurement batches.

Advanced users modify applications to optimally adapt the measuring system to a particular material combination or create a new application for previously unused coating materials and substrates.

6.3 Launching the OS Manager

The OS Manager is invoked via the OS Manager icon in the Optisense folder of the Windows Start menu.

For quick access to the OS Manager, you can right-click the icon to pin it to the Windows taskbar.
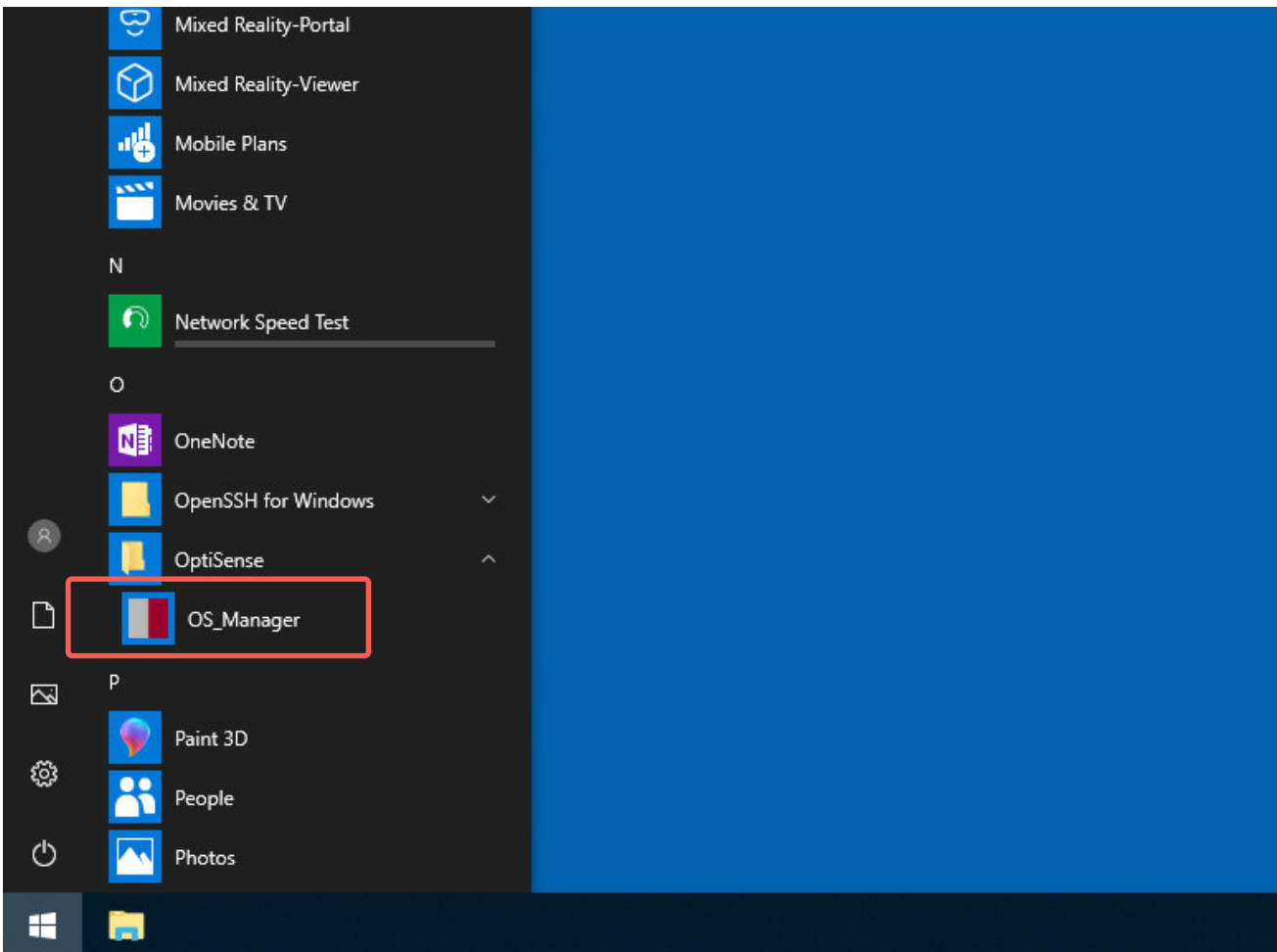

Figure 1: The OS Manager is invoked via the Optisense folder in the Windows Start menu

6.4 User Interface

When started, the OS Manager opens the measurement view. The interface is divided into four areas:

Menu bar (1)

The menu bar contains the menu items familiar from Windows programs. Here you can create a new measurement batch, load and save measurement batches and applications and import them from the PaintChecker device.

Various editing functions are available to delete measurement points and copy them for use in other programs. The menu bar can also be used for settings basic software properties and for switching between the measurement view and the application view.

Statistics pane (2)

The statistics pane displays statistical parameters of the measurement batch shown in the diagram pane (3). Here you also define the tolerance limits that will be displayed in the diagram pane and used in the calculation of the statistical parameters. By entering a time interval, only certain sections of a measurement batch are displayed and used for calculation.

Diagram pane (3)

In the diagram pane, the measured values are displayed as a line chart. Tolerance limits entered in the statistics pane are highlighted in color. Zoom and pan features enable convenient navigation with the mouse. Measurements can be selected, copied and deleted by simple mouse click.

Measurement pane (4)

In the measurement pane, measurements are taken and the measurement results are displayed numerically. Here you can also select the application used for measuring and, in case of multi-sensor instruments, select the desired measuring head. Multiple measurements support the automatic recording of measurement batches in an adjustable time grid.

6.5 Language and Design Settings

As one of the first steps after the installation, you can set the language and design of the OS Manager user interface in the Settings menu. German and English language versions are available, as well as a dark and a light user interface design. You can change the language and design later at any time.

Figure 2: The user interface is split into four panes

7. Measuring with the OS Manager

One of the most common OS Manager applications is the interactive measurement and recording of coating thickness with a PaintChecker Mobile.

7.1 Measurement View

Interactive measurements are performed in the mea-

surement view. To switch to measurement view, click the Measurement View selection in the View menu.

As long as no PaintChecker is connected and no measurements are available, most of the controls are inactive (grayed).
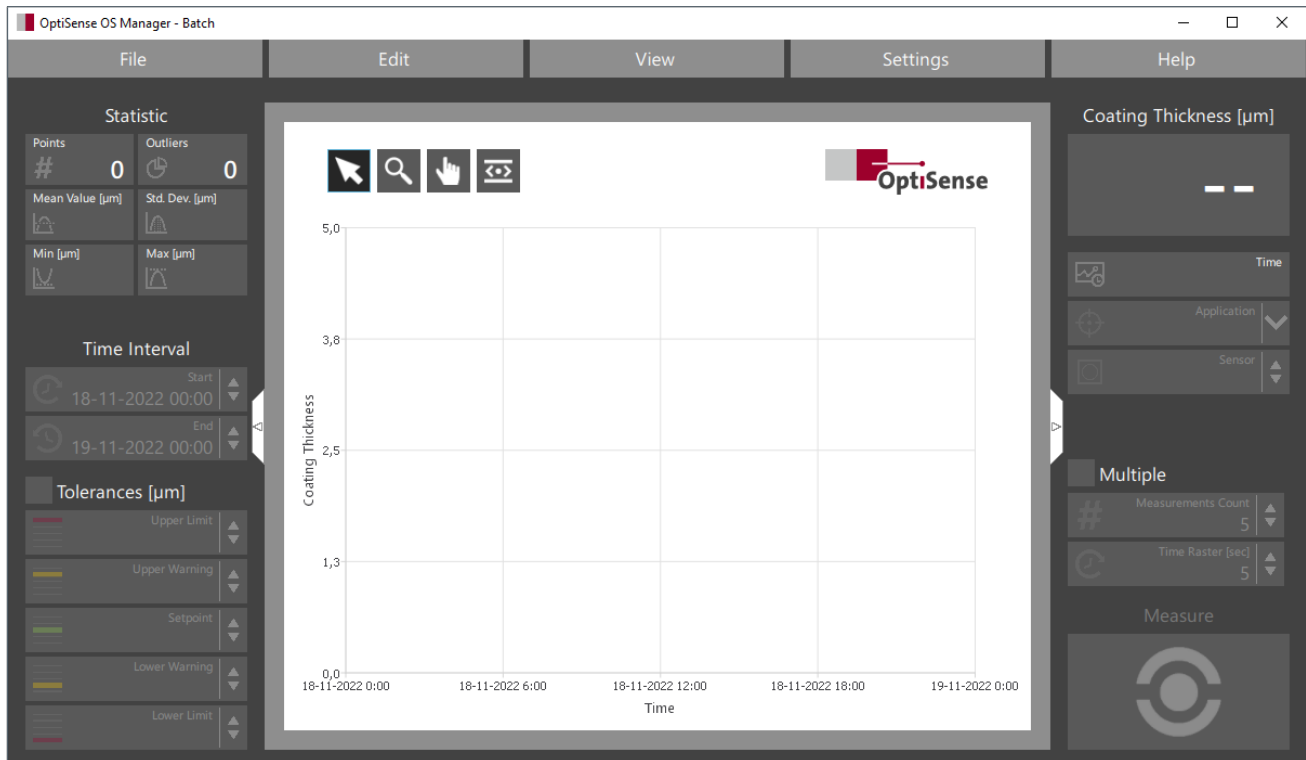

Figure 3: Interactive measurements are performed in the measurement view

7.2 Connecting the PaintChecker

For interactive measurements, connect the Paint Checker Mobile to a USB port of the PC via the supplied cable and switch on the device.

As soon as the PaintChecker is detected, the measurement button changes from grayed to active and the OS Manager is ready to measure the coating thickness.

7.3 Measuring Coating Thickness

7.3.1 Selecting the application

After connecting the PaintChecker, an application suitable for the measuring task needs to be selected. Clicking on the Application selection control opens a drop down menu with the applications available on the connected PaintChecker. The Cured application is suitable, e.g. for measurements on powder coatings
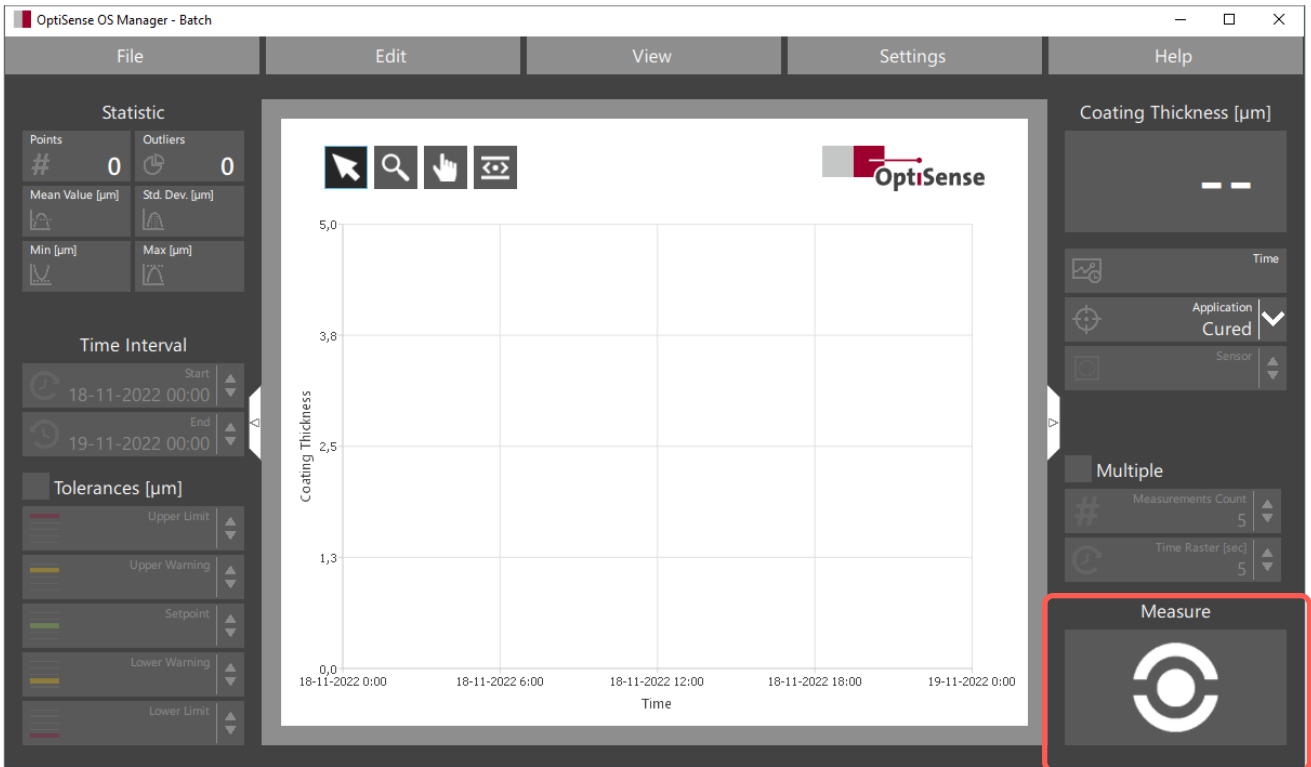
Figure 4: The OS Manager is ready to measure the coating thickness

after baking. All values of a measurement batch have to be measured with the same application. Therefore, the application can no longer be changed after the first measurement has been taken and becomes grayed. When loading a measurement batch file, the application previously used for this batch is automatically selected.
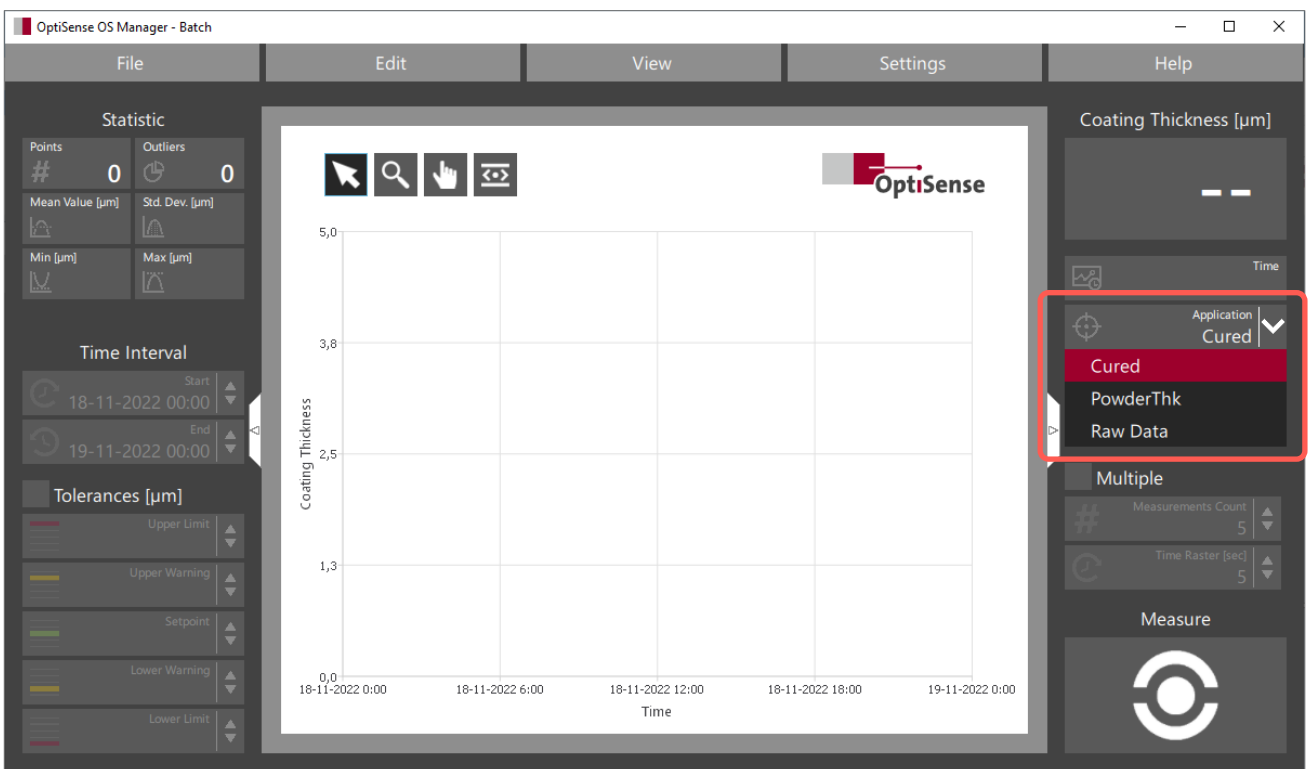

Figure 5: Selecting the application on the connected PaintChecker

7.4 Single Measurements

After choosing an appropriate application, a click on the measurement button starts the measurement. The measuring process is similar to manual measurement with the PaintChecker Controller:

- Aim the sensor at the target

- Align the three lights of the sight at the desired measuring spot

- Start the measurement by clicking on the *measure button*

As an alternative to clicking on the measure button, pressing the *space bar* on the PC keyboard also triggers a measurement. This simplifies handling when the view is directed to sensor and part during the measurement process.

7.5 Multiple Measurements

Series measurements on several parts or the recording of a measurement grid are supported by the multiple measurement mode. An adjustable number of measurements is performed automatically at a selectable time interval. During multiple measurement, the measuring head can be manually guided from part to part or point to point with one measurement taken at a time.

Multiple measurement is activated by checking the box. Select the number of measurements and the time interval between two measurements in the two corresponding controls.

Click on the measurement button (or press the space bar) to start multiple measurement. After recording the specified number of measurements, it stops automatically.

Clicking the measurement button again starts another multiple measurement. To cancel an ongoing multiple measurement prematurely, remove the check mark in the Multiple measurement box.
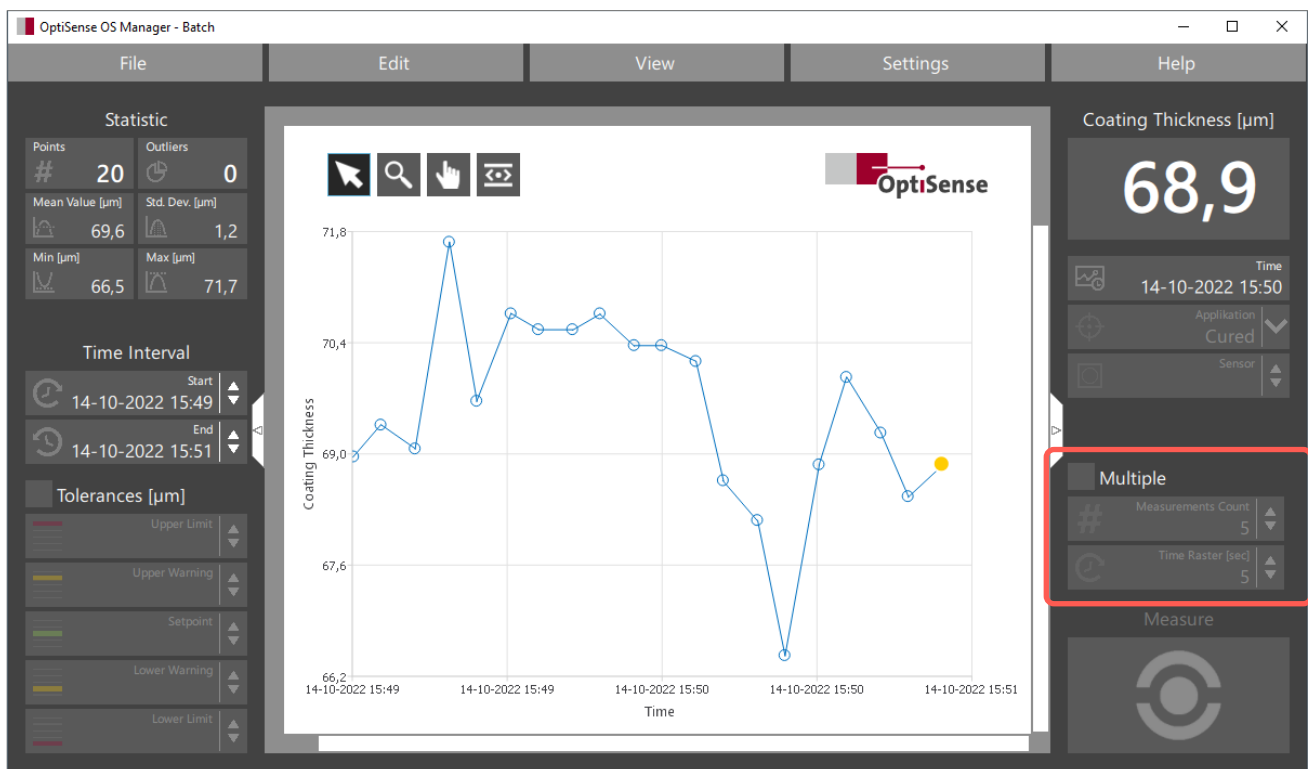

Figure 6: Multiple measurement is activated by checking the box

7.6 Statistics Features

The statistics pane contains the statistical parameters of the measurement batch. The data refers to the measuring points selected in the chart. If no measuring point or only one measuring point is selected (marked yellow), all measuring points are used for the statistics calculation. If two or more measuring points are selected (see 7.13), only the selected measuring points are included in the calculation. The parameters displayed have the following meaning:

Term	Meaning
Number of measurements	The number of measurement points used for statistical calculation
Out of tolerance	The number of measuring points exceeding the upper or lower error limits (see Tolerances)
Mean value	The arithmetic mean of the measuring points
Standard deviation	The variation of the measuring points around the mean value
Min	The measuring point with the least coating thickness
Max	The measuring point with the largest coating thickness

7.7 Tolerances

For easy detection of scrap parts, you can add tolerance limits to the chart. The tolerance limits are activated by ticking the Tolerances checkbox. They have the following meaning:

Tolerance limit	Meaning
Upper limit	If the coating thickness exceeds this value, the Outliers statistics control is increased by one
Upper warning	The coating thickness is critical. The application quantity is at the upper limit
Setpoint	The nominal value of the coating thickness
Lower warning	The coating thickness is critical. The application quantity is at the lower limit
Lower limit	If the coating thickness falls below this value, the Outliers statistics control is increased by one

The values of the tolerance limits must be in valid order, i.e.

Upper limit ≥ Upper warning ≥ Setpoint ≥ Lower warning ≥ Lower limit

Invalid error limits (e.g. upper warning limit higher than upper error limit) are not displayed in the chart and are marked red in the input control.

It is not necessary to enter all limit values. Only the limits whose input controls contain a value are displayed in the chart and taken into account in the statistical evaluation. Empty input controls are ignored.

Thus, for example, you can display only the reference line or only a lower error limit in the diagram pane.
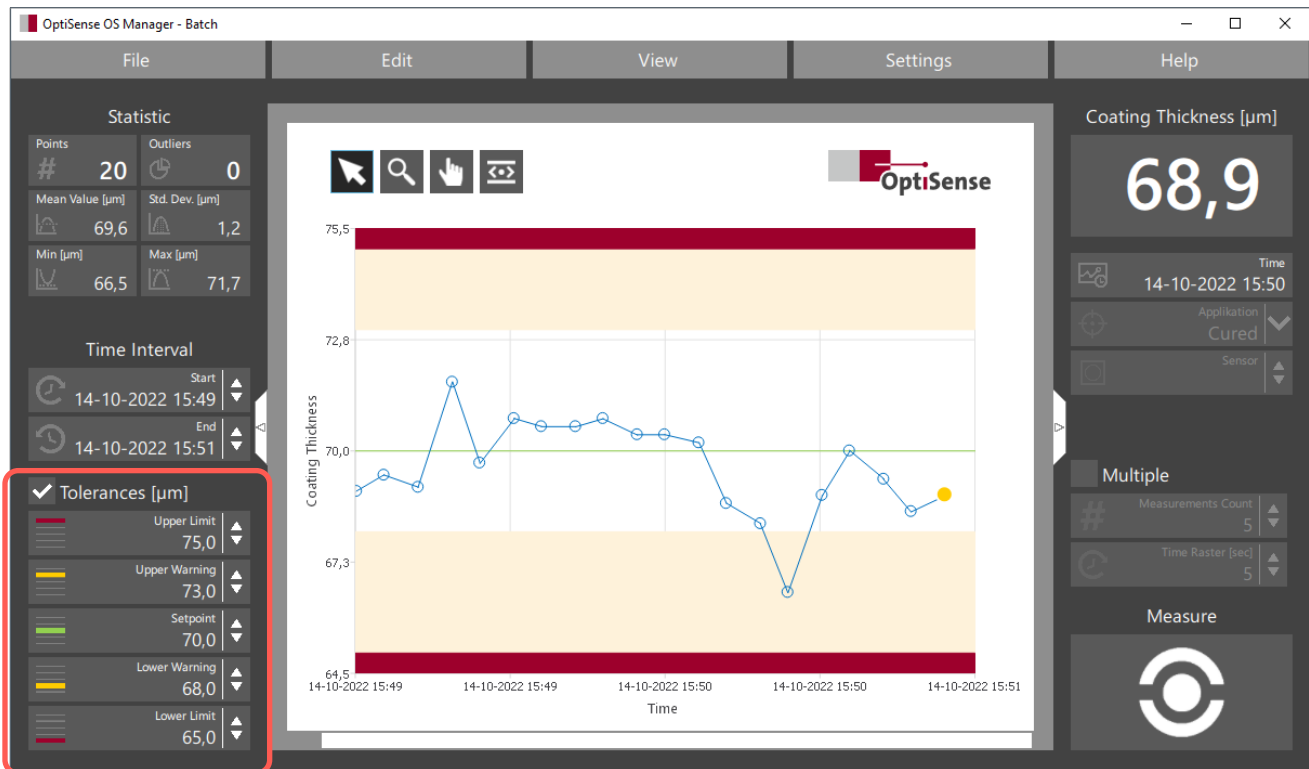
Figure 7: Tolerance limits can be displayed for easy detection of scrap parts

7.8 Selecting the Sensor

For PaintChecker systems with several sensors – e.g. the PaintChecker Industrial Multi –one of the connected sensors needs to be selected before taking measurements. This is done via the input control Sensor. For devices with only one sensor, the selection is made automatically and the control remains grayed.

7.9 The Line Chart

The values of a measurement batch are displayed in the diagram pane as a line chart connecting the measurement points. Date and time of the measurement is plotted on the X-axis and the coating thickness on the Y-axis. Each measurement adds another point to the line chart at the right end.

Figure 8: Navigation tools and scroll bars

7.10 Zoom/Pan

For more detailed investigations, the line chart of the measurement batch can be enlarged (zoom) and moved (pan). First select the appropriate tool by clicking with the left mouse button - the magnifying glass to zoom and the hand to move the chart.

To zoom into the chart, hold down the Shift key and click with the left mouse button into the chart. Left-clicking without holding down the Shift key zooms out again.

Move the mouse with the left button pressed to select a zoom area or to move the chart. Alternatively, the chart can also be moved with the mouse wheel or via the scroll bars of the diagram pane.

Double-clicking the Zoom or Pan tool resets the line chart view so that all points of the measurement batch are visible.

7.11 Selecting a Time Interval

In case of large measurement batches or if a measurement batch is continued after a longer period of time, the chart sometimes appears crowded or with large gaps between the points. In such cases, you can determine the section of the measurement batch to be displayed by specifying a time interval.

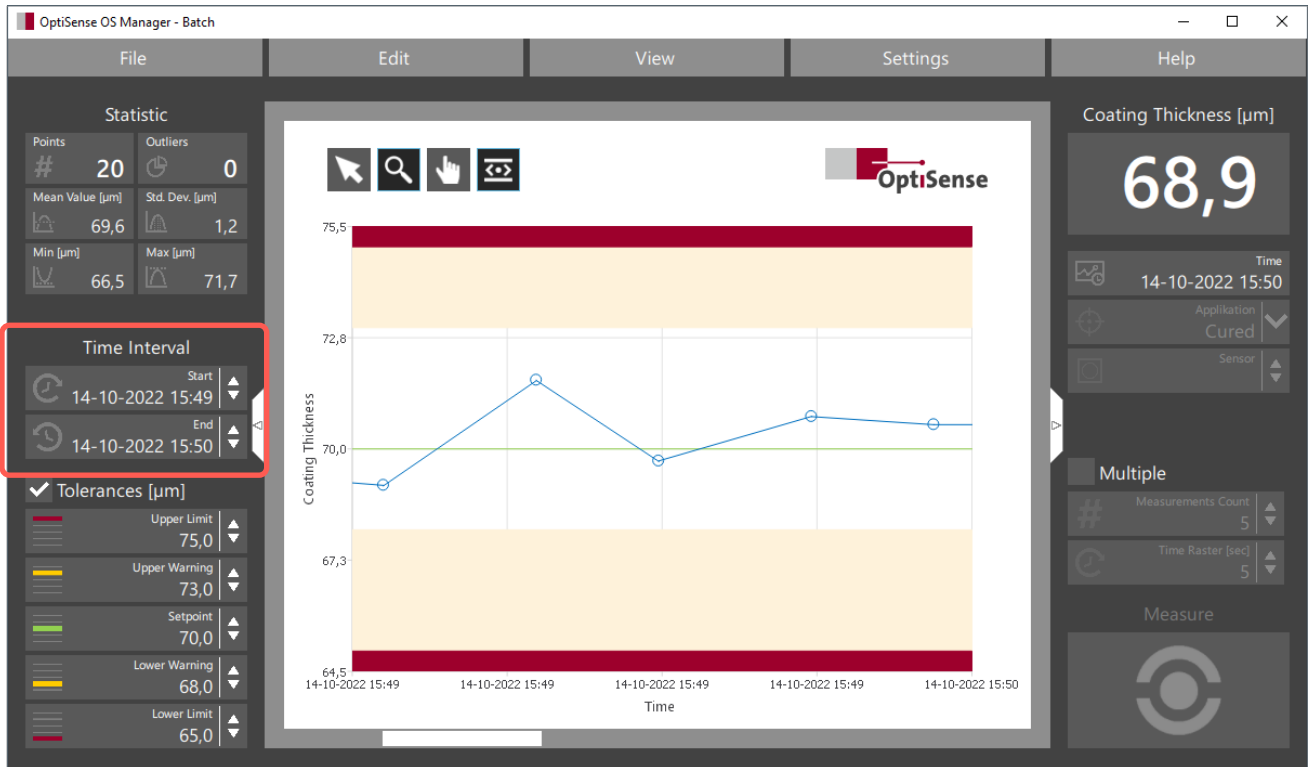*Figure 9: The part of the measurement batch to be displayed can be determined by entering a time interval*

This is convenient if you e.g. want to view the values of a particular shift from a measurement batch that extends over several days. To do this, enter the beginning and end of the shift as date and time in the time interval controls, and you will get the measurement points of this shift in the diagram pane.

7.12 Fixing

The *Fixing tool* freezes the Y-axis in such a way that the tolerance limits and all measurement points always remain visible, even when zooming and panning. The line chart can only be enlarged and moved in the X direction while fixing is active.

Figure 10: The Fixing tool is used to freeze the Y-axis

7.13 Selecting Measurement Points

With the Select tool you can select single measuring points or ranges of measuring points to delete them or to copy them to the Windows clipboard.

Selected measurement points are displayed in yellow in the chart. The following selection options are available:

Term	Meaning
Clicking on an empty area	The selection is canceled
Clicking on a point	The selection is canceled and only this point is selected
Clicking on a point with the Shift key pressed	The selection of the point is reversed. A previously unselected point is added to the selection, a previously selected point is removed from the selection
Dragging	The existing selection is canceled and all points in the dragging area are selected
Dragging with the Shift key pressed	The selection of all points in the dragging area is reversed. Previously unselected points are added to the selection, previously selected points are removed from the selection

Figure 11: Selected measuring points are marked in yellow

7.14 Displaying Measured Values

By selecting measuring points, you can determine the measured values of individual points or the statistics of a subset of points. If only a single point is selected, the coating thickness and the time of measurement are displayed in the measurement pane. If several points are selected, the statistical parameters of this subset of points are displayed in the statistics pane.

7.15 Copy/Delete Measurement Points

In the *Edit menu* you can cut or copy the selected (yellow marked) points to the Windows clipboard or delete them from the measurement batch. The measurement value and time of the points in the clipboard can be copied to other programs, e.g. Microsoft Office, using the common Windows *paste* functions.
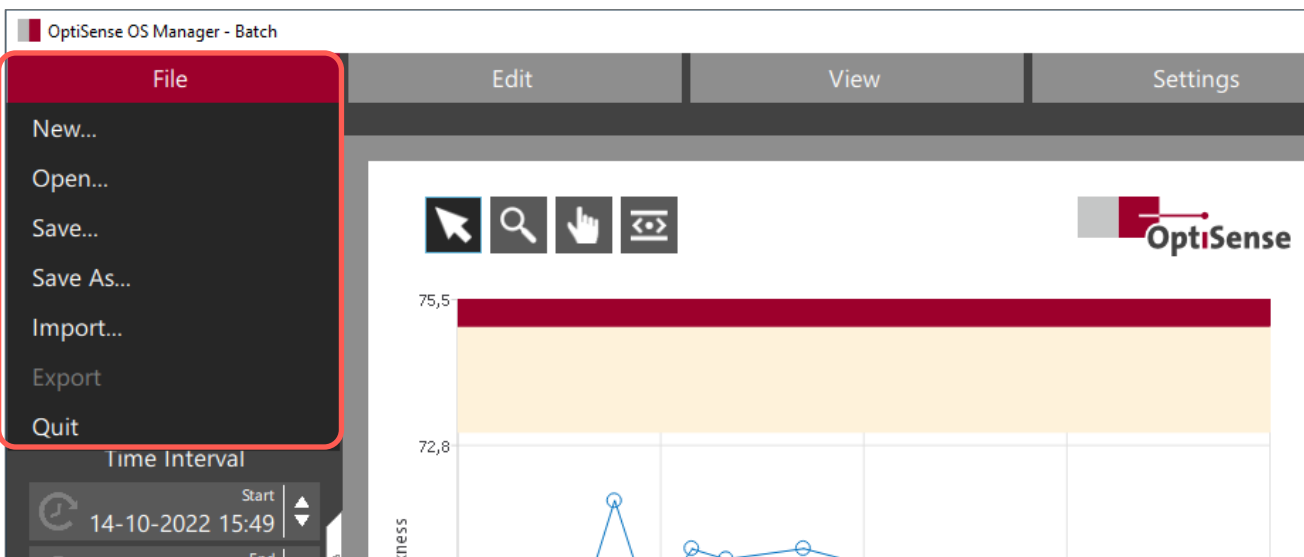

Figure 12: The File menu *is used to organize measurement batches*

7.16 Managing Measurement Batches

The OS Manager combines the coating thickness measurement points in the line chart, the application used to measure these points and other properties of the measurement in a measurement batch. The File menu is used to organize the measurement batches in the PaintChecker device and on the PC.

7.17 Creating a new Measurement Batch

File/New creates a new, empty measurement batch. Any existing measuring points and tolerance limits in the chart are discarded and the measurement settings are reset to the default state.

Immediately after creating a new batch, it is necessary to select the application to be used, as this cannot be changed after the first measurement has been taken (all points of a batch must be measured with the same application).

7.18 Saving and Loading Files

Measurement batches can be saved as files on the PC for archiving or later continuation. By default, the binary OSM format with the .osm file extension is used. Saving the batch is performed with the usual Windows *File/Save* or *File/Save As functions.*

With *File/Open,* files in OSM format can be loaded into the OS Manager at a later time, e.g. to continue a batch or to analyze it in detail. Like most Windows programs, OS Manager uses the Windows Explorer for file operations. All Explorer functions such as file search or creating new folders are thus also available in the OS Manager in the usual way.

As an alternative to the OSM format, batches can also be saved in the widely used CSV format in order to further process the measurement data with e.g. Microsoft Excel. However, batches saved in CSV format cannot be reloaded into the OS Manager.

7.19 Importing Batches from the PaintChecker

The PaintChecker Mobile devices can record measurement batches stand alone without connection to a PC. This allows the coating staff to take measurements directly at the line, which are stored as batches internally in the device.

With the *File/Import* menu, these stored batches can be imported into the OS Manager in order to either visualize and edit them or to simply archive them as OSM file on the PC.
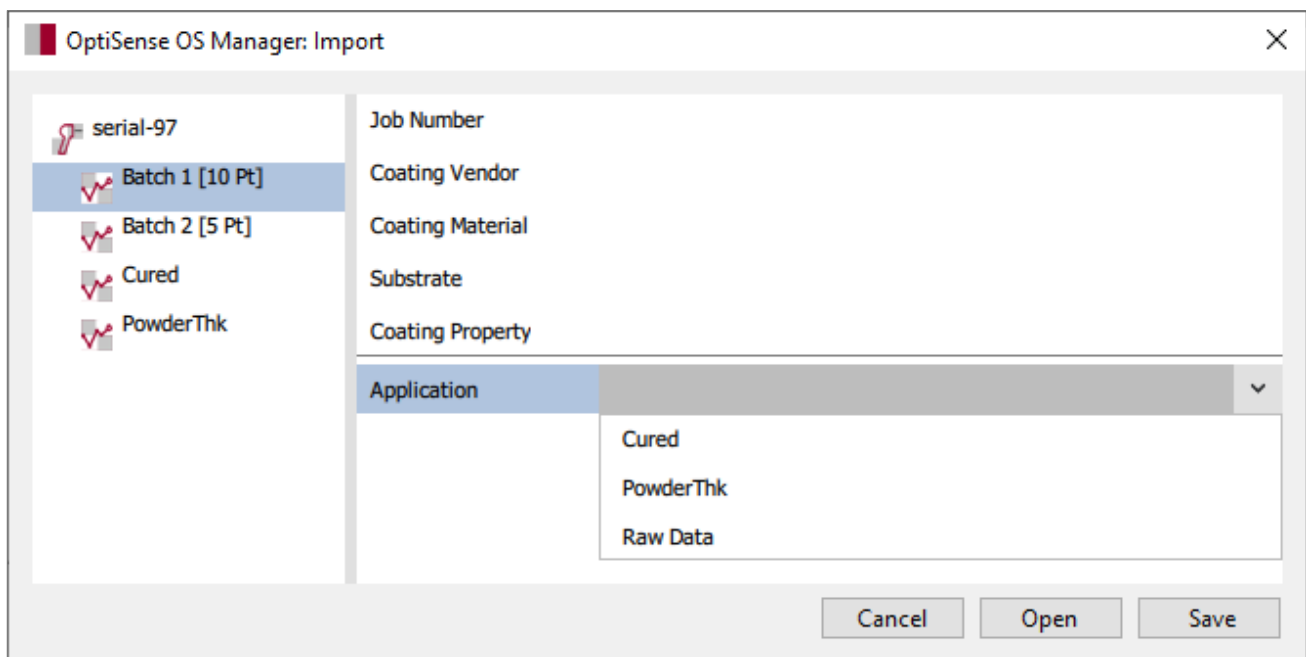

Figure 13: With File/Import*, stored measurement batches can be transferred from the PaintChecker*

The measurement batches stored on the Paint-Checker appear in the *File/Import* dialog under the name *Batch* with consecutive numbers. In this example, two measurement batches (Batch 1 and Batch 2) are available on the device, containing 10 and 5 measurement points, respectively.

Measurement batches always bear the designation Batch supplemented by the number of measurement points contained. All other items are not batches but applications that can be processed with the OS Manager in application view (see section Applications).

After choosing one or (with the Shift key held down) several batches with the left mouse button for import, the application used to create these batches must first be specified.

Furthermore, additional information such as manufacturing or material data or special properties of the coating can be optionally entered. Currently the OS Manager stores these properties in the .OSM file for archiving and documentation purposes only. It does not evaluate it in any way.

With *Save*, all selected measurement batches are saved as OSM files on the PC. The Windows Explorer thereby provides the usual file operations.

Open loads a measurement batch from the device into the OS Manager where it can be visualized and edited like any other batch.

Selected batches can be deleted from the device via the context menu (right mouse button). However, at least one empty batch always remains on the device, which cannot be deleted.

7.20 Adding Properties
The PaintChecker Mobile devices from OptiSense use the photothermal method for coating thickness measurement. This is a contactless measurement method for paints, powder coatings and glazes on metallic and non-metallic substrates. The different thermal properties of coating and substrate are used to determine the coating thickness.

Figure 14: Additional information such as production or material data can be entered under Properties

8. Creating Applications

8.1 Overview

The PaintChecker Mobile devices from OptiSense use the photothermal method for coating thickness measurement. This is a contactless measurement method for paints, powder coatings and glazes on metallic and non-metallic substrates. The different thermal properties of coating and substrate are used to determine the coating thickness.
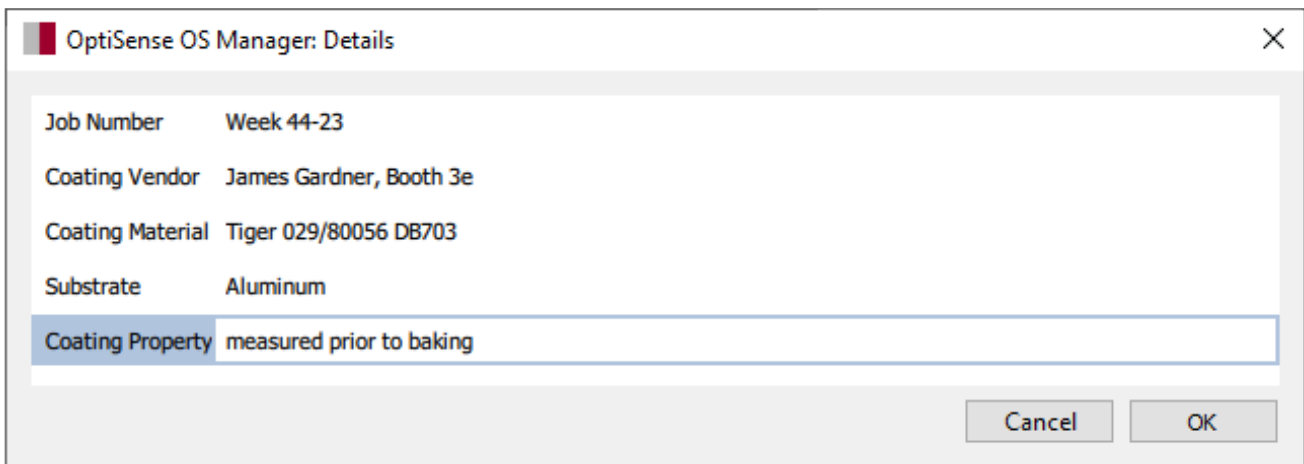
8.1.1 The photothermal method

The surface of the coating is warmed up by a few degrees with a short, intense light pulse and then cools down again by dissipating the heat into deeper areas. The thinner the coating, the faster the temperature drops. The temperature curve over time is recorded with a highly sensitive infrared sensor and converted into the coating thickness.

The measurement is carried out without contact from a distance of several centimetres. This means that wet and sticky coatings can be measured just as easily as soft and sensitive surfaces.

As with other non-destructive coating thickness measurement methods, e.g. ultrasonic, eddy current or induction, photothermal coating thickness is not measured directly, but calculated from measurement signals. It is therefore important to consider the individual thermal properties of the coating material and the substrate.

8.1.2 Material specific application

Thick, heavy coatings need more energy to heat up and cool down more slowly than thin, light coatings. During the measuring process, it is therefore important, as in photography, that the strength of the light source and the measuring time are optimally adjusted to the respective situation, in order to obtain accurate and reproducible measurement results.

in case of powder coatings and paintwork, the user often does not want to know the thickness of the powder or wet film that has just been applied, but the later, final thickness after baking or drying. To achieve this, the device must take into account the expected shrinkage of the coating material during curing.

Optimum power level, measurement time and number of measurement cycles as well as the correlation between thermal behavior and thickness of the coating are compiled in so-called applications.

Included with the PaintChecker devices are several applications for standard situations that cover a wide range of typical applications.
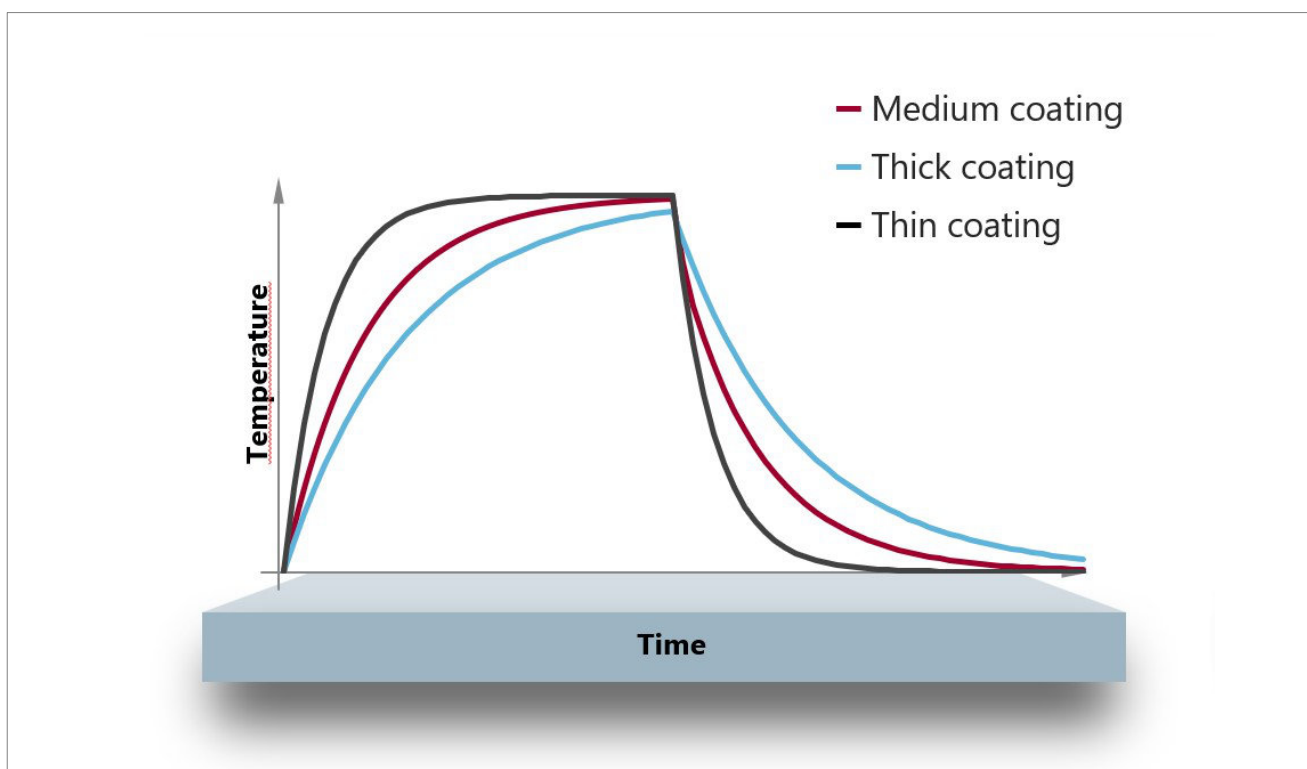

Figure 15: The photothermal method

8.2 Application View

The OS Manager application view is used edit existing applications or create completely new applications. To enter application view, click in the *View / Application View* menu.

Menu Bar (1)

Here you can create new applications, load an existing application, save it, import it from a PaintChecker Mobile and export it to the device. Grid points of the
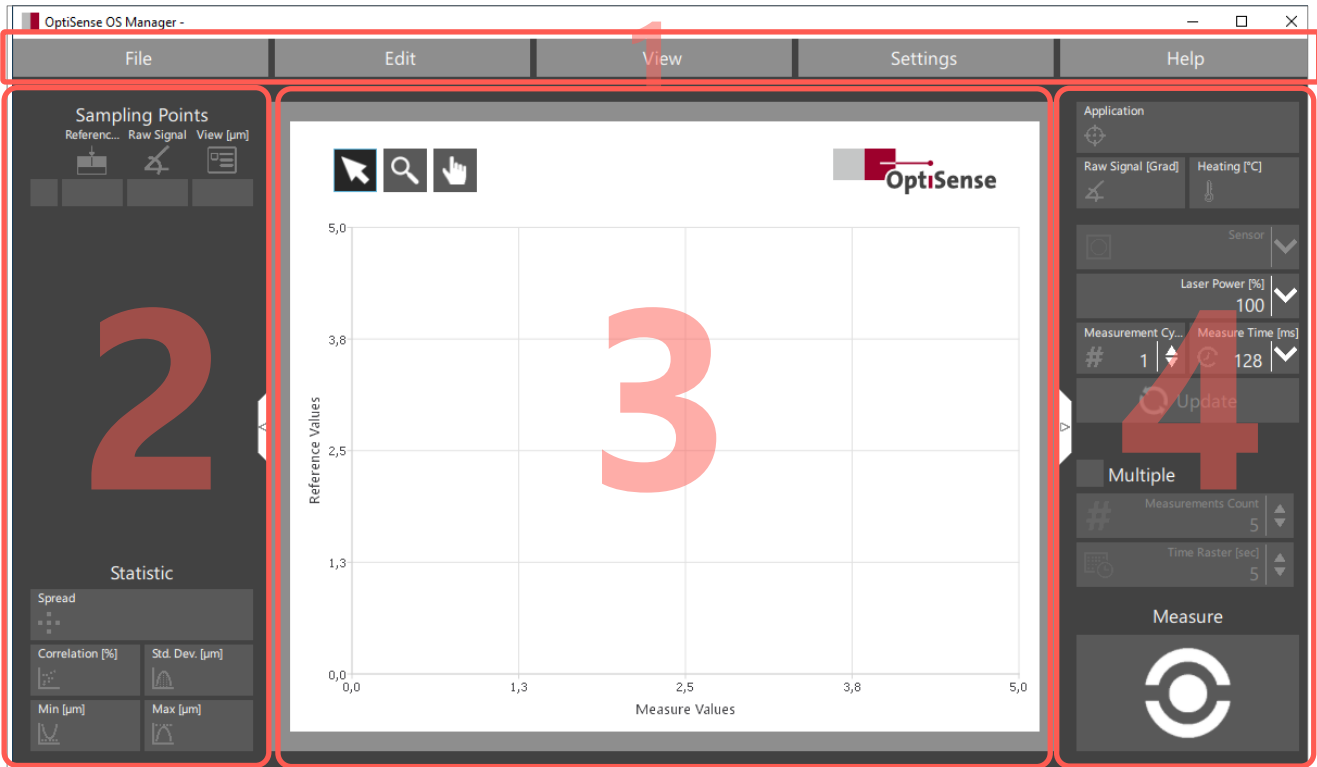

Figure 16: The OS Manager application view

Creating an application is a multi-step process. First, the basic parameters of the photothermal measurement system have to be set so that it provides reproducible and well-distinguishable raw signals at different coating thicknesses while heating the parts sufficiently but not excessively.

In the next step, actual coating thickness values are assigned to the raw signals. This is done in the form of grid points, which are pairs of raw signal (measured value) and the associated coating thickness. The OS Manager then calculates an application curve that approximates these grid points as close as possible.

Finally, measurement parameters and application curve are combined into an application and transferred to the PaintChecker measurement device. The Paint-Checker uses this application to calculate all intermediate values of the coating thickness between the grid points.

This multi-step process is supported by the four panes of the application view:

application can be deleted via the menu bar and copied for use in other programs.

Grid point pane (2)

The relationship between the photothermal measurement signal (raw signal) and the actual coating thickness is determined by an application curve. This application curve is based on a series of grid points measured with different material samples. The grid point pane is used to create and organize such grid points. A statistical evaluation assesses the quality (scattering width) of the grid points and provides information on how well the number and distribution of the grid points are suitable for the targeted coating thickness measurement range.

Diagram pane (3)

In the diagram pane, the grid points are displayed in an X-Y diagram. A horizontal line passes through each point, whose length represents the standard deviation of the grid point. If at least two grid points are available, the OS Manager calculates an application

curve that optimally connects the grid points with each other. Zoom and pan features support convenient navigation with the mouse. Grid points can be selected, copied and deleted with a mouse click.

Parameter pane (4)

This is where the basic photothermal measurement parameters are set. Laser power, measure time and measurement cycles should be adjusted in such a way that adequate heating is achieved in the intended coating thickness range and a well distinguishable raw signal is measured for different coating thickness values.

8.3 Opening an Application

New applications are created in the menu bar with *File/New*.

Alternatively, existing applications can be loaded into the OS Manager with *File/Open* from PC or with *File/Import* from a PaintChecker Mobile device.

After creating a new application or loading an existing one, first enter a name in the Application field in the parameter pane. This is the name under which the new application will later appear in the PaintChecker measuring device. The application name *Remote* is reserved internally in the system and cannot be used.
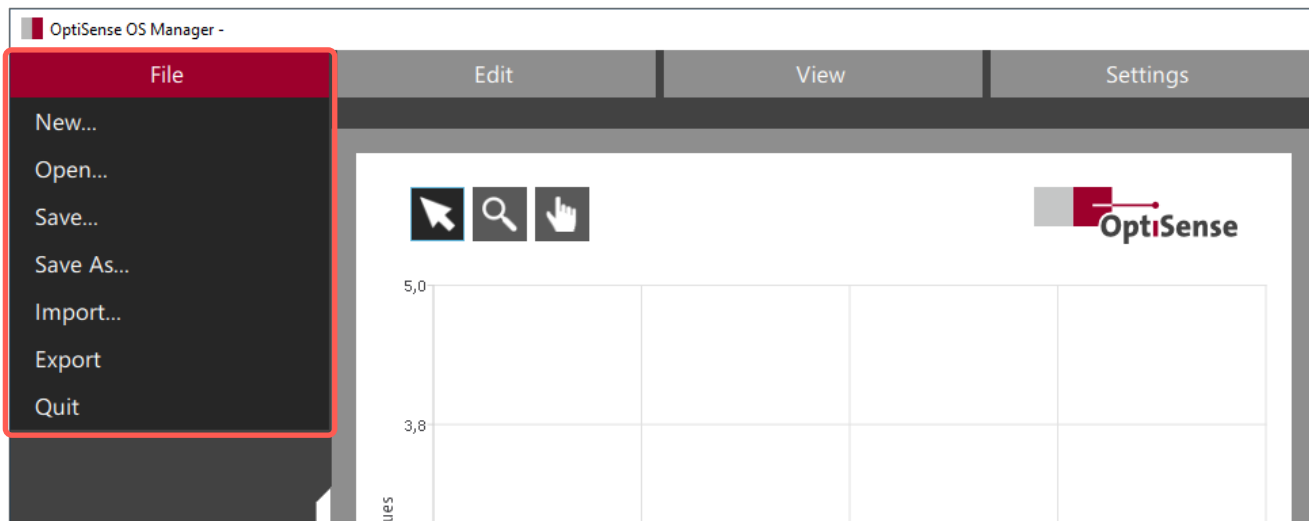

Figure 17: New applications can be created in the menu bar with File/New

8.4 Adjusting the Measurement Parameters

The next step is to set suitable parameters for the photothermal measurement system. The aim is to the excitation power, check the surface of the part for damage after each measurement and reduce the excitation power if there are visible material changes.
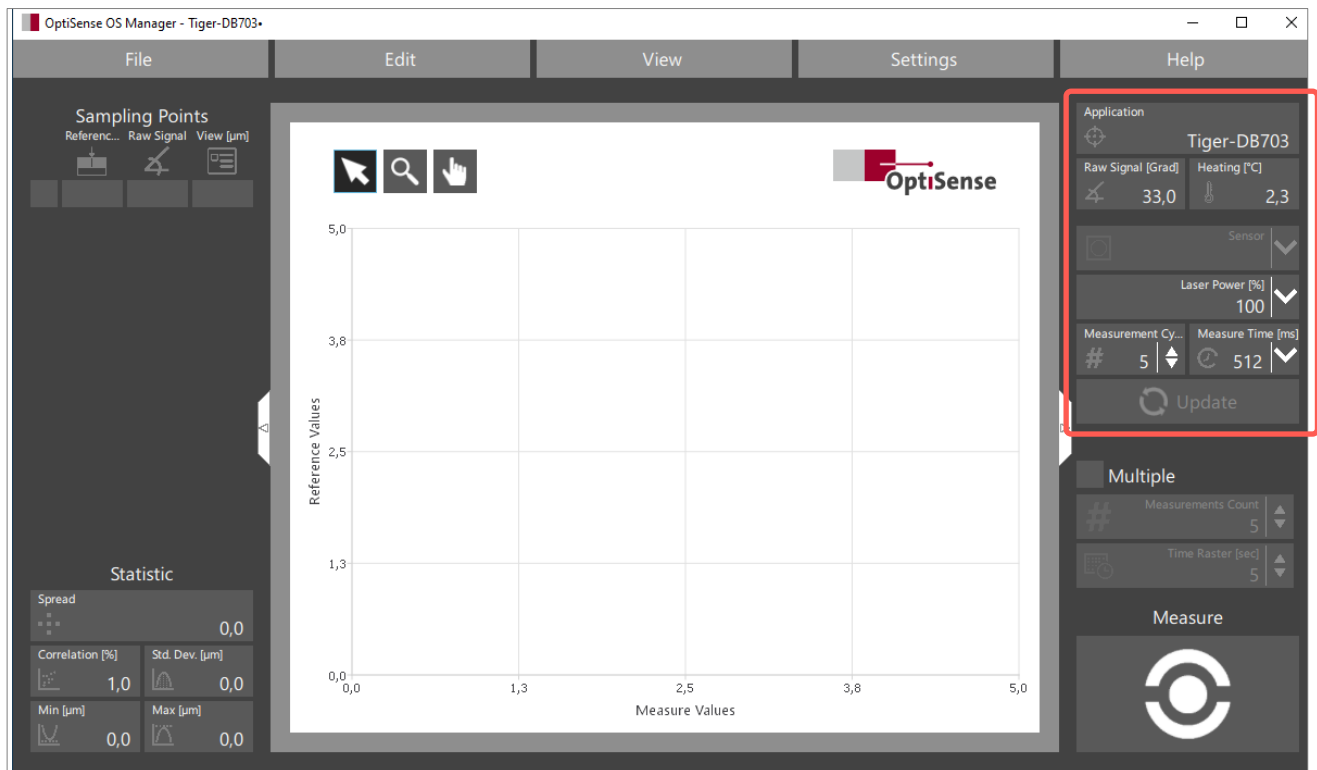

Figure 18: Suitable parameters for the photothermal measuring system are set here

obtain well distinguishable raw signal values for different coating thicknesses without overheating the samples. Enter suitable initial values for laser power, measurement cycles and measure time first. The values shown are well suited as starting points for most coatings. However, for temperature-sensitive samples, you should begin with reduced laser power.

Then transfer the parameters to the PaintChecker device by clicking Update.

8.4.1 Excitation power

The excitation power is the intensity of the light source heating the part in the focal point of the measuring system. The first generation of photothermal measuring instruments used a laser for excitation. Therefore, the excitation power is called laser power; even if the excitation source is not a laser.

For stable, reproducible results, the power should be selected in such a way that the highest possible temperature rise is achieved without damaging the coating. Dark coating surfaces in particular can already overheat at moderate excitation power. When setting

8.4.2 Measurement time

The measurement time is the period of time during which the temperature curve of the part is recorded after excitation and used to calculate the coating thickness. Thick, heavy coatings react slower than thin, light coatings and therefore require a longer measurement time. A suitable compromise between accuracy and measurement duration has to be found for the particular application, depending on the required measurement accuracy and the time available between two measurements.

8.4.3 Measurement cycles

You can use the Measurement cycles control to specify whether the time span entered in the Measure time control is used for one long measurement or whether the PaintChecker takes several short measurements and then averages the results.

E.g. if a number of 5 measurements is entered for a measuring time of 512 ms, the Paint Checker performs 5 measurements over 102.5 ms each and then calculates the average. The optimum number of measurements depends on the type of coating surface.

8.5 Finding suitable Measurement Parameters

8.5.1 Sample selection

To create or optimize an application, at least two samples with different coating thicknesses are required. These samples must match both the coating (type of paint, pretreatment) and the substrate (material, thickness) of the series parts to be measured later. Ideally, you take some parts from the ongoing production for this purpose. Use a reference method, e.g. ultrasound or eddy current, to find areas with different coating thickness. Mark these areas without covering them, e.g. with a ring sticker, and note the reference values of the coating thickness. The target is to find reference points for the entire coating thickness range to be measured later.

8.5.2 Heating

In photothermal measurement, the coating must first be heated so that the temperature change during cooling can be evaluated. After a measurement, the Heating control shows the temperature increase cau-

sed by the light radiation of the excitation. For common organic coating materials on metallic substrates, a heating of 2 - 4 °C should be targeted.

Attention: The displayed value is the temperature rise during measurement and not the maximum surface temperature of the coating. Dark coating surfacess in particular can be damaged even with only a few degrees of temperature rise. When selecting the excitation power, you should always observe the coating surface in addition to the heating.

8.5.3 Raw signal

The raw signal is the direct, unprocessed output signal of the photothermal sensor. This value is not a coating thickness, but a dimensionless measure of the thermal behavior of the sample. The raw signal depends on the excitation parameters and the properties of the coating.

Suitable raw signal values are in the range of 20 - 60. Much more important than the value itself, however, is that measuring the same sample yields very similar

Figure 19: Ring stickers marking the points where the reference coating thickness was measured

raw signals and different samples yield significantly different raw signals. This is essential for a clear and reproducible assignment of raw signal to coating thickness.

8.5.4 Stair plots

A stair plot is well suited for the qualitative assessment of the raw signal. You first select the measurement parameters (laser power, measure time and measurement cycles) and then create a line chart from raw values of different reference points. Stair plots can be generated similar to normal measurement batches using the OS Manager measurement view.

In the Application control, select the Raw Data application so that the raw signal of the sensor is displayed instead of the coating thickness.
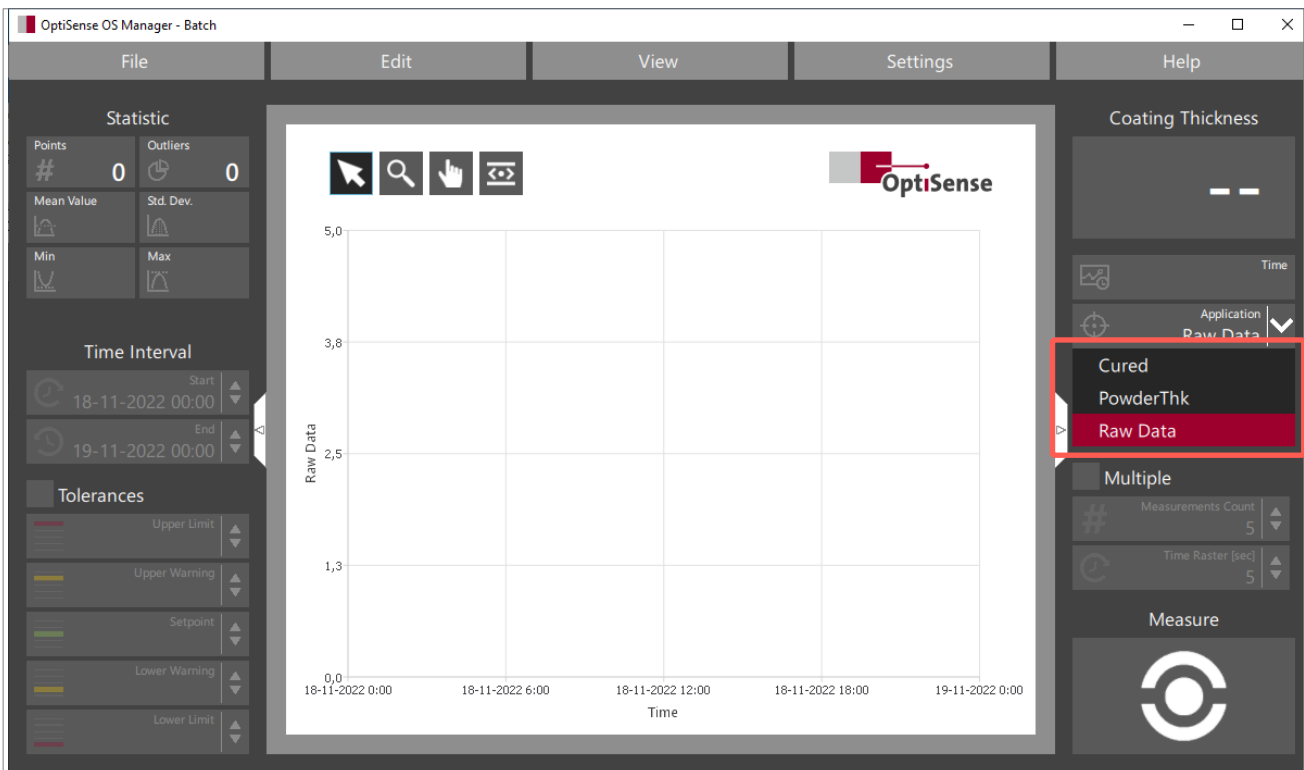

Figure 20: The Raw Data application is used to create a stair plot

Suitable measurement parameters provide a chart with clearly distinguishable steps in staircase form. If the steps are hardly distinguishable or very uneven, the parameters are unsuitable for this application.

Figure 21: If the steps are hardly distinguishable or very uneven, the parameters are unsuitable

Figure 22: Suitable measurement parameters provide a chart with clearly distinguishable steps
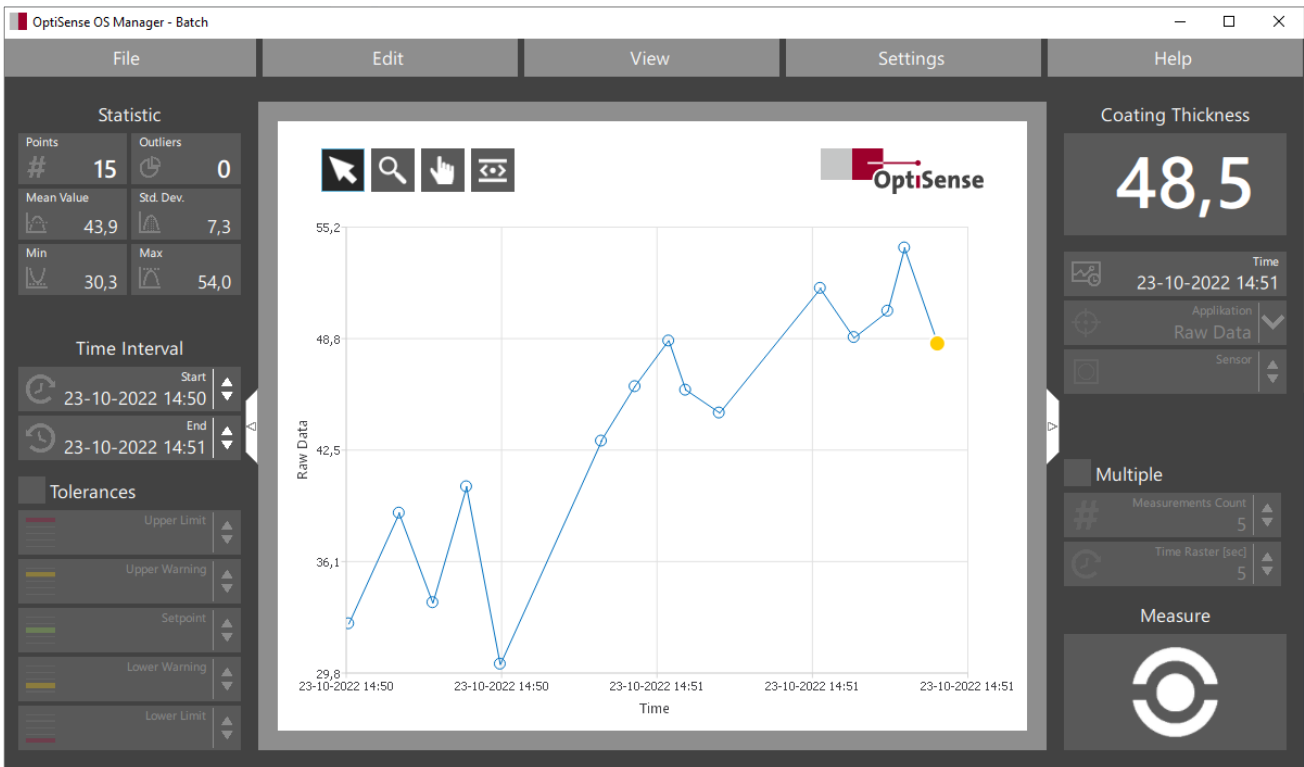
8.6 Creating Grid Points

After suitable measurement parameters have been found, the application function can be created. This is a curve that represents the relationship between the measured raw signal and the actual coating thickness. It takes the specific material properties of coating and substrate into account. In case of measurements before curing or baking, the application function also includes the expected shrinkage of the coating material.

Applications initially apply only to the material combinations and measurement parameters with which they were created. However, the photothermal properties of many materials are so similar that the same application can be used. The basis for an application are at least two grid points. For each grid point, a coating sample is measured with a reference method and the reference value of the coating thickness is entered in a grid point table. The OS Manager connects these grid points by a curve, which is then used to measure the intermediate values.

8.6.1 Grid point table

The grid points are located in a table in the grid point pane of the application view. Each row of the table represents a grid point and a material sample and contains the following columns:

| Column	Meaning
1	Enable. If this control is checked, the grid point is used for the application curve, otherwise not.
2	Reference. Enter the actual coating thickness of the sample measured with a reference method here. For measurements in the raw state, this is the coating thickness after curing or baking.
3	Raw signal. The raw signal from the sensor of this sample. Activate this control by clicking with the left mouse button to receive raw signal values from the measurement.
4	View. This is the coating thickness value that the PaintChecker device will finally display for this particular sample. The displayed value may deviate slightly from the entered reference value, since the application curve is an approximation curve that does not always run exactly through all interpolation points.
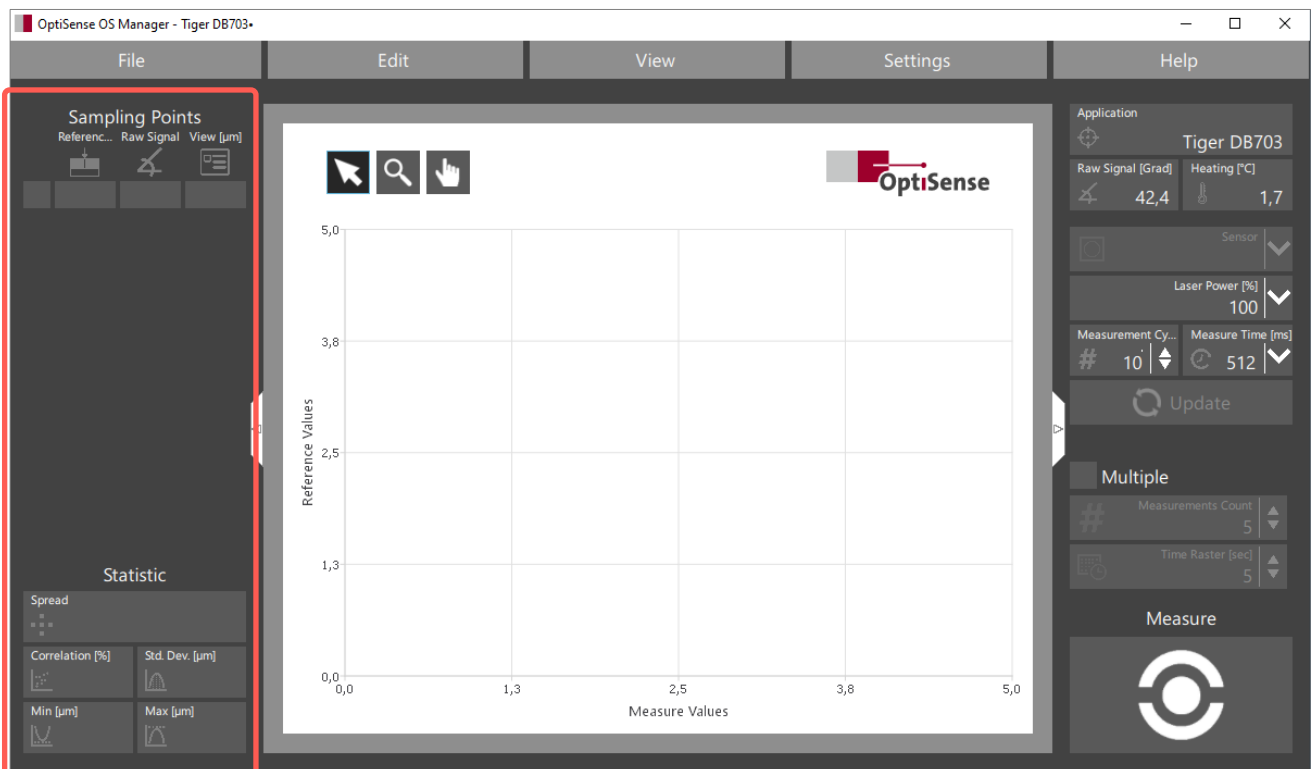
Figure 23: Grid point pane with grid point table still empty

8.7 Capturing a Grid Point

Initially, the grid point table consists only of an empty row whose columns are grayed. The diagram pane is also still empty. Now prepare the first coating sample and take some measurements. Make sure that reasonable and stable values are displayed for raw signal and heating. Click in the reference column of the first grid point, enter the reference coating thickness in µm and confirm with the Enter key.

The reference value is inserted into the table and another empty row is appended at the bottom of the grid point table. Now click into the raw signal column to start the raw signal recording. All subsequent measurements are assigned to this grid point.

Perform 5 - 10 measurements on the coating sample. As in measurement view, you can optionally use the multiple measurement mode for your convenience. The raw signal column finally contains the average of all these measurements.
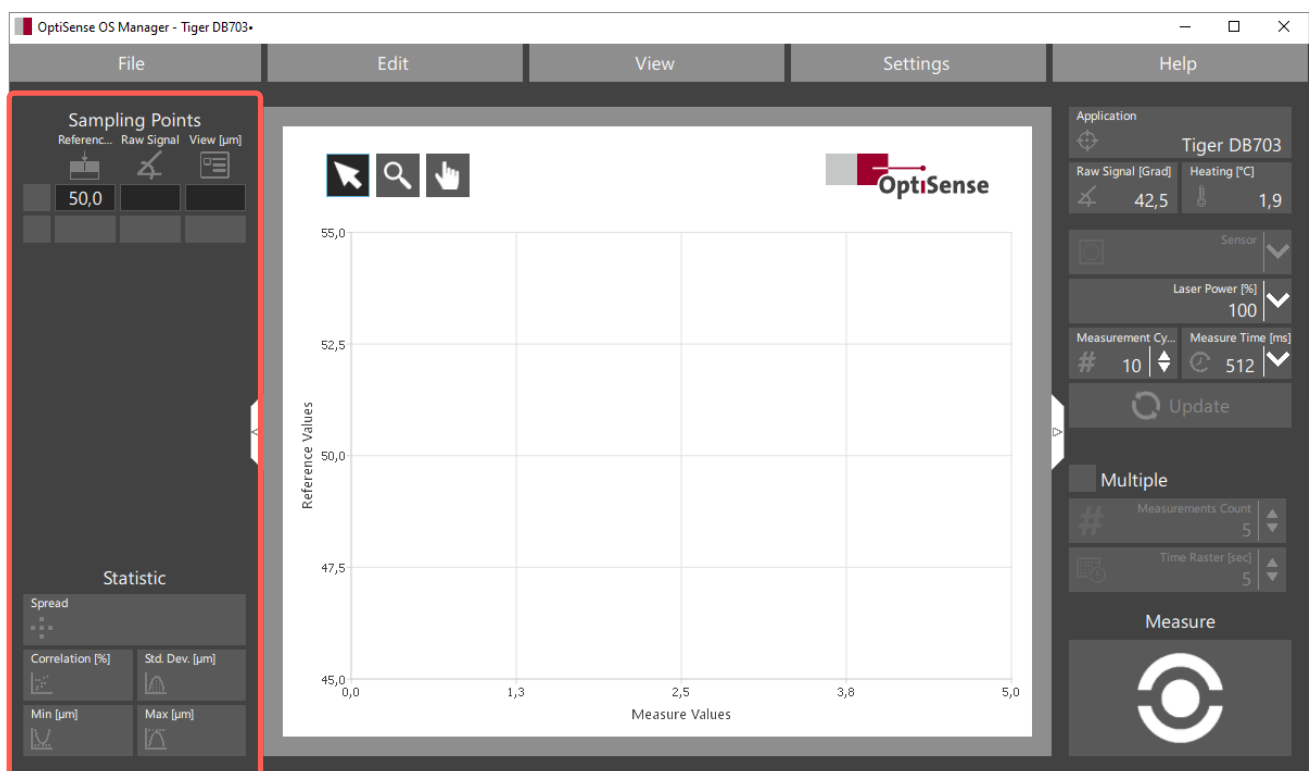

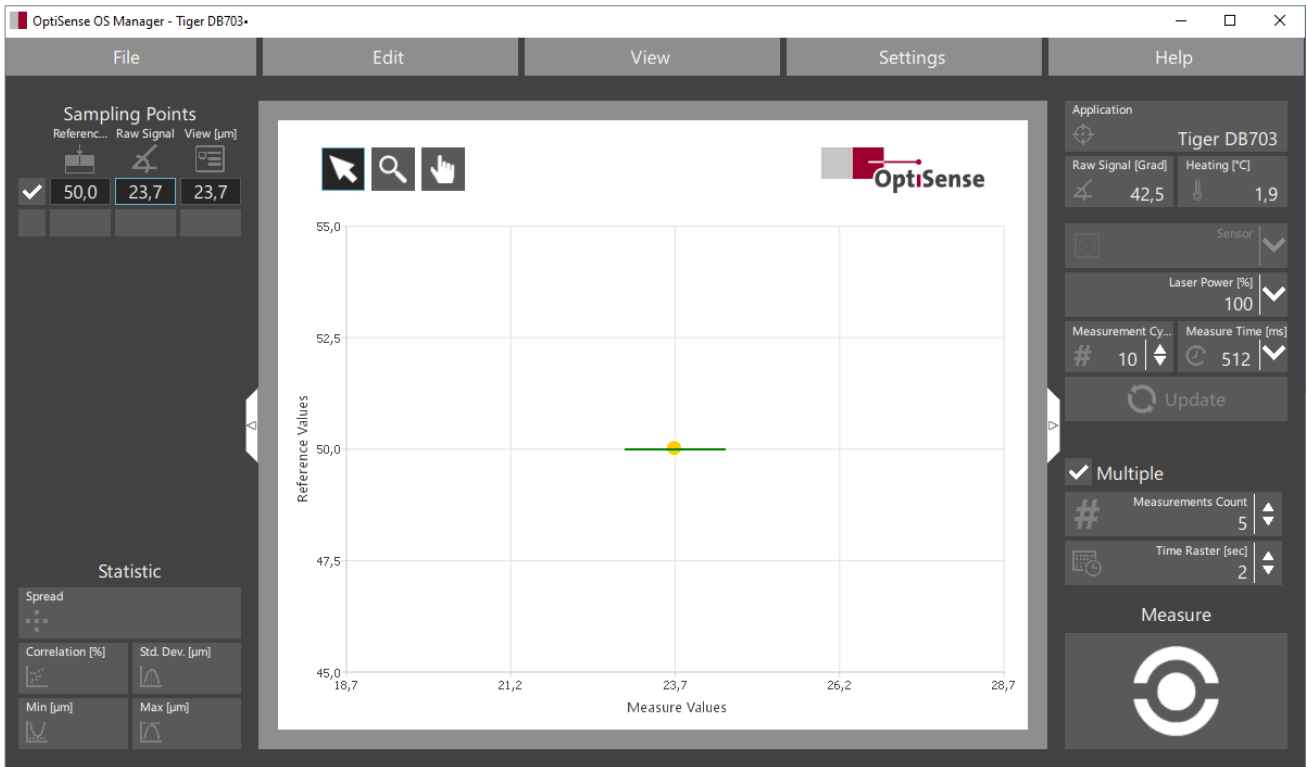*Figure 24: First enter the reference coating thickness of the grid point*

Figure 25: After measuring the raw signal, the grid point appears in the chart

At the same time, the grid point appears in the grid point chart at the intersection between the raw signal on the X-axis and the reference layer thickness on the Y-axis. A horizontal line passes through the point, whose length represents the spread (standard deviation) of the measurements. The numerical value of the standard deviation can be displayed by touching the line with the mouse cursor.
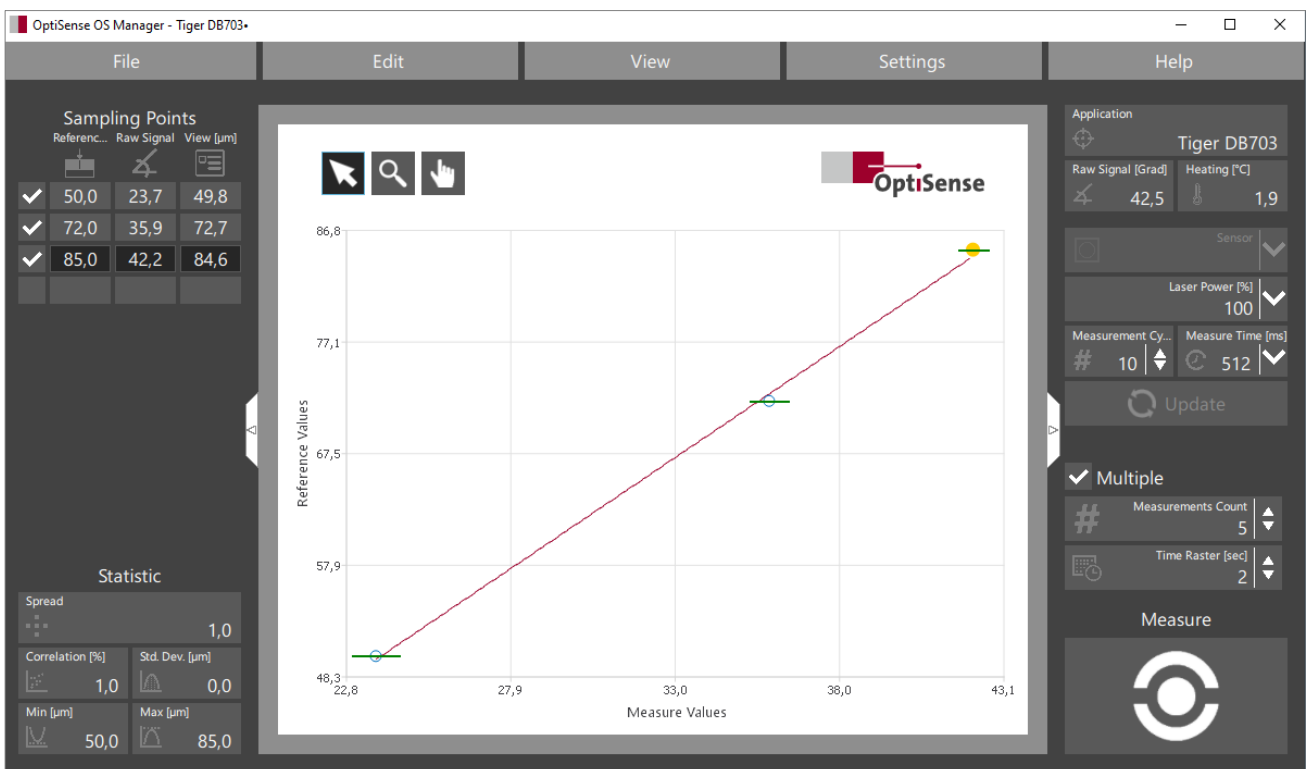

Figure 26: As soon as two or more grid points are available, the OS Manager calculates an application curve

Now add more grid points in the same way by measuring additional coating samples. As soon as two or more grid points are available, the OS Manager calculates an application curve and displays it in the diagram pane.

By default, all grid points are used to calculate the application curve. Sometimes, however, it may be useful to exclude an individual grid point in order to achieve a better fit of the application curve to the remaining points.

If a grid point is to be left unused, remove the corresponding check mark in the first column. Note that the grid point is still displayed in the diagram even though it is not used.

8.8 Grid Point Chart

The grid points are displayed as dots in the diagram pane. The raw signal from column 3 of the grid point table is plotted on the X-axis and the corresponding reference coating thickness from column 2 is plotted on the Y-axis. Each completely filled row of the grid point table adds another dot to the grid point chart.

Each grid point originates from multiple measurements of a coating thickness sample. The mean value of these measurements is the raw signal value in the grid point table. The variation of the measurements is displayed as a horizontal line through the grid point, with the line length representing the standard deviation. The shorter the line, the less the variation in the measured value, i.e. the more accurate the grid point. The numerical value of the standard deviation can be displayed by touching the line with the mouse cursor.

If at least two grid points are available and active, the OS Manager calculates a compensation function that leads through all activated grid points with as little deviation as possible. This application curve is later used by the PaintChecker Mobile device to measure the values between the grid points.

Using the grid point chart, you can visually check how well and evenly the application curve runs between the grid points. Poor grid points are easy to recognize due to their position away from the application curve and should be measured again or deactivated.

8.8.1 Zoom/Pan

As in measurement view, zoom and pan features are available in the diagram pane of the application view to examine individual chart areas in more detail. First select the appropriate tool by clicking with the left mouse button – the magnifying glass to zoom in and the hand to move the chart.

To zoom into the diagram, hold down the Shift key and click into the chart with the left mouse button. Clicking without holding down the Shift key zooms out again.

Move the mouse with the left button pressed to select a zoom area or move the diagram. Alternatively, the chart can be moved with the mouse wheel and via the scroll bars of the diagram pane.

Double-clicking on the Zoom or Pan tool resets the chart so that all grid points become visible.

8.8.2 Selecting grid points

Similar to the measurement view, you can use the select tool to select individual grid points by clicking on them with the left mouse button, and then edit or delete them. A selected grid point is marked yellow in the diagram and highlighted in the grid point table.

8.8.3 Copy/delete grid points

Clicking a grid point with the right mouse button opens a context menu with various zoom and pan features. Furthermore, this allows grid points to be easily copied to the clipboard, deleted and removed from the grid point table..
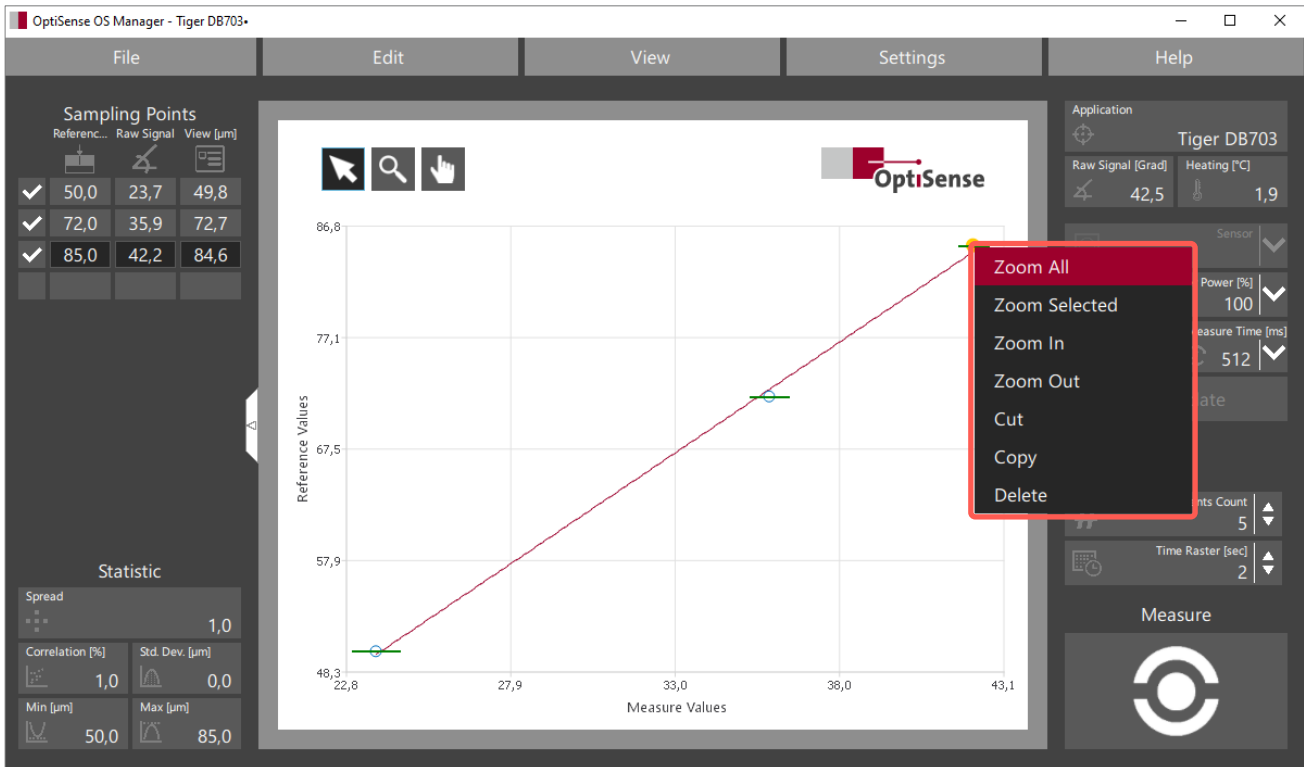
Figure 27: Right-clicking the grid point opens a context menu

8.9 Grid Point Quality

When selecting the coating samples, make sure that the entire coating thickness range to be measured later is covered as completely as possible and that the grid points are evenly distributed. The statistical indicators below the grid point table provide information about the quality of the grid points and their distribution

An optimal grid point configuration is achieved when the statistical spread and correlation are as close as possible to 1. Moreover, there should be as wide a gap as possible between the green lines in the grid point chart. They should not overlap in any way.

8.10 Managing Applications

The OS Manager combines measurement parameters, grid point table and application curve into applications. The *File menu* allows to organize these applications on the PaintChecker device and on the PC.

8.10.1 New application

With File/New a new, empty application is created. Any existing grid points are discarded and the measurement parameters are reset to their default state. Immediately after creating a new application, it must be given a unique name in the Application control.

8.10.2 Saving, loading from file

Applications can be saved as files on the PC for archiving or later editing. The binary OPT format with the .opt file extension is used for this purpose. Saving is performed using the common Windows *File/Save* or *File/Save* as functions.

With *File/Open*, files in OPT format can be reloaded into the OS Manager at a later time, e.g. to edit an application or to transfer it to a PaintChecker device.

8.10.3 Importing from the PaintChecker Mobile

File/Import transfers applications from a PaintChecker Mobile into the OS Manager to make adjustments or copy the application to another PaintChecker. The applications saved on the PaintChecker appear in the *File/Import* dialog under the name that was assigned in the Application control of the Application view when they were created. This name might be different from the file name.

Items named Batch are not applications but measurement batches that can be processed with the OS Manager in measurement view (see section Measure).

With the *Save menu* the selected application is saved as an OPT file on the PC. The Windows Explorer provides the usual file operations.
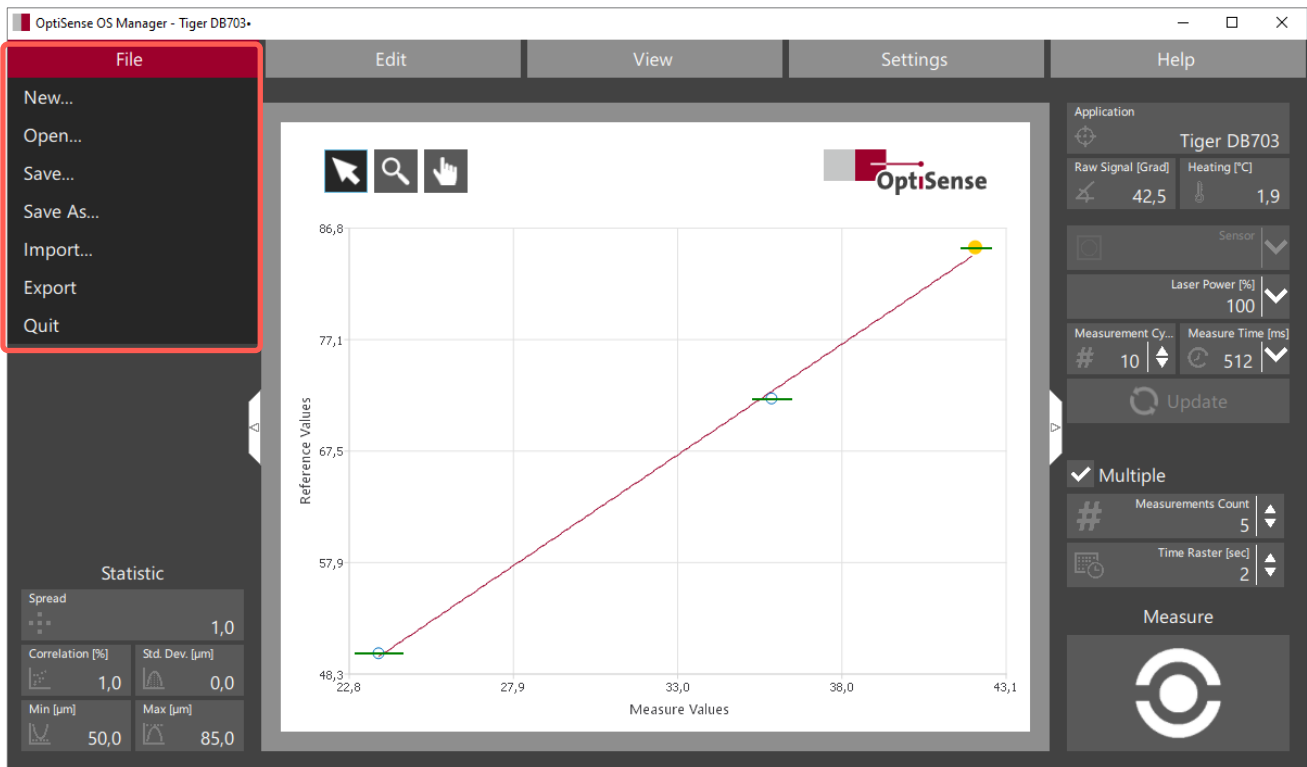
Figure 28: After measuring the raw signal, the grid point appears in the chart

The Open menu transfers an application from the PaintChecker device into the OS Manager where it can be visualized and edited. Editing is limited to simple, basic application features, such as those of applications created with the OS Manager. The factory-supplied applications like Cured or PowderThk are much more complex, adaptive applications suitable for a wide range of materials. These cannot be fully edited but be saved with the OS Manager and used as templates for new applications if necessary.

Selected applications can be deleted from the Paint-Checker device via the context menu (right mouse button).

8.10.4 Export to the PaintChecker Mobile

The File / Export menu is used to transfer the currently loaded application to the PaintChecker Mobile. The content of the Application control in the Application view is used as the name. Existing applications with the same name are not overwritten, but must be explicitly deleted beforehand.
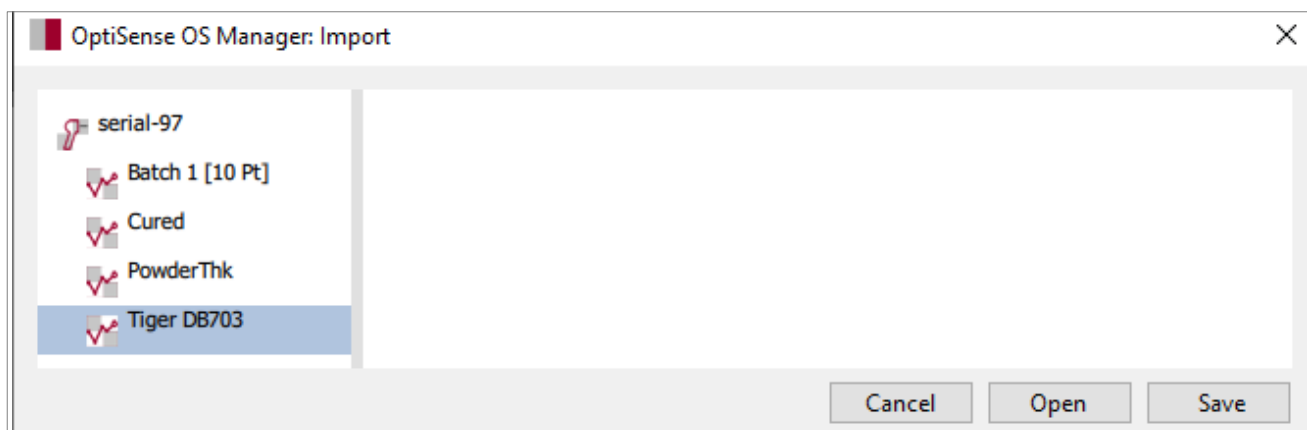

Figure 29: With the Save menu the selected application is saved as an OPT file to the PC

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