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1. Introduction

The Rhopoint Aesthetix Measurement System comprises of the Aesthetix measurement sensor, Rhopoint Appearance Elements software and an optional API interface.

This help guide will assist you in connecting the instrument, operating the software, integrating it into your workflow, and utilise the results to enhance your products or processes.

Aesthetix Measurements to Mimic Human Perception

The Aesthetix system uses advanced imaging technology to precisely analyze how surfaces interact with light.

By capturing HD high-resolution images under controlled lighting conditions, Aesthetix quantifies surface appearance in a way that closely mirrors human perception, delivering critical insights into surface quality and visual characteristics.

Modular Format Software

The modular format of the Aesthetix system offers significant flexibility and cost efficiency.

Users can pay only for the measurement capabilities they need, reducing upfront investment.

This approach also provides easy access to additional features or future measurement modules, ensuring the system can evolve alongside changing requirements.

The modular design makes the Aesthetix a scalable and adaptable solution for a wide range of applications.

- **Surface Brilliance Module**: Measures gloss, haze, DOI, Waviness (Orange Peel) and Visual Gloss. Used to evaluate the reflective quality and visual appeal of high-gloss surfaces.
- **Effect Pigment Module (Effects Finish Module):** Analyzes the appearance of metallic and pearlescent pigments, ensuring consistent and vibrant effects.
- **Surface Texture Module (Texture Module)**: Captures surface roughness, cell amplitude and size, and hill to valley reflectiveness of textured surfaces to ensure uniformity and quality.

- **Polishing Quality Module (Polishing Quality Module)**: Simultaneously measure glossiness, haze, polishing defects and scratches to optimise polishing processes and ensure consistent finishes.
- **Cross-cut Adhesion Module (Cross-cut Module)**: Objectively quantify the results of adhesion strength tests, providing reproducible results that confirm suitability and durability of paints and coatings.
- **Bespoke Measurement Modules**: Rhopoint offers bespoke measurement modules where measurement capability is exactly matched to end user requirements.

Measure Flat and Curved Parts

The Aesthetix system is designed to assess flat parts, curved surfaces, and small areas using both contact and non-contact methods.

Versatile Integration Options

The Aesthetix can function as a portable device, be integrated into fixed installations, operate robotically, or serve as a measurement sensor directly within production lines.

Powerful Software- share, store, analyse results

Rhopoint Appearance Elements Software is integral to the Rhopoint Aesthetix system, offering built-in image analysis, a results database, cloud data storage, and comprehensive results analysis and reporting software. This powerful combination ensures efficient data management and in-depth surface quality assessment.

Optional API Integration

Rhopoint Appearance Elements Software offers an optional API for seamless integration with existing systems, allowing users to automate data retrieval, analysis, and reporting processes, thereby enhancing efficiency in surface quality assessment.

Minimum System Requirements

Before installing, check the requirements for the host PC.

Recommended System Requirements

- OS: Windows 11 (Windows 10 support ends October 2025)
- Memory: 16 GB
- CPU: x64 (x86 and ARM are not supported)
- Port: USB 3.0 USB-C or Thunderbolt
- Screen Resolution: 1920 x 1080

Minimum System Requirements

- OS: Windows 11 (Windows 10 support ends October 2025)
- Memory: 8 GB
- CPU: x64 (x86 and ARM are not supported)
- Port: USB 3.0 USB-C or Thunderbolt
- Screen Resolution: 1440 x 900

Languages

The help guide is available in the following languages:

- EN - English (javascript:location.href='./welcome.html')
- JA - Japanese (日本語) (javascript:location.href='./ja/welcome-ja.html')
- ZH - Chinese (中文) (javascript:location.href='./zh/welcome-zh.html')

Packing List

Package contents

- Aesthetix sensor with USB-C connector
- Gloss module calibration standard
- USB stick containing:
  - Appearance Elements software installer
- Lanyard hand strap
- Small part and curved surface adapter
- Calibration certificates
- Printed quick start guide
- Cleaning Cloth
- Optional:
  - Texture measurement calibration standard
  - Rubber base standard adapter
  - Rubber base small part and curved surface adapter
  - Measurement stand
  - Non-contact small part and curved surface adapter
  - Bespoke part adaptors
  - USB-A connector cable
  - 3m connector USB-C cable

Download & Install Appearance Elements

Appearance Elements is the Rhopoint software used to operate the Aesthetix sensor.

The latest version of Appearance Elements can be installed from the Rhopoint website.

The functions of Rhopoint Appearance Elements include measurement control, quality control reporting, results analysis, and database storage.

Installation

Visit Rhopoint Instruments Website (https://www.rhopointinstruments.com/help-services/resources/software/) to download the latest software installer.

Double-click the “AppearanceElements.msi” package to install the software.

Follow the onscreen instructions.

> Software installation includes camera drivers and requires requires administrator permissions.

Starting the software

Connect the sensor

Connect the Aesthetix sensor using the provided cable to an available USB 3.0 USB-C or Thunderbolt port on your chosen host computer.

Only use Rhopoint supplied cables- low cost cables may not support the data transfer speeds required by the Aesthetix system to perform correctly.

Start the software

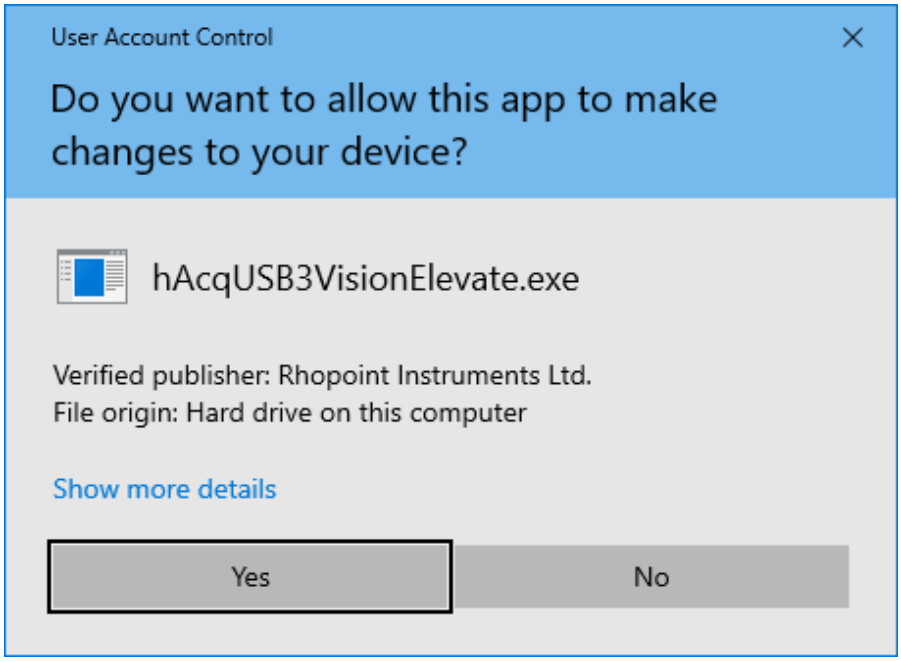
Double-click the Rhopoint Appearance Elements icon created on the desktop to start the software.

Rhopoint Appearance Elements desktop icon

Rhopoint Appearance Elements desktop icon

Additional setup

On the first start, the camera drivers are checked. If the drivers are missing, they will be installed upon confirming the following dialog:

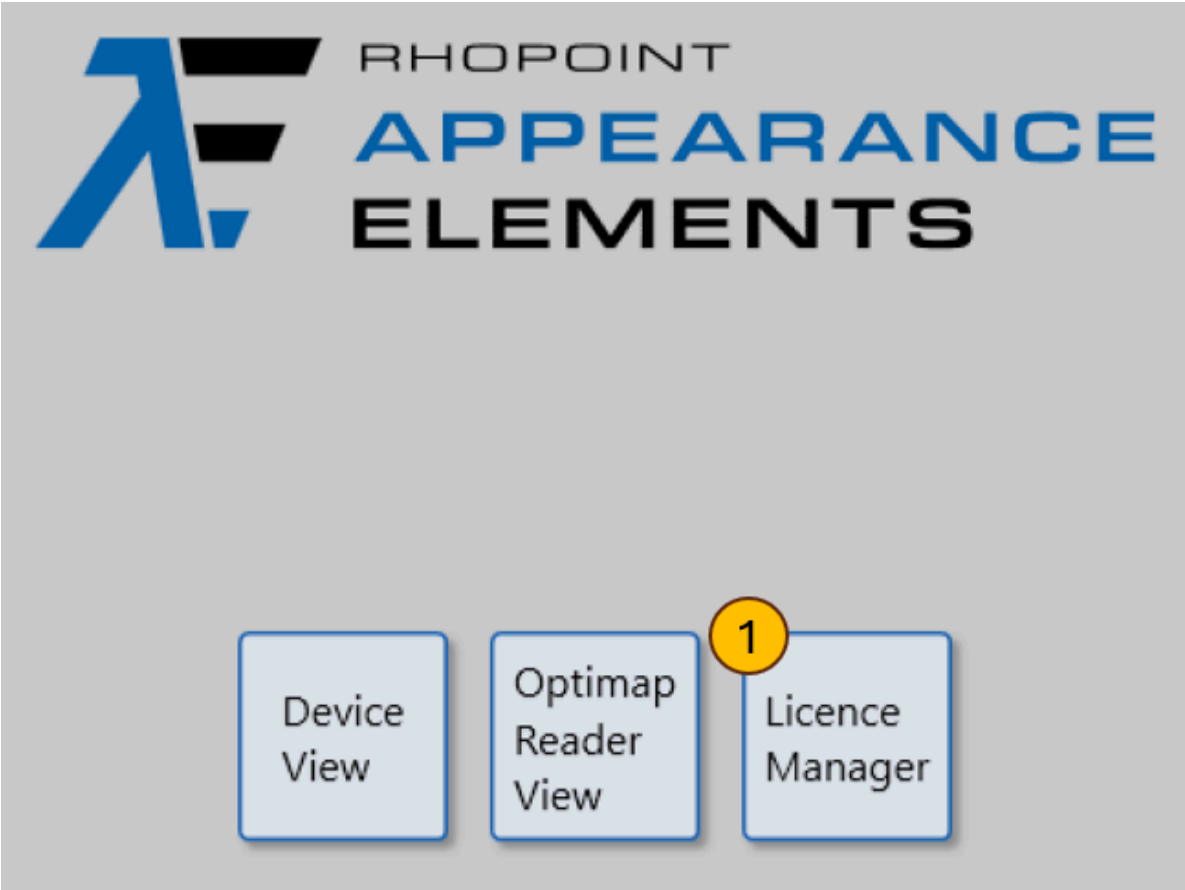


Install USB vision

USB camera driver installation

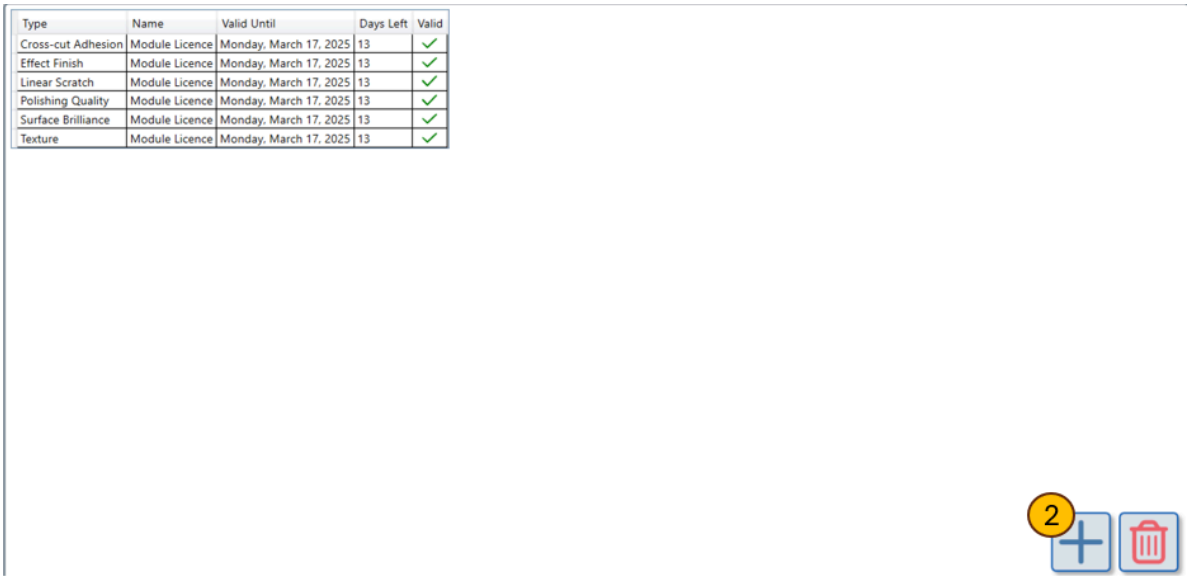
Install Aesthetix Licenses

To install Aesthetix licenses, follow these steps:



license manager

1. Aesthetix Licenses are emailed to you when your Aesthetix Sensor is shipped from the Rhopoint factory.
2. Download the received licenses onto your PC.
3. Click the License Manager (1) button.
4. Press the add licenses button (2)
5. Select the saved license(s) to install them.



license screen

Additional Information

Replacement Licenses: If you've lost your licenses, you can request them to be resent. Contact enquiries@rhopointinstruments.com and provide:

- The serial number of your instrument
- Your user details

Demo Licenses: Rhopoint offers a free 2-week trial for all modules.

To obtain a demo license, contact enquiries@rhopointinstruments.com.

Additional Licenses: To purchase licenses for a new module please contact your regional Rhopoint office, premium authorised distributor or send an email to enquiries@rhopointinstruments.com.

Get help in the software

To access built-in help, press the F1 key on your PC or click the ? button on the bottom right of the screen.

Help button on the status bar

Software Update

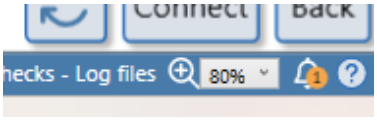
When connected to the web, Rhopoint Appearance Elements will check for updates.

Updated software will include Security updates, bug fixes, an updated manual and feature enhancements.

The availability of a new update is indicated as a orange alert on the toolbar.

To install new software click on the alert and follow on-screen instruction.

Installing a new update will not affect saved data or remove licenses.



Update notification

Setup the Aesthetix Sensor

Selecting the correct adaptor

The Rhopoint Aesthetix measurement setup can be modified by changing adaptors magnetically attached to the base of the sensor.

The Aesthetix sensor is supplied with Standard and Curved Surface and Small Area Adaptors.

Optional adaptors include: Non-Contact Curved Surface and Small Area Gloss adaptor, Novo-Curve Adaptor and bespoke 3-D printed adaptors.

Adaptors

Standard Adaptor, Curved Surface and Small Area Gloss Adaptor and Non-Contact Curved Surface and Small Area adaptors.

Standard Gloss Measurement Setup

The Aesthetix standard adaptor is used for measuring the gloss of flat surfaces with identical measurement to a conventional 60° Glossmeter.

Curved Surface and Small Area Gloss Adaptor

This adaptor reduces the gloss measurement area to 2 x 4mm. Aesthetix Measurements made with this adaptor are compatible with Novo-Curve and Novo-Gloss Flex 60

instruments.

Non-Contact Measurement

Without an adaptor attached to the base of the instrument, the Aesthetix can be used in non-contact mode.

For non-contact applications, the Aesthetix can be used with a stand or laboratory cobot.

When measuring non-contact, it is important to respect the focal distance from the bottom of the instrument to the target surface. The distance must be maintained at 10mmm +/- 0.5mmm).

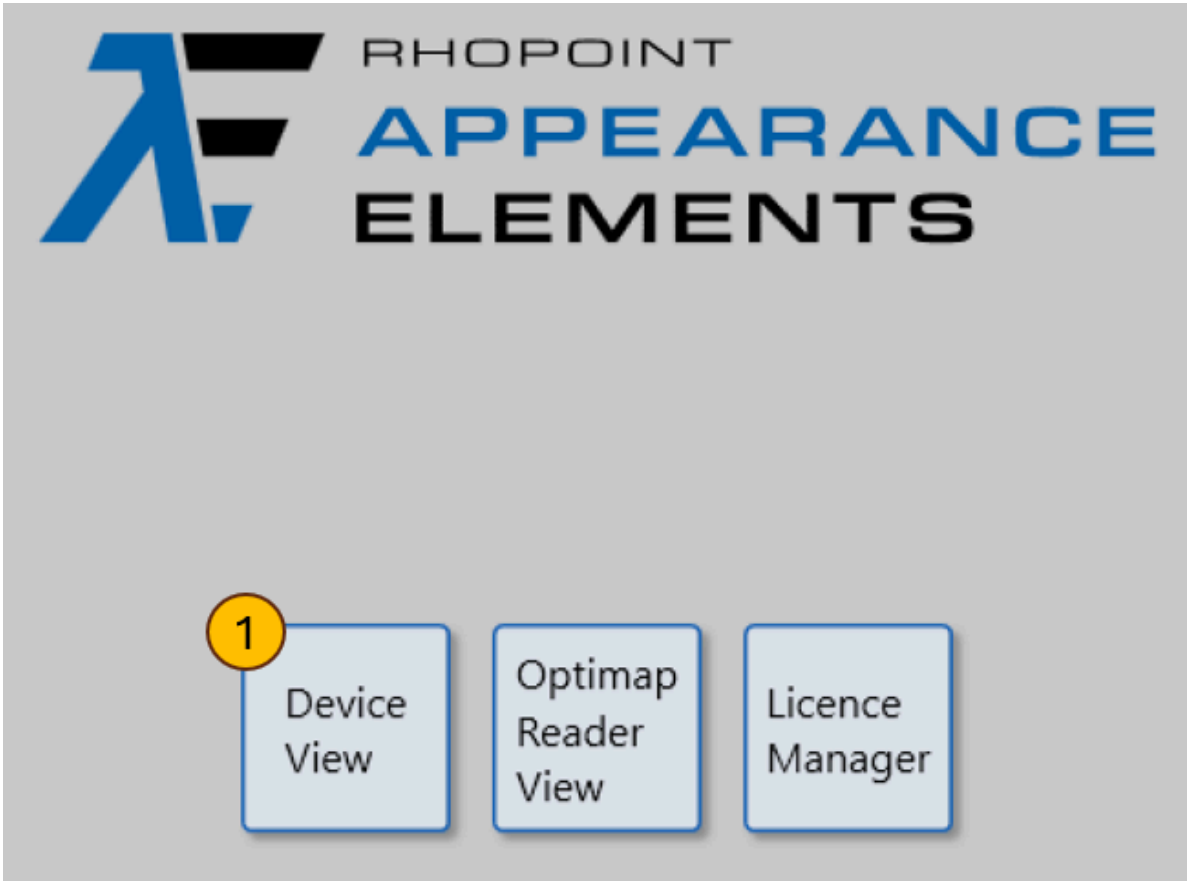
Bespoke Jigs

The Rhopoint Aesthetix can be used with 3D-printed jigs for repeatable measurement of small parts or curved surfaces.

> Rhopoint offers a 3-D Jigs and fixtures design service.
>
> To design your own jigs and fixtures, contact Rhopoint to receive a 3-D design advice pack with example STL's.

> The instrument must be recalibrated after changing adaptors.

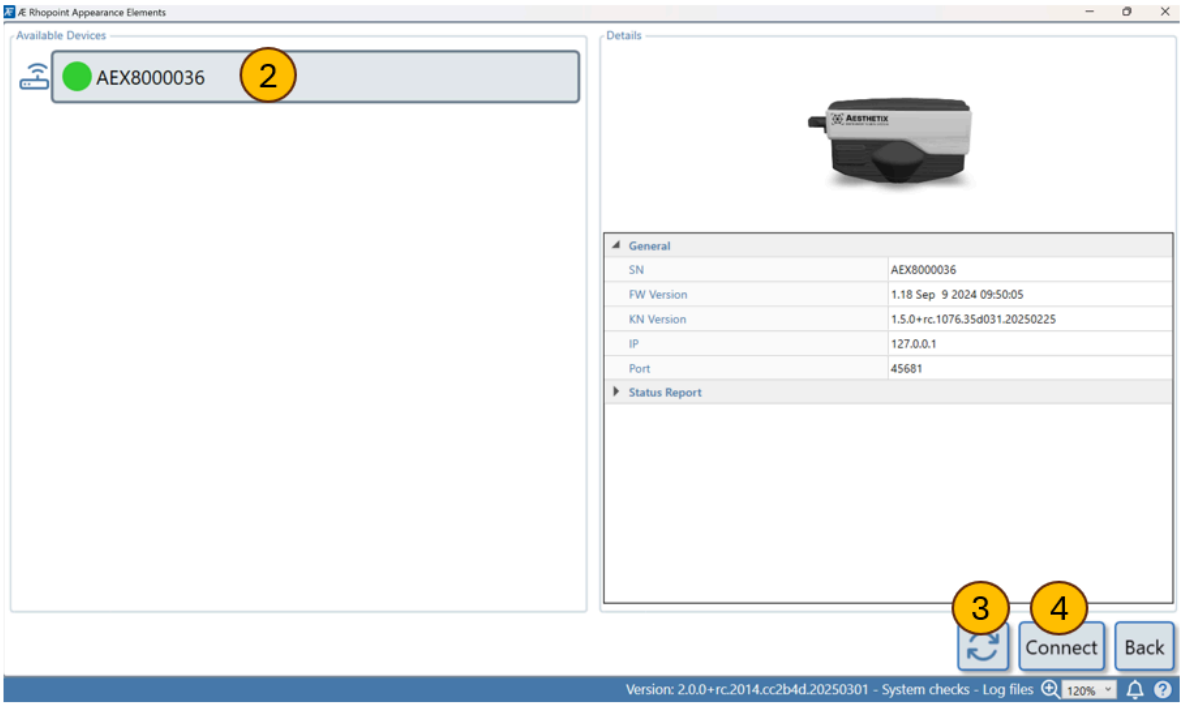
Connect the Aesthetix Sensor



Deviceview

Software startup page

Click the Device View icon (1) to access the connection menu.



Connectionwindow

Connection View The software automatically searched for available devices.

Once discovered click on the sensor that you wish to use (2).

If the sensor becomes disconnected, press the refresh button (3) to re-start the sensor discovery process.

Press connect (4) to start the software.

> This discovery process takes up to 45 seconds dependent on hardware and configuration.

Calibration

Once a module is chosen, it may be required to calibrate the sensor.

Calibration Standards

The following standards must be used dependent on the module.

Module	Standard
Gloss Module	B8000-011 Gloss Module Standard
Texture Module	B8000-012 Texture Module Standard
Coatings Physical Test	B8000-011 Gloss Module Standard

Modules which do not require calibration include:

- Sparkle Module

Click on the calibration icon to begin calibration and follow the on-screen instructions.

Calibration Button

Calibration Button

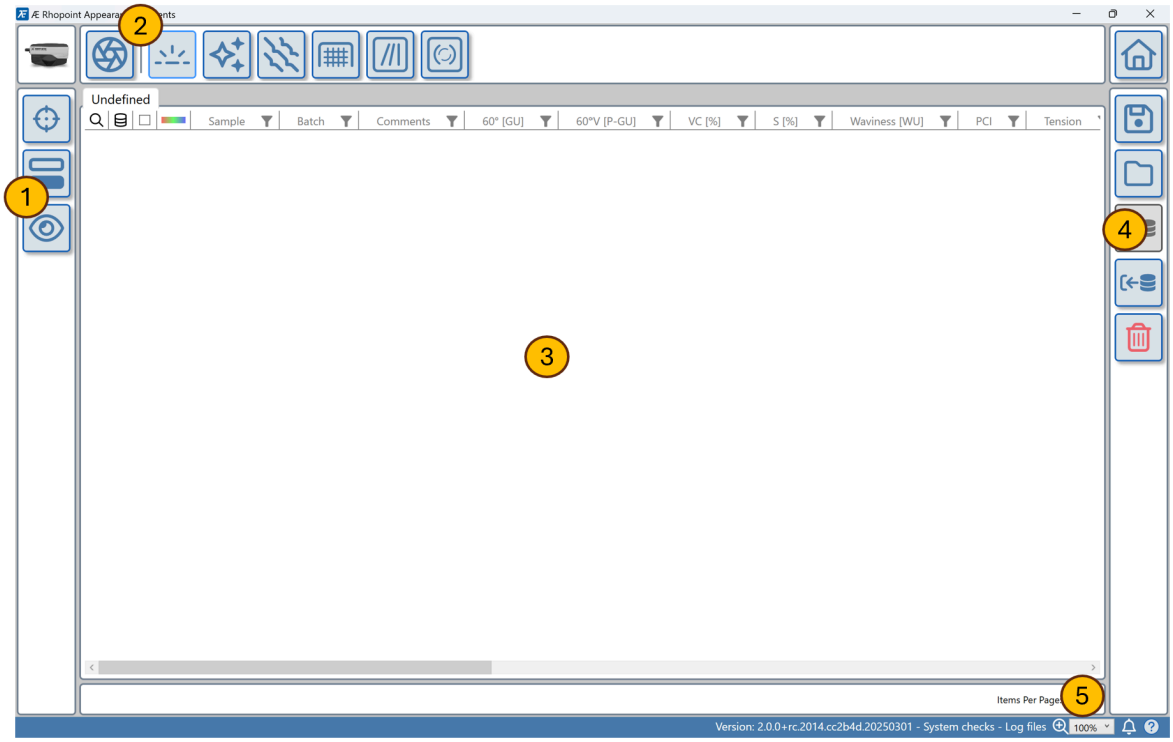
Calibration interval: The instrument should be checked by measuring the calibration tile daily and comparing read values with the certified values. If values are out of tolerance, recalibrate the sensor.

Calibration artifacts must be clean with no contamination, visible damage, or fingerprints. Access Aesthetix Software help for more information and cleaning

recommendations.

Measurement Screen

The Aesthetix Measurement Screen is the hub for choosing a module, taking measurements, reviewing measurement data, images and maps.



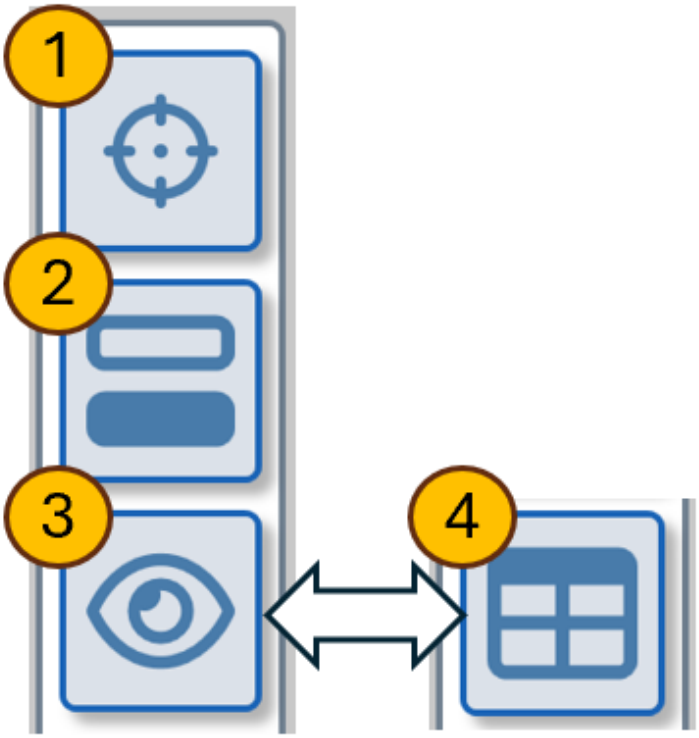
Main screen

1. **Action Bar (Action Bar)** The buttons in this section are used to take measurements and calibrate.
2. **Module Bar (Module Bar)** Used to switch between measurement modules.
3. **Data Table (Data Table)** Measurement data will be displayed here.
4. **Data Bar (Data Bar)** Used to save and retrieve data and set up the appearance and functions within the measurement page.
5. **Information and Systems Info (Information and Systems Info)** Diagnostic tools and system info.

Action Bar

The Action Bar is used to control the instrument.

1. **Measure Button** Click here to start a measurement- results will be recorded in the measurement table. A "greyed out" measurement button indicates the license for this module is not present or expired. Install a new Aesthetix License (Install Aesthetix Licenses)
2. **Calibration** Press to begin Calibration
3. **Interactive Measurement Button** Pressing this button will start an interactive measurement, this includes live views from the Aesthetix camera to allow for sample alignment and adjustment of measurement parameters. Interactive measurement is not available for certain modules or instruments- this button will not be present in the Action Bar
4. **Table View** Press this button to toggle the table view.

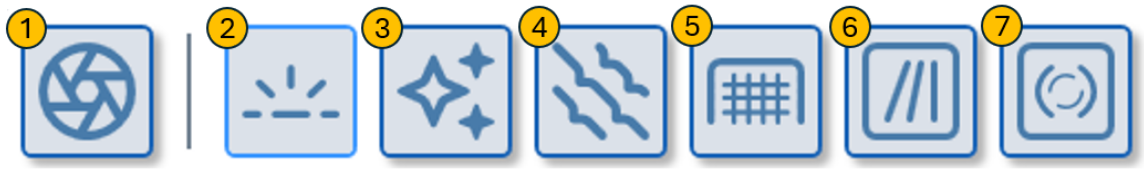


Actions bar

Module Bar

The Module Bar is used to select Measurement Modules.

1. **Visual Demo** A feature which gives the user control over the instrument cameras and light sources. Read more (Visual Demo Module)
2. **Surface Brilliance Module** Measure the gloss, perception gloss, haze, sharpness, DOI and orangepeel on a surface. Read more (Surface Brilliance Module)
3. **Effect Pigment Module** Analyses the appearance of metallic and pearlescent pigments, anodised metals and natural sparkling materials. Read more (Effects Finish Module)
4. **Texture Module** Captures surface roughness, cell amplitude and size, and hill to valley reflectiveness of textured surfaces Read More (Texture Module)
5. **Cross-Cut Adhesion Module** Objectively quantify the results of adhesion strength tests using digital imaging analysis. Read More (Cross-cut Module)
6. **Linear Scratch Module** Measure the size and area of defects visible in 0/45° lighting conditions.
7. **Polishing Quality Module** Measure the size and area of defects visible in 0/45° lighting conditions. Read More (Polishing Quality Module)



Module bar

Data Bar

Tools to save and retrieve data.

Information and Systems Info

This bar shows the firmware version and allows access to diagnostic tools.

1. **Systems Check** The diagnostic tool used by Rhopoint service to check the health of the hardware and connections.
2. **Log Files** Allows access to saved log files, used by Rhopoint service to diagnose faults and bugs in the Aesthetix system.
3. **Font Control** Adjust the size of on-screen font and icons.
4. **System Alert** Used to indicate the availability of software updates.
5. **Help Icon** Adjust the size of on-screen font and icons.

Take a measurement Overview

Start a measurement

To begin a measurement, press the button on the instrument or the software measurement button, many Aesthetix modules also include an interative measurement feature which allows for accurate sample positioning and live adjustment of measurment parameters.

Measurement button

Start measurement

Interactive button

Interactive Measurement Feature

Measurement technique

To achieve accurate repeatable measurement, the instrument should remain still during image grabbing stage (red light shown on instrument)). On large curved parts is always preferable to measure the flattest area where the instrument is stable, alternatively utilise jigs or the measurement stand for small or highly curved parts.

Aesthetix Indicator Lights (green)

Aesthetix Indicator Lights (green)

The Aesthetix sensor has two status indicator lights.

Color	Status
Green	Ready to take a measurement.
Red	Grabbing images - keep the instrument still.
Blue	Processing data - OK to move.

Data Table

Measurement data is displayed in a table format.

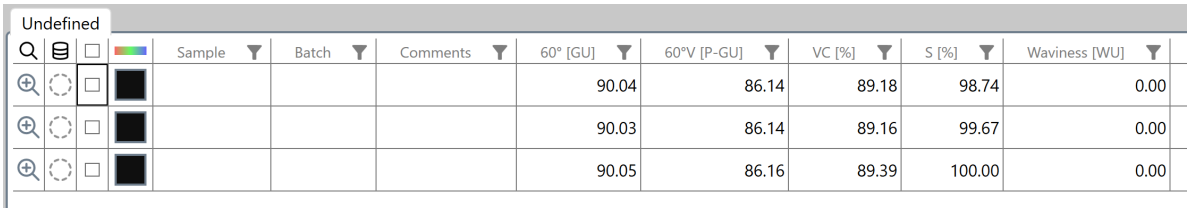
View results

To access the table view from live view press the Table View icon.

Table view button

Table view button

Delete results



Data table

The results table.

To delete unwanted or erroneous results-

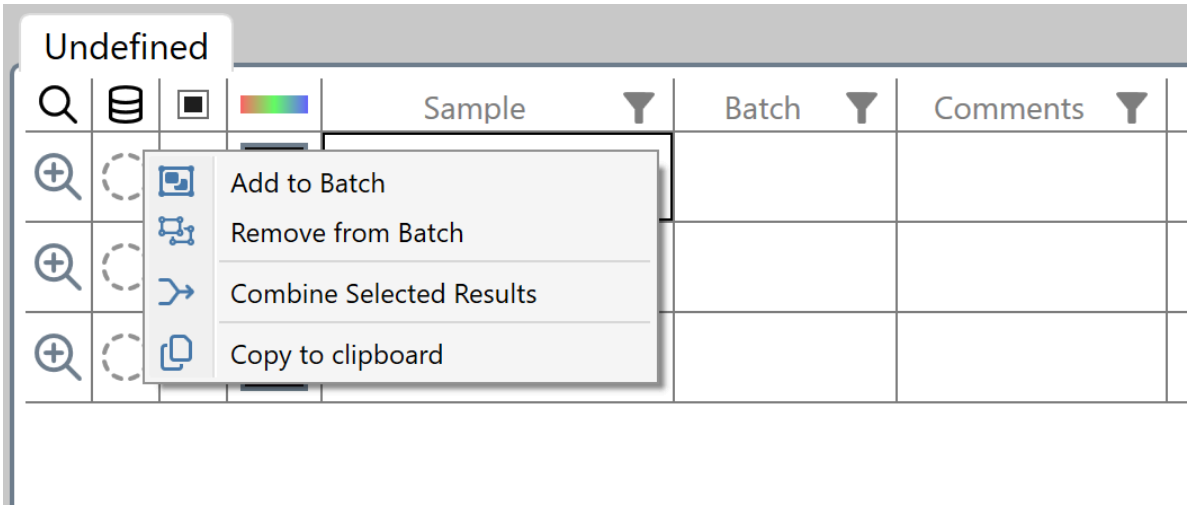
- Click the delete results icon
  - If no results are selected the software will prompt “Do you want to delete all results”
  - If one or more results are selected the software will prompt “Do you want to delete the selected rows”
- Drag and drop single or selected results onto the Delete Results icon.

Delete button

Batching and statistical analysis

Batch results together

Batched results are combined with the same batch name. Click on the selection square next to measurements which are to be combined. Right click and press add to batch.

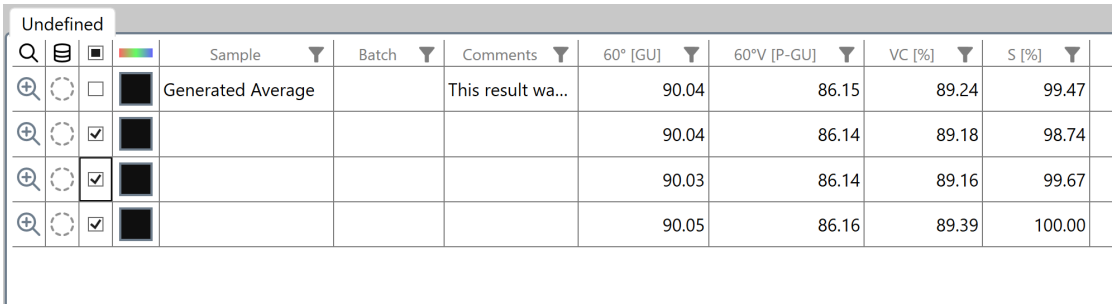


Add to batch

Measurements of the same part can be batched together

To create an average for measurements

- Select results to be combined in the selection column
  - Right click on the table
  - Select “Combine Selected Results”
  - An "Generated Average" entry will be added to the table.

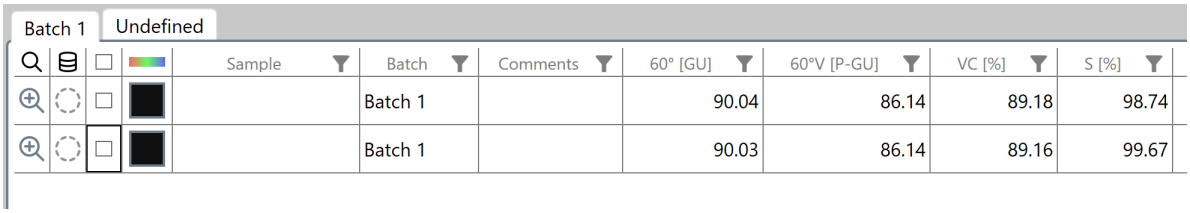


Combined results

Remove results from batch

To remove results from a batch

- Type a new batch name in the batch column of a single results
- Select single or multiple results and right click
  - Click remove from batch



New batch tab

Batched reading are put into separate tabs

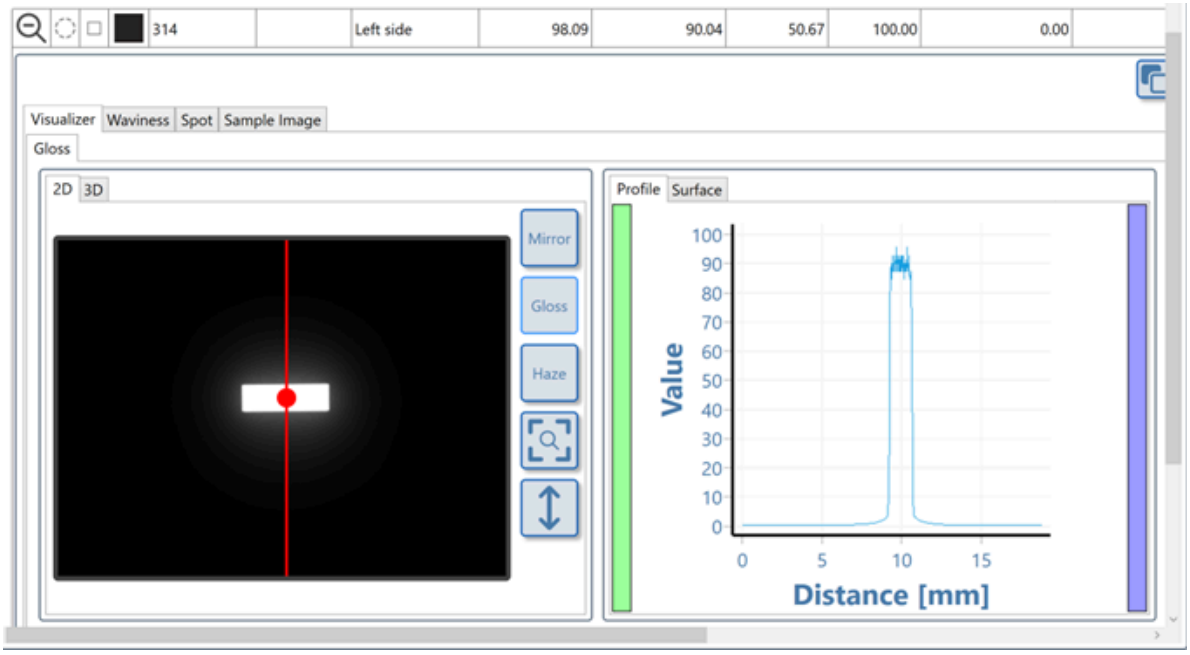
- If one or more results are selected the software will prompt “Do you want to delete the selected rows”
- Drag and drop single or selected results onto the Delete Results icon.

Measurement Images, Maps, Graphs and Histograms

Individual measurements can be expanded to view measurement images, maps and further analysis tools.

Expand measurement button

The Expanded Measurement View is accessed by using the expand control The expanded measurement view contains multiple tabs with measurement images, maps, and graphs.

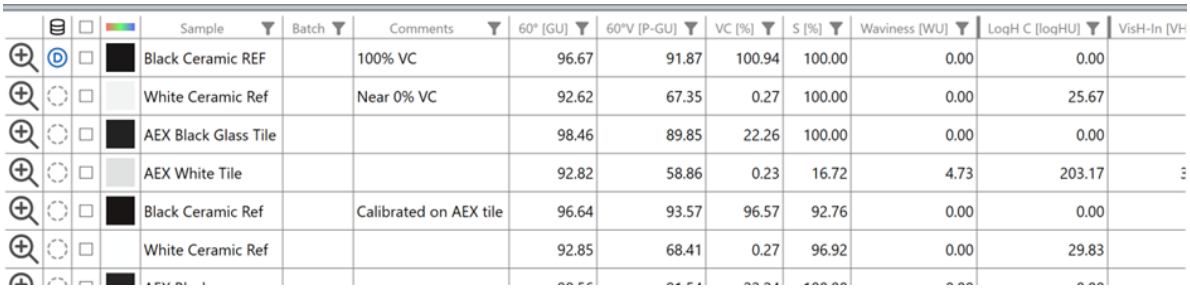


The contents and layout of the Expanded Measurement View depend on the measurement module.

The contents and layout of the Expanded Measurement View depend on the measurement module.

Results database (beta)

Selected measurements can be saved dynamically in the results database.



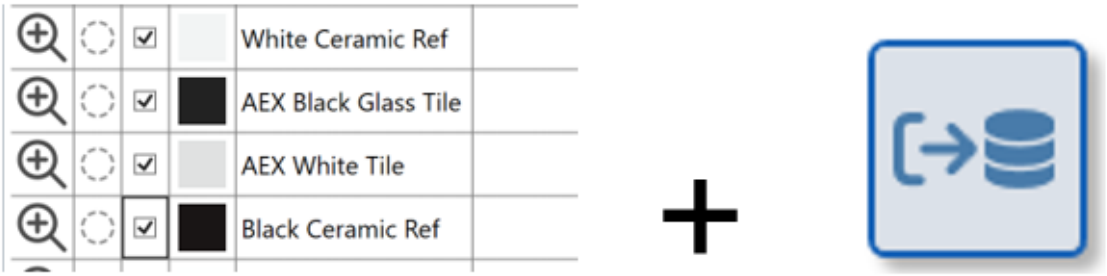
	Sample	Batch	Comments	60° [GU]	60°V [P-GU]	VC [%]	S [%]	Waviness [WU]	LogH C [logHU]	VisH-In [VH
D	Black Ceramic REF		100% VC	96.67	91.87	100.94	100.00	0.00	0.00	
	White Ceramic Ref		Near 0% VC	92.62	67.35	0.27	100.00	0.00	25.67	
	AEX Black Glass Tile			98.46	89.85	22.26	100.00	0.00	0.00	
	AEX White Tile			92.82	58.86	0.23	16.72	4.73	203.17	
	Black Ceramic Ref		Calibrated on AEX tile	96.64	93.57	96.57	92.76	0.00	0.00	
	White Ceramic Ref			92.85	68.41	0.27	96.92	0.00	29.83	

Results saved in the database are marked with a “D”

Results saved in the database are marked with a “D”

Measurements marked with a D in the database column are saved in the Appearance Elements database. To add measurements to the database

- Click on the dashed circle next to the measurement.
- Select multiple measurements in the selection column and click the Save to Database icon.



Several results can be saved in the database by selecting them and clicking the Save to Database icon

Several results can be saved in the database by selecting them and clicking the Save to Database icon

⚠ Once results are uploaded to the database they cannot be removed from measurement view. Measurements deleted from the measurement view will

remain in the Database. To delete measurements from the database it is necessary to access the database view.

Changes to text or batches made in the Results Table will automatically be updated in the database.

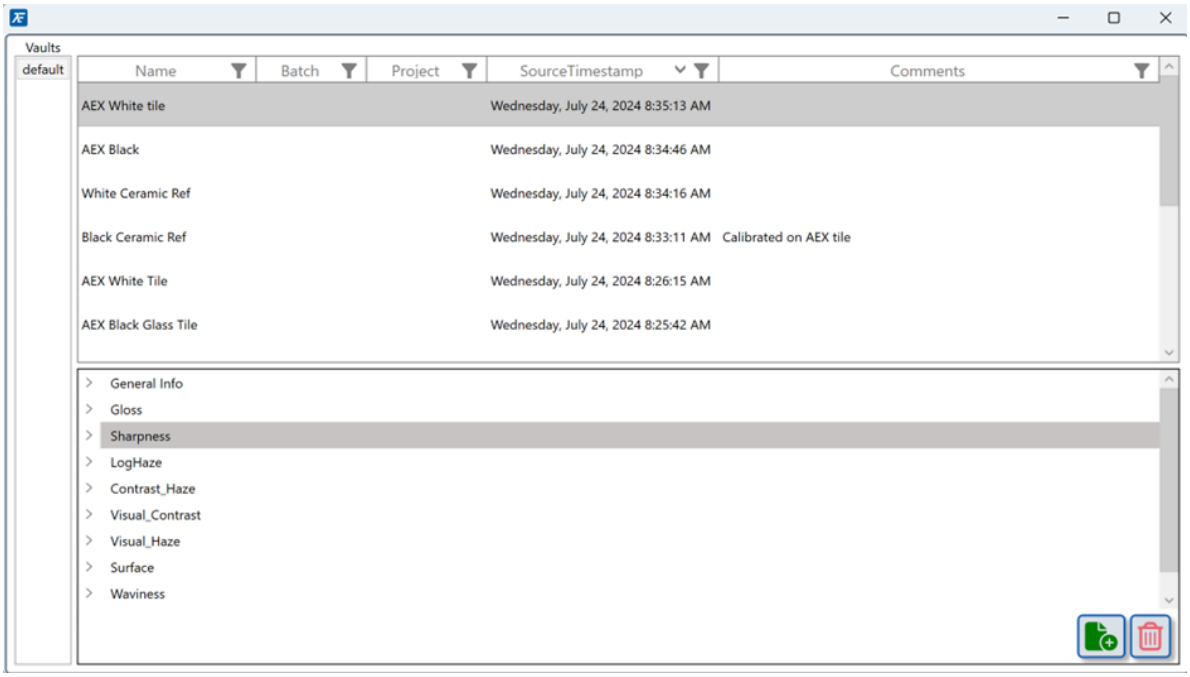
Database viewer

To access the data base view click the Data Base View icon.

Database view button

Database view button

> ⚠ If the database view icon is greyed out, the user does not have required permissions to access the database and cannot delete saved data.



Database view

Database view Measurements saved in the database are listed. Double click a measurement saved in the database to restore it to the measurement view. Highlight a measurement and click the delete icon to remove it from the database.

Saving and Loading results

Results in the measurement table are saved using the Save Results icon.

Results can be saved as a simple .csv which can include optional images (this option is available during saving procedure). .csv results cannot be reloaded into the data table.

For modules which include topographical data a heightmap xyz file (.xyz) can be saved.

A summary of all selected results in a table can be saved as a (.pdf) report including embedded images.

To share or archive results a Rhopoint Appearance Archive file (.raa) should be used.

To access this function, click the Save Results icon and follow onscreen instructions. Data is saved locally as .csv, measurement images and maps are also saved.

Save results button

The Aesthetix database can be used to securely store large data sets

4. Aesthetix Modules: Operation, Measurement parameters and how to interpret results

The Rhopoint Aesthetix system employs a modular approach to surface characterization, allowing users to tailor their measurement capabilities to specific needs.

This modular format offers significant flexibility and cost efficiency, as users can pay only for the measurement capabilities they require.

Module Concept

The Aesthetix system comprises several measurement modules, each designed to analyze specific surface characteristics:

1. **Surface Brilliance Module**: Measures gloss, visual gloss, haze, sharpness, distinctness of image (DOI), waviness, luminance, and RGB color.
2. **Effect Finish Module**: Ideal for coatings with effect pigments, measuring coarseness, RGB color, luminance, haze, sparkle density, sparkle visibility, waviness, and gloss.
3. **Surface Texture Module**: Suited for textured surfaces, measuring cell amplitude, count, size, reflectivity, luminance, RGB color, and gloss.
4. **Polishing Quality Module**: Simultaneously measures glossiness, haze, polishing defects, and scratches.
5. **Cross-cut Adhesion Module**: Objectively quantifies the results of adhesion strength tests.

Licenses and Demo Options

Rhopoint offers flexible licensing options for Aesthetix modules:

1. **Full Licenses**: Customers can purchase licenses for individual modules or bundles directly from Rhopoint Instruments.

2. **Demo Licenses**: Rhopoint provides free limited time demo licenses to qualifying Aesthetix users.

Adding New Licenses

To add new licenses to your Aesthetix system:

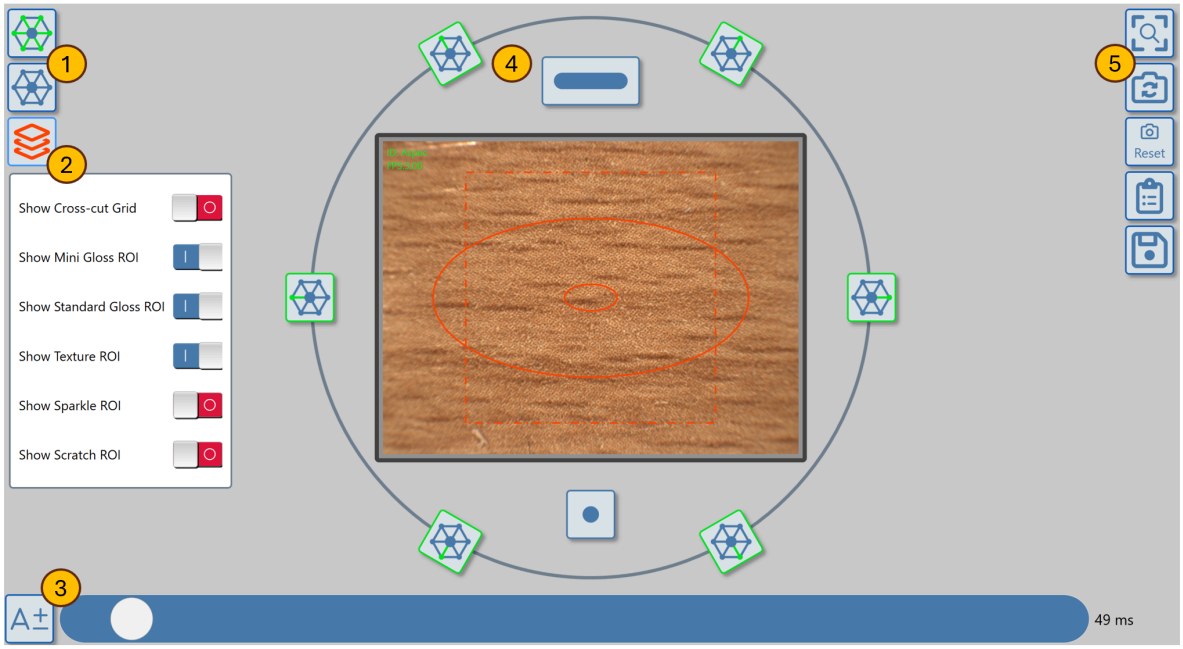
1. **Contact Rhopoint or Premium Rhopoint Distributor**: Reach out to Rhopoint directly via email at sales@rhopointinstruments.com (mailto:sales@rhopointinstruments.com).
2. **Discuss Requirements**: Talk with an application specialist to determine your specific measurement needs.
3. **Purchase Licenses or Free Demo**: Buy a new license or obtain a free demo to try out a new module.
4. **Activate Licenses**: Rhopoint will provide instructions for activating the new licenses within your Appearance Elements software.

The modular design of the Aesthetix system ensures that it can evolve alongside changing requirements. Rhopoint continuously develops new software modules, allowing customers to expand their measurement capabilities as new features become available.

Visual Demo Module

This module is used to manually control Aesthetix light sources and cameras. Surface or gloss images from these screens can be saved with or without overlays.

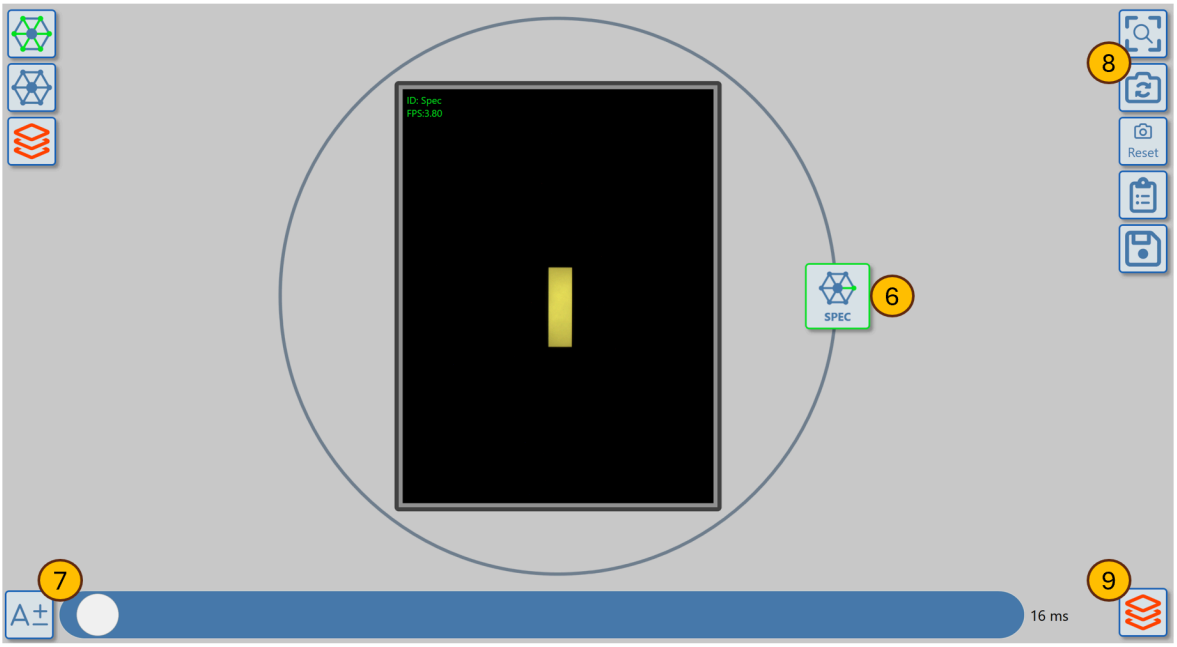
Surface View Mode



Visual Demo screen

Surface View Controls

1. 45 Degree Light- toggle between all on and all off.
2. Overlay control- switch on overlays to indicate measurement areas for Aesthetix Modules.
3. Camera exposure control, click "A" to activate auto-exposure or use manual slider.
4. Individual LED control (Line light, 6 x 45 degree ring lights, 10 degree spotlight)
5. Image Controls (Reset view, switch to gloss view, reset camera, copy image to clipboard, save image to file)



Visual demo specular camera

Gloss View Mode

6. Specular 60 degree light toggle on/off.
7. Camera exposure control, click "A" to activate auto-exposure or use manual slider.
8. Image Controls (Reset view, switch to surface view, reset camera, copy image to clipboard, save image to file).
9. Toggle gloss overlay.

Surface Brilliance Module

The Surfaces Brilliance Module quantifies all of the aspects of a glossy surface which contribute to the perception of appearance quality.

Measuring Glossiness Perception

Describing the perceived surface quality of high gloss surfaces requires a multi-faceted approach that includes gloss, contrast gloss, haze, sharpness, and waviness measurements. Each parameter provides unique insights into the surface's reflective properties, contributing to a comprehensive understanding of its aesthetic and functional qualities.

Gloss

Definition: Gloss refers to the overall shiny appearance of a surface when light is reflected directly off it. It is often measured using glossmeters which quantify the amount of reflected light at specific angles.

Importance: Gloss is the most widely used measure of a surface's ability to reflect light in a specular manner, contributing to its shiny appearance.

Continue reading (Gloss)

Visual Gloss

Definition: Also known as contrast gloss it is a measure of the perceived gloss the specular and diffusely reflecting areas on a surface.

Importance: This measure is crucial for distinguishing between high gloss surfaces that may have similar specular gloss but differ in their overall perceived shininess due to texture or material properties (Ignell et al., 2010).

Continue reading (Visual Gloss)

Haze

Definition: Haze refers to the light scattering that causes a milky or cloudy appearance around specular reflections. It is often the result of surface imperfections or coatings that scatter light.

Importance: High haze reduces the perceived clarity and glossiness of a surface (Vangorp et al., 2017).

Continue reading (Haze)

Sharpness

Definition: Sharpness, also referred to as distinctness of image (DOI), measures the clarity and detail of reflections seen on a surface. High DOI indicates clear, sharp reflections.

Importance: DOI is critical for surfaces where the quality of reflected images is essential, such as in automotive finishes and photographic papers. It correlates strongly with customer perception of quality (Tse et al., 2005).

Continue reading (Distinctness of Image DOI)

Waviness

Definition: Waviness refers to the surface texture's longer wavelength deviations. It is a measure of surface smoothness and orange peel effects.

Importance: Surface waviness can significantly affect the overall appearance of gloss. Smooth surfaces with minimal waviness have better visual appeal.

Comprehensive Glossiness Perception

Combining Measurements

By integrating measurements of gloss, contrast gloss, haze, sharpness, and waviness, a more comprehensive understanding of surface glossiness can be achieved. Each measurement addresses a different aspect of the reflective quality and texture of the surface.

Interdependencies

Contrast gloss and haze often interact, where surfaces with high contrast gloss may exhibit lower haze, leading to clearer reflections.

Sharpness (DOI) and waviness are related; surfaces with low waviness typically have higher DOI due to the reduced scattering of light.

Taking a Measurement (Surface Brilliance)

How to measure sparkle and Graininess

The measurement button is used to start single or multiple measurment that are sent directly to the table.

1. Calibrate the sensor
2. To access the multiple readings feature, right click on the measurement button.
3. Press the measurement button to start.

Measurement button

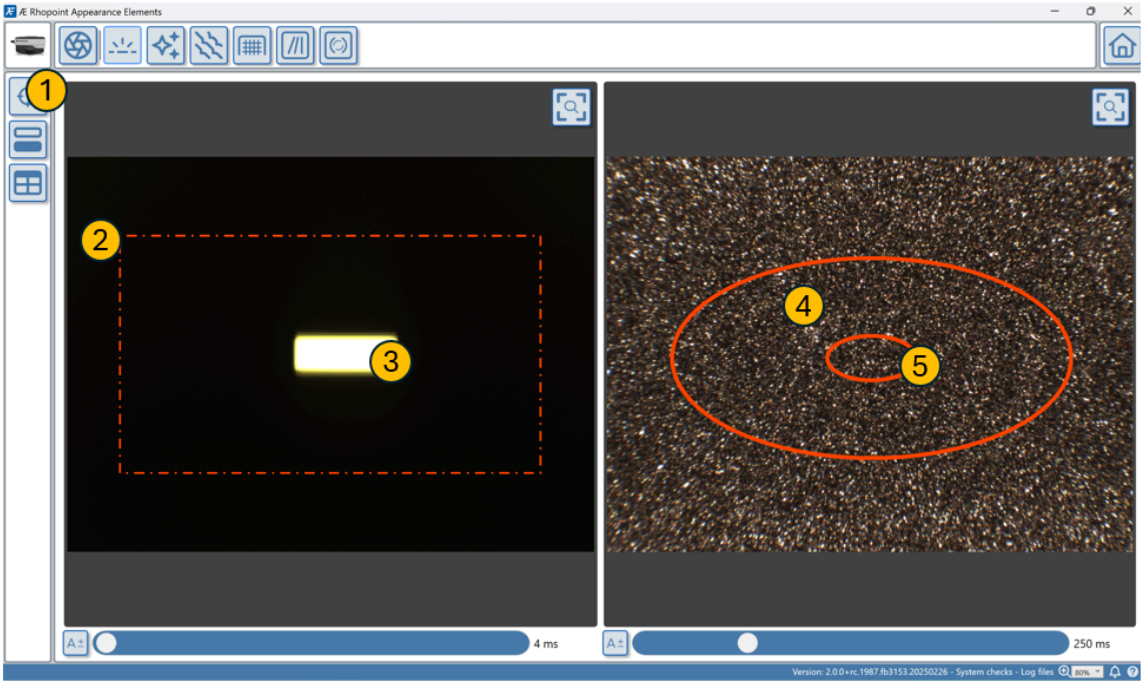
How to measure sparkle and graininess on surfaces using the interactive measurement feature

The interactive measurement function is a "live" view of the sample surface. It is used to identify particular areas of interest when measuring surface brilliance.

Measurement Procedure

1. Ensure the sensor is calibrated.
2. Press the button (1) to activate the interactive measurement feature.

Interactive button



gloss interpretation 2

3. Use the auto-exposure button to optimize the camera exposure for the surface's reflectivity.
4. Manually adjust exposure if needed using the slider or input box.
5. The red dashed area on the live display indicates the target measurement area for gloss.
6. If measuring a curved or uneven surface ensure the gloss peak (3) is centered in the red dashed box (2) by changing the alignment of the sample or sensor.
7. To measure the gloss of an identified area on the surface move the sensor until the required area is enclosed by the correct red ellipse (4 & 5).

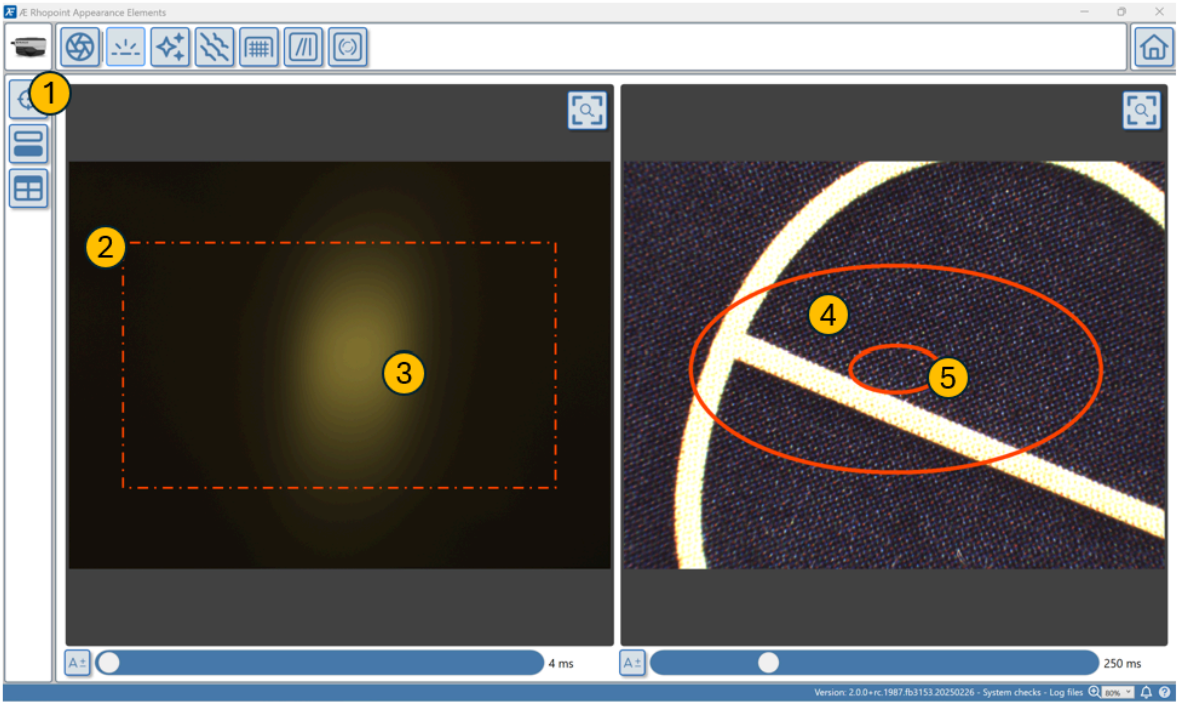
Adjusting the exposure settings do not affect measurements. This control is used

to get a clear surface or gloss image for positioning purposes.

The reflected gloss image on this high gloss coating is intense and sharp & positioned centrally for an accurate gloss measurement.

The surface image shows the area on the surface where the gloss is measured (4- measurement area for standard gloss adaptor & 5- Small area/ curved surface adaptor)

> Appearance Elements automatically corrects for minor sample misalignment, if the gloss peak is within the central region (6) gloss measurement will be accurate.



Gloss interpretation 1

The gloss peak for matt and semi-gloss surfaces is less distinct, for alignment purposes ensure the brightest part of the image is within the red square (2).

Matt surfaces will reflect a image without a peak, alignment is less critical for these surfaces, ensure the camera sesnor is evenly lit before taking a measurment.

Gloss

60° Gloss is the universal gloss measurement parameter used in most industries.

Standard Gloss Overview

Gloss is a measure of how well a surface reflects light in a specular (mirror-like) direction. In industry, gloss is crucial for assessing the aesthetic and functional qualities of products.

A High gloss finish is often desired for its visual appeal, giving surfaces a shiny, sleek, and premium look, commonly seen in automotive finishes, consumer electronics, and high-end furniture.

Low gloss or matte finishes are used to reduce glare and provide a softer, more subtle appearance, which is preferred in certain architectural coatings and household appliances.

Gloss measurement helps ensure consistency and quality control in manufacturing processes, influencing customer satisfaction and product performance.

Gloss GU (Standard Gloss)

The Aesthetix measures the amount of light reflected from a material in a specific, controlled manner according to ISO 2813 and ASTM D523 international standards.

The Aesthetix measures gloss using the "universal" measurement geometry of 60 degrees, the most widely used measurement for understanding glossiness of a material.

Gloss Measurement with Rhopoint Aesthetix

Why Use the Rhopoint Aesthetix for High-Gloss Surfaces?

Experience teaches us that simple gloss measurement is not sufficient to measure the surface quality of high-gloss products because common imperfections like haziness and orange peel reduce percieved quality but are not measured by a simple glossmeter.

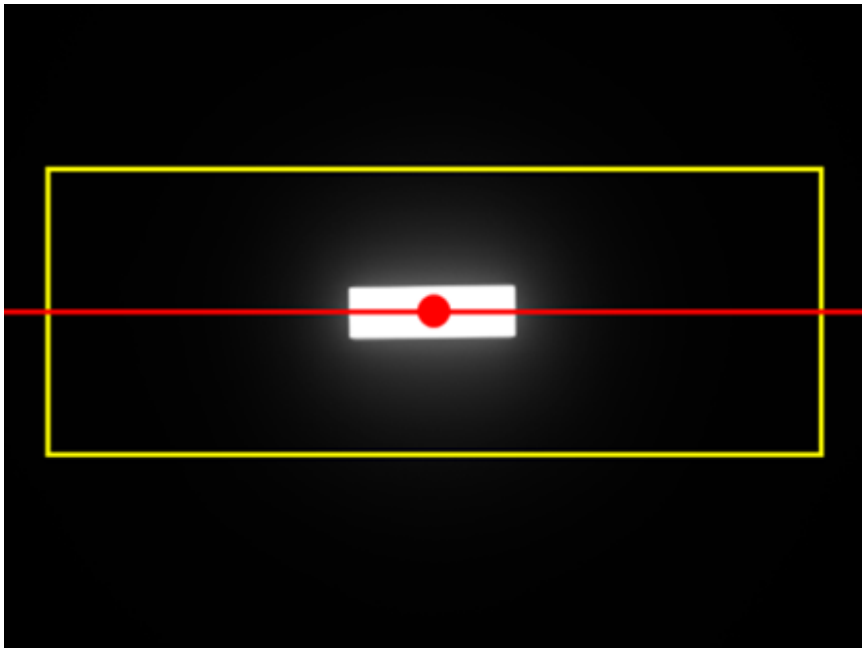
The Rhopoint Aesthetix Gloss Module accurately measures gloss, haze, distinctness of image (DOI), and visual gloss to ensure surfaces look perfect and uniform.

This is important in industries like automotive, electronics, and luxury products, where surface quality affects product value and customer appeal.

Gloss Calibration

Aesthetix instruments are supplied with a ISO 17025 high gloss calibration tile in accordance with the relevant standards.

Measurement of Gloss



Gloss Window—measurement of a glass standard

Gloss Window—measurement of a glass standard

Aesthetix measures by projecting a rectangular image on to the sample surface which is reflected onto an internal camera sensor. The camera sensor measures the amount of light reflected in the Gloss ROI shown in yellow in the figure.

Surface Characteristics that determine Gloss

Surface texture present on a surface material (roughness, micro roughness, and nano texture) will reflect a mixture of specular and scattered (diffuse) light.

The refractive index of a coating determines the proportion of light that is reflected from the surface (gloss) compared to the amount absorbed within the basecoat or substrate.

Metallic and special effect coatings contain mirror like facets of mica or metal flake will demonstrate increased gloss due to light reflected within the from these elements.

Highly background colours- for example white & yellow exhibit a slightly higher gloss level than absorbent colours black, dark grey, etc.

For multilayer transparent materials, gloss values can be increased due to multiple reflections within the material.

Where is gloss used?

- **Quality Control in Manufacturing**: To ensure consistency and quality of products, gloss measurements can be taken at various stages of production.
- **Surface Treatment and Finishing of low to mid gloss material**: After processes like painting, varnishing, to verify that the desired level of gloss has been achieved.
- **Comparative Analysis of materials with the same background colour**: When comparing different batches of materials or products to ensure uniform appearance.
- **Surface Damage Assessment**: To assess wear, fading, or other surface changes over time.

Gloss Interpretation

Gloss Values and Their Meaning

Gloss is measured in Gloss Units (GU). Here are some typical gloss values for different materials:

Material	60-Degree Gloss Value
Automotive Clearcoat	85-95 GU
Semi-Gloss Paint	50-75 GU
Satin Paint	25-35 GU
Matte Paint	5-15 GU
Polished Metals	300-950 GU
Perfect Mirror	1000 GU

Higher values indicate a more reflective, glossier surface.

Visualizing Gloss in Appearance Elements

Changing Surface Gloss

To change the gloss of a surface:

1. **Surface Texture**: Smoother surfaces generally have higher gloss. Polishing or sanding can increase gloss, while roughening the surface can decrease it.
2. **Coating Formulation**: For coated surfaces, adjust the refractive index of the coating. Higher refractive index materials tend to be glossier.

3. **Pigmentation**: For paints, the type and amount of pigments can affect gloss. Generally, fewer pigments result in higher gloss.
4. **Application Method**: The way a coating is applied can impact gloss. Spray application often yields higher gloss than brush application.
5. **Curing Conditions**: For certain coatings, the curing process can affect final gloss. Proper curing conditions are essential for achieving desired gloss levels.
6. **Substrate**: The underlying material can influence gloss. A smoother substrate often results in a glossier finish.

Remember that changing gloss may affect other surface properties, so consider the overall impact on the product's performance and appearance.

Gloss measurement tips

Tips include, when to use Gloss or Visual Gloss, sensor placement and calibration advice.

Measurement Advice

Make sure the instrument is placed flat on the surface.

Regularly calibrate the instrument, once per day is recommended.

For curved surfaces use the curved surface measurement adapter and interactive measurement feature.

Measurement Advice—Curved Surfaces

It is not advisable to measure curved surfaces with a radius of <0.5m with the standard gloss adaptor setup.

The instrument is supplied with a curved surface/small parts adaptor which reduces the measurement spot to 2x4 mm- this makes it suitable for curved surfaces.

Measurement Advice—Complex Parts

For complex shapes or small radius parts it is difficult to correctly position the instrument during measurement - for best results

- Measure non-contact using measurement stand or cobot.
- Use the live positioning feedback to ensure correct positioning.
- For highly reproducible results create 3D printed jigs to position the part in the correct position.

Measurement Advice—Small Areas

It is possible to measure small areas using curved surface/small parts adaptor use the interactive measurement feature to correctly position the instrument before measuring.

Standard Gloss Disadvantages compared to Visual Gloss

- Standard Gloss is does not match customer perception when comparing different coloured materials.
- Gloss measurement alone does not detect surface effects that reduce the appearance quality of high gloss materials- such as Haze, Orange Peel and poor sharpness.

Measurement tip-When to measure with Standard Gloss

Standard gloss measurement is Important for quality control of materials with existing specifications, Aesthetix standard gloss measurements are fully compliant with ISO and ASTM international norms.

Backward compatibility with customers instruments- Aesthetix 60 degree gloss values are perfectly correlated to those supplied by Rhopoint IQ or NG glossmeters or BYK Micro Gloss instruments.

When a quantitative measurement of light reflection is required.

For Gloss measurements that better correlate with perception use VISUAL GLOSS.

For high gloss surfaces- Haze, Sharpness and Waviness are often superior predictors of surface quality than Gloss measurement.

Measurement tip-When Standard Gloss is important

Backwards compatibility with existing measurements : Standard gloss measurements are fully compliant with ISO and ASTM international norms.

Regulatory and Technical Specifications: Many industries have defined standards for gloss levels that need to be met. In such cases, using a glossmeter ensures compliance with these technical specifications.

Measure the Gloss of Curved Surfaces

Measuring curved surfaces is challenging due to beam distortion and positioning difficulties. The Rhopoint Aesthetix addresses these issues with its advanced optical design, small measurement beam size adaptors and interactive measurement feature.

Preparation

1. **Adaptor Selection:**

- Replace the standard flat surface adaptor with the curved surface/small parts adaptor, Novo-Curve Adaptor or custom 3D printed Jig. This adaptor reduces the beam size, making it suitable for curved surfaces.
- To attach the adaptor:
  - Remove the standard adaptor by pulling it off (magnetically attached).
  - Attach the curved surface adaptor securely in its place.

2. **Calibration:**

- Recalibrate the instrument after changing adaptors to ensure accurate measurements. Use the supplied calibration tile certified to meet traceability standards.

3. **Positioning Tools (Optional):**

- For repeatable measurements on small or complex parts, use bespoke 3D-printed jigs or a laboratory stand. These tools help maintain consistent positioning during measurement.

Measurement Procedure

Using the Curved Surface Adaptor

1. **Instrument Placement:**

- Use the interactive measurement feature to ensure that the measurement beam is centered on the reflection image. Misalignment can lead to inaccurate results.

2. **Measurement Execution:**

- Press the measurement button once alignment is confirmed. The Aesthetix will capture data for gloss, haze, DOI, and other parameters simultaneously.

Non-Contact Measurement (Optional)

For fragile or delicate surfaces:

1. Mount the Aesthetix on a height-adjustable stand or integrate it into a COBOT system. Ensure that the focal distance is maintained at 10 mm ± 0.5 mm from the target surface.
2. Follow steps for live alignment and execute measurements as described above.

Tips for Accurate Measurement

- Avoid measuring surfaces with a radius smaller than 0.5 m using standard adaptors; always use the curved surface adaptor for such cases.
- For highly complex shapes, consider non-contact measurement methods combined with custom jigs or COBOT systems for precise alignment.
- Regularly calibrate the instrument to maintain accuracy, especially after changing adaptors or environmental conditions.

Applications

The Rhopoint Aesthetix excels in industries requiring precision appearance control of curved components, such as:

- Automotive (e.g., chrome trims, high-gloss paint finishes)
- Medical devices (e.g., orthopedic implants)
- Consumer electronics (e.g., buttons, casings)
- Pharmaceuticals and confectionery (e.g., pills, candy coatings).

By following these steps and leveraging its advanced features, you can achieve reliable and repeatable measurements of curved surfaces with your Rhopoint Aesthetix instrument.

Visual Gloss

Visual Gloss (VGU): A NEW measurement which matches gloss perception of human observers when comparing surfaces of different colour.

Gloss perception of high gloss surfaces is influenced not only by the intensity of the reflected light but also the background colour of the material it is reflected in.

Gloss car example

Materials with a dark background appear glossier to a human observer than the same amount of reflection on a material with a light background.

Visual Gloss Scale

The scale for Visual Gloss (VGU) was obtained through psychophysical experiments where human observers rated the glossiness of various samples under controlled lighting conditions.

Experiments involved a light booth with adjustable specular and background light sources, and samples with different back painted colours and various gloss levels.

Observers used a method called magnitude estimation to assess the glossiness of each sample, comparing them to a standard reference with a predefined gloss value.

Visual Gloss and Human Perception

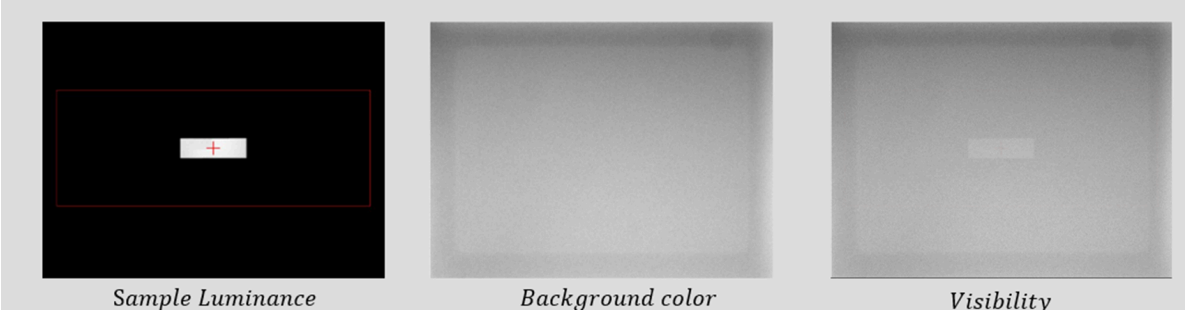
The VGU equation was derived from the psychophysical experiments showed a high degree of correlation with human perception of gloss, the equation predicts visual gloss (VG) based on the contrast between the brightness of the reflected image against the background colour of the surface.

The performance of the Visual Gloss prediction formula was evaluated using a psychophysical scaling function, and it achieved a high adjusted coefficient of determination (r2 =0.963).

Visual Gloss Measurement

The Aesthetix measures Visual Gloss (VGU) using dual cameras and a combination of light sources, images of the sample are captured under direct illumination by the specular source and background illumination provided by the 45 degree circumferential ring light.

The visual gloss algorithm calculates considers intensity of the specular highlight viewed against the luminance of the background viewed in indoor conditions.



Sample luminance and background color

The Rhopoint Aesthetix measures Visual gloss with images from the specular and observer camera.

Visual Gloss Validated

The Aesthetix method for calculating visual gloss was validated using an Imaging Luminance Measurement Device (ILMD), mathematical modelling and ray-tracing simulations.

Results were empirical tested using diverse samples from a commercial gloss scale.

This validation demonstrated a strong correlation between the Aesthetix measurements and the contrast gloss formula, particularly effective in mid to high gloss ranges.

Visual Gloss measurement tips

When to use Visual Gloss VGU compared to Standard Gloss GU

Visual gloss is better suited for applications where human perception is crucial, standard gloss is useful when compliance to a standard is key or measurements need to match historic specifications.

Balancing between these two methods can be essential depending on the specific requirements of the project or product

Measurement tip-When Visual Gloss is important

Subjective Perception is Key: If the goal is to understand how people perceive the glossiness of a surface under real-world conditions, VG is more appropriate.

This is crucial in industries where the aesthetic and visual appeal are critical, such as in automotive finishes, furniture, consumer electronics, and interior design. Both measurements are visible simultaneously in Rhopoint Appearance Elements software.

Product Development and Marketing: When developing products where the consumer's perception influences their decision to purchase, VG can provide insights into how potential buyers might view the product under typical use conditions.

Quality Control: If the product quality is judged visually by consumers, VG assessments can help ensure consistency in how products are perceived in the marketplace.

Haze

Haze refers to the scattering of light by a surface that causes a reduction in the contrast of a reflected image. It results in a milky appearance which can reducing the perceived depth of the finish.

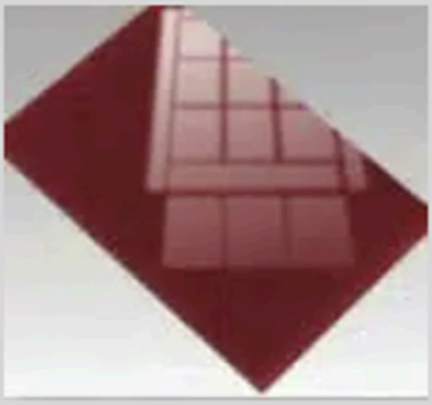
Reflection haze

Reflection haze is an optical phenomenon usually associated with high gloss surfaces.

It is a common surface fault that reduces appearance quality. A hazy surface has a visibly shallower reflection with a milky finish and halos appear around reflections of strong light sources.

Sample 1

No Haze, deep reflection



Sample 2

High Haze, 'shallow' finish

A high gloss finish with haze exhibits a milky finish with low reflective contrast, reflected highlights and lowlights are less pronounced.

On surfaces with haze, halos are visible around the reflections of strong light sources.

Sample 3

Low Haze

Sample 4

Higher Haze

Reflection Haze Examples

The visibility of haze on a surface is influenced by viewing conditions and the background colour of the material.

Viewing conditions- Haze effects are highly visible when viewed with a high intensity specular light- for example viewed with a powerful inspection light or outside in bright sunshine.

Haze effects diminish the perceived quality of high gloss coatings and are usually an undesirable attribute.

Log Haze Compensated- LogH C (LogHU)

The LogH C parameter in the Rhopoint Aesthetix represents the logarithmic haze value calculated using contrast-based measurements.

LogH C (compensated) compensates for background colour when measuring Haze, hence this is value is used extensively in QA Application.

LogH C measurements with Aesthetix are correlated to values measured with Rhopoint IQ.

In the Rhopoint Aesthetix, this process is performed using a 60° measurement angle instead of the traditional 20°, with haze regions defined between 2° and 4° off-specular angle.

Log Haze- LogH (LogH)

The LogH parameter in the Rhopoint Aesthetix is derived from the haze measurement process. It is calculated by converting the haze value into a logarithmic scale. The ASTM E430 and ISO 13803 standards describe haze evaluation based on the ratio of luminous flux in off-specular regions to the flux from a specular gloss reference sample. is the flux from the specular gloss reference sample.

In the Rhopoint Aesthetix, this process is performed using a 60° measurement angle instead of the traditional 20°, with haze regions defined between 2° and 4° off-specular angle.

Note- Log H value is no longer used in QC applications as the measured value is influenced by background colour of the paint.

Michelson Contrast Haze- MC H (HU)

The MC H parameter, or Michelson Contrast Haze, in the Rhopoint Aesthetix is a haze

metric based on Michelson contrast.

It quantifies the difference between the luminance of the specular highlight and the adjacent off-specular regions. This method provides insights into how surface microstructure affects visual haze, which traditional haze measurements may overlook.The MC H parameter, or Michelson Contrast Haze, in the Rhopoint Aesthetix is a haze metric based on Michelson contrast. It quantifies the difference between the luminance of the specular highlight and the adjacent off-specular regions.

This method provides insights into how surface microstructure affects visual haze, which traditional haze measurements may overlook.

Haze Interpretation

What is Haze?

Haze refers to the scattering of light by a surface that causes a reduction in the contrast of a reflected image. It results in a milky appearance which can reduce the perceived depth and clarity of a finish[^1]. Haze is often caused by microscopic surface irregularities, contaminants, coating defects, or subsurface imperfections that scatter light in various directions[^1].

How Aesthetix Measures Haze

The Aesthetix measures haze using an advanced imaging technique:

1. It captures a high-dynamic-range (HDR) image of the surface reflection
2. The system analyzes the light distribution around the main specular reflection
3. It quantifies the amount of scattered light in specific angular regions

This method allows for a more comprehensive assessment of haze compared to traditional haze meters.

Haze Metrics Provided by Aesthetix

The Aesthetix provides several haze-related metrics:

1. LogH (LogHaze): Logarithmic haze value in logHU
2. LogH C: Logarithmic haze with background compensation in logHU
3. Haze C: Haze with background compensation in HU
4. MC H (Contrast Haze): Calibrated contrast haze value in HU
5. Visual Haze Indoors: Visual haze value for indoor viewing conditions in VHU
6. Visual Haze Outside: Visual haze value for outdoor viewing conditions in VHU

Comparison and Usage

- LogH and LogH C provide logarithmic scales, which can be useful for materials with a wide range of haze values.
- Haze C and MC H offer linear scales with background compensation, providing more accurate results for colored or textured surfaces.
- Visual Haze metrics (Indoors and Outside) are perception-based measurements that correlate closely with human observation under different lighting conditions.

For most applications, Visual Haze metrics are recommended as they best represent how haze is perceived by human observers. Use Visual Haze Indoors for products primarily viewed indoors, and Visual Haze Outside for products exposed to outdoor lighting[^1].

For technical or research applications where comparison to traditional haze measurements is needed, LogH or Haze C may be more appropriate.

Visualizing Haze in Appearance Elements

Altering Surface Haze

To alter the haze of a surface:

1. Surface Polishing: Fine polishing can reduce surface irregularities and decrease haze.
2. Coating Formulation: Adjust the coating formula to include additives that promote smoother surface formation or reduce micro-texture.
3. Application Technique: Optimize spray patterns, drying conditions, and curing processes to minimize surface irregularities during coating application.
4. Surface Cleaning: Thoroughly clean the surface to remove contaminants that may contribute to haze.
5. Substrate Preparation: Ensure the underlying substrate is smooth and free of defects that could telegraph through the coating.
6. Post-Treatment: For some materials, post-application treatments like heat or UV curing can help reduce haze by promoting better surface leveling.

7. Environmental Control: Control humidity and temperature during application and curing to prevent issues like blushing that can increase haze.

Remember that altering haze may affect other surface properties, so consider the overall impact on the product's appearance and performance when making changes.

Haze measurement tips

Tips on which Haze metric works to use to characterise a surface, when to use Haze or Visual Haze.

Measurement Advice- Which Haze Metric should I use for my surface

LogH C is the most commonly used QC metric for paints and coatings.

For automotive polishing and finesse application visual hase indoor VisHin (VHU) and VisHout (VHU) are recommended.

Measurement Advice- Which surfaces are suitable for Haze Measurement

Haze measurement is designed for high gloss surfaces, haze is quantified by measuring the amount of light reflected near the gloss angle.

Matt and semi gloss surfaces have a high reflection of light in this region because of their diffuse nature- this wiil show as a high haze reading but this will not match the perception of the surface.

Measurement Advice – Haze Directionality

The haze measurements taken with the Rhopoint Aesthetix are **directional**, meaning haze is quantified specifically within the plane of measurement. This characteristic makes the instrument particularly sensitive to surface patterns or textures introduced during manufacturing.

Why Directionality Matters

During production, many materials develop directional characteristics due to:

- **Printing processes** (e.g., lithographic varnishes)
- **Mechanical treatments** (e.g., rolling or polishing for stainless steel)
- **Environmental influences** (e.g., gravity effects in painted surfaces)

How to Detect Directionality

To assess whether a material has directional properties:

1. **Perform the first measurement** in the standard orientation.
2. **Rotate the instrument 90°** and repeat the measurement.
3. **Compare the results**:
   - **Isotropic surfaces** (no directionality) will yield similar haze measurements regardless of orientation.
   - **Anisotropic surfaces** (directional) will show significant differences between the two measurements.

Practical Importance

Understanding haze directionality helps maintain consistent appearance, especially for materials where surface texture is a critical aesthetic feature, like brushed metal or patterned coatings. Manufacturers can use this information to ensure uniformity across production batches or to deliberately enhance the directional characteristics for specific applications.

Causes of Reflection Haze in a Surface

1. Surface Roughness and Texture
   - Microscopic Irregularities: Small-scale surface roughness and microscopic irregularities scatter light in various directions, causing a diffuse reflection. This scattering creates a hazy appearance around the main reflection.
   - Physical Texture: Surfaces with physical textures, such as fine scratches or uneven coatings, can scatter light and contribute to haze.
2. Contaminants and Impurities
   - Dust and Particles: Presence of dust, dirt, or other particles on the surface can scatter incident light, leading to haze.
   - Chemical Residues: Residues from cleaning agents, polishing compounds, or

manufacturing processes can leave behind films or particles that scatter light.

3. Coating and Material Defects

- Inhomogeneous Coatings: Variations in the thickness or composition of coatings can create regions that scatter light differently, increasing haze.
- Material Inclusions: Embedded particles or inclusions within the material or coating can scatter light and contribute to a hazy reflection.

4. Subsurface Imperfections

- Internal Scattering: Imperfections beneath the surface, such as air bubbles, voids, or subsurface cracks, can scatter light internally and cause haze.
- Layer Interfaces: Interfaces between different layers of a coating or composite material can reflect and scatter light, contributing to haze.

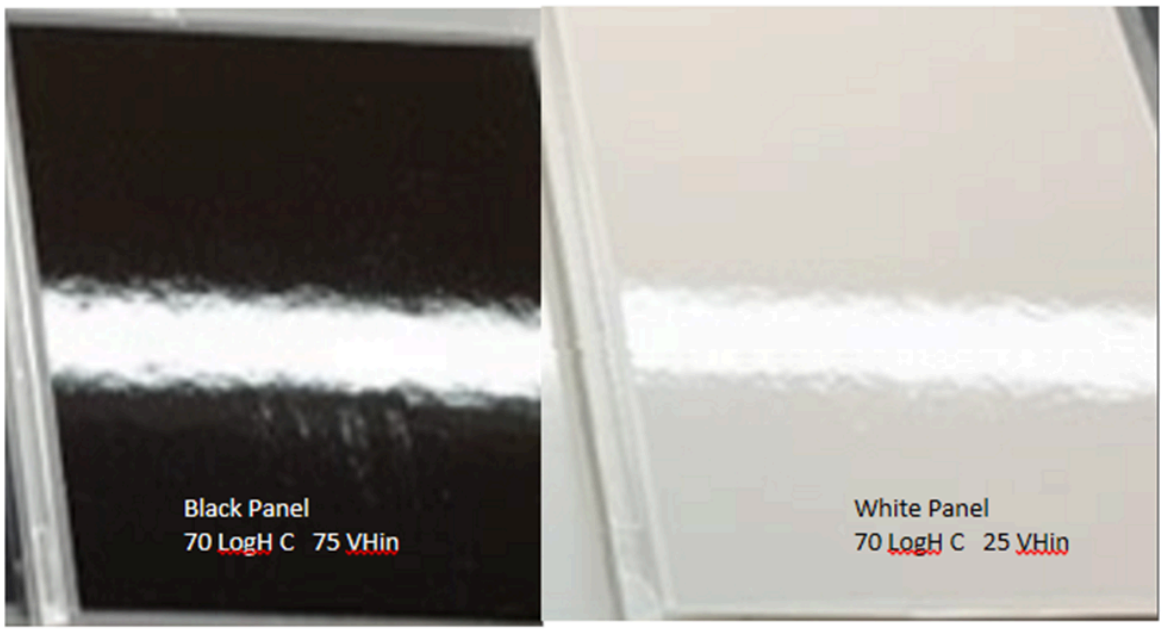
5. Degradation and Wear

- Aging and Weathering: Environmental exposure, UV light, and aging can degrade the surface quality, increasing roughness and promoting light scattering.
- Mechanical Wear: Repeated mechanical actions, such as cleaning, polishing, or abrasion, can introduce surface defects that scatter light and increase haze.

Visual Haze

NEW Visual Haze measurement is more sensitive and more consistent with human perception because it accounts for illumination conditions and background paint colour.

Visual haze is calculated considering the luminosity of the background colour and the luminosity of the near specular reflection (Haze). Two values are provided to account Haze visibility in two different viewing conditions, indoor viewing compared to outdoor viewing in strong sunlight.



Two panels visual haze

Two panels with identical reflective properties but Haziness is not visible on the white material. Visual Haze records the perceived haziness.

> High levels of technical haze (LogH C) on low contrast colours are not visible but may cause the material to fall outside of specification. Visual Haze matches human perception and used to avoid unnecessary material rejections and over processing.

Visual Haze VH Indoor Vhin and Visual Haze Outdoor Vhout

Haze effects are amplified in strong sunlight- swirls whirls and holograms which are not visible in indoor conditions are prominent when illuminated by a high intensity light-

source.

Surface defects not detected by LogH C

Surface Defects which are not detected by technical haze (LogH C) are very visible in strong sunlight. The Aesthetix can predict the visibility of haze, scratches and polishing marks in workshop and sunny outdoor conditions.

	Conditions	Surface illumination	Specular Illumination
VH_{in}	Standard indoor lighting	0.5k Lux	25k cd/m^2
VH_{out}	Sunny day- clear sky	100k Lux	1.6m cd/m^2

Coatings or materials which are to be viewed in outdoor conditions should be assessed using the Visual Haze Outdoor (Vhod) parameter- which will quantify

the visibility of unwanted haziness in all conditions, avoiding customer dissatisfaction and material re-work.

Haze	Surface	Description/Perception
<50 Hu (Indoor or outdoor)	High Quality Surface	Almost perfect surface- haze not visible under normal viewing conditions.
50-100	Ultra Low Haze Surface	Good depth of finish- Barely visible halo around reflected light sources.
100-250	Visible Haze	Depth of finish is compromised- swirls and polishing marks are visible
250-300	Hazy Surface	Poor quality finish
300-500	Poor Quality Surface	Prominent halos, holograms or polish marks. Poor depth of finish

Visual Haze Interpretation

Haze	Surface	Description/Perception
<50 Hu (Indoor or outdoor)	High Quality Su rface	Almost perfect surface- haze not visible under n ormal viewing conditions.
50-100	Ultra Low Haze Surface	Good depth of finish- Barely visible halo around reflected light sources.
100-250	Visible Haze	Depth of finish is compromised- swirls and polis hing marks are visible
250-300	Hazy Surface	Poor quality finish
300-500	Poor Quality Su rface	Prominent halos, holograms or polish marks. Poo r depth of finish

Waviness

What is Waviness?

Waviness refers to gentle undulations or waves visible on a surface that is meant to be smooth. In coated surfaces, this effect is often called "orange peel" because the texture resembles the skin of an orange.

Waviness is an optical effect caused by large structures (0.1-10mm) on the surface of the material.

For high gloss finishes, excessive waviness reduces the perceived quality by disrupting the uniformity and clarity of reflected images.

Waviness is a key parameter when observers judge the appearance quality of high gloss coatings. A smoother, low waviness coating is perceived as higher quality compared to a similar surface with more surface texture (higher waviness).

How Aesthetix Measures Waviness

The Aesthetix measures waviness by quantifying the distortion in a 25mm straight line reflected in the material surface.

Waviness Interpretation

Waviness Values and Their Meaning

The Aesthetix waviness scale is highly correlated to Rhopoint TAMS waviness - a measurement parameter derived from multiple human perception trials.

The value quantifies the visual impact of orange peel observed in high gloss coatings at a viewing distance of 1.5m.

This value has been proven effective for quantifying orange peel in sectors such as automotive, yacht Coatings, powder coatings and high quality furniture.

Waviness values and their meanings:

- 2 WU: Piano Finish - Very smooth with no visible waviness. Imparts a feeling of very high quality.
- 2-5 WU: Low orange peel - Smooth finish, orange peel is barely visible with a good or neutral impact on judgement of surface finish.
- 5-10 WU: Standard Orange Peel - Surface with moderate orange-peel which is visible and is a factor when judging finish quality, especially on high contrast colors (black).
- 10-15 WU: High Orange peel - Surface with prominent orange peel which has a negative impact on surface quality judgement.

Visualizing Waviness Using Appearance Elements

Changing the Waviness of a Surface

To change the waviness of a surface:

1. Improve Application Technique: Proper spraying distance, angle, and technique can reduce uneven paint distribution that leads to orange peel.
2. Adjust Paint Viscosity: Use paint with the correct viscosity for better flow and leveling, reducing bumpy finishes.

3. Control Environmental Factors: Maintain appropriate humidity and temperature during application and drying to prevent uneven drying that can cause orange peel.
4. Enhance Surface Preparation: Adequate sanding and cleaning of the surface before painting can minimize imperfections that contribute to waviness.
5. Allow Proper Curing Time: Sufficient drying time between coats can result in a more even surface texture.
6. Optimize Equipment Settings: Use the correct nozzle size and pressure settings on spray guns for proper paint atomization.
7. Address Substrate Issues: Improve the underlying material quality, as texture in the substrate can telegraph through the coating layers, causing visible orange peel[^1].

Remember that changing waviness may affect other surface properties, so consider the overall impact on the product's appearance and performance when making adjustments.

MC Haze

Haze refers to the scattering of light by a surface that causes a reduction in the contrast of a reflected image. It results in a milky appearance which can reducing the perceived depth of the finish.

Michelson Contrast Haze- MC H (HU)

The MC H parameter, or Michelson Contrast Haze, in the Rhopoint Aesthetix is a haze metric based on Michelson contrast.

It quantifies the difference between the luminance of the specular highlight and the adjacent off-specular regions. This method provides insights into how surface microstructure affects visual haze, which traditional haze measurements may overlook.The MC H parameter, or Michelson Contrast Haze, in the Rhopoint Aesthetix is a haze metric based on Michelson contrast. It quantifies the difference between the luminance of the specular highlight and the adjacent off-specular regions.

This method provides insights into how surface microstructure affects visual haze, which traditional haze measurements may overlook.

Sharpness

NEW Sharpness measurements are used to quantify the ability of a surface to reflect a sharp, clear reflection.

Sharpness is closely related to DOI but focuses specifically on the sharpness and clarity of the edges within the reflection.

Good sharpness/DOI is important for high gloss surfaces as it indicates a smooth mirror like reflective surface which is often perceived high quality.

Low sharpness surfaces indicate blurry, indistinct surfaces with poor depth of finish which reduces the "quality feeling" for consumers.

High Sharpness is essential for maintaining the visual appeal of products such as automotive finishes, consumer electronics, polished stone, reflective metal parts and high-end furniture.

The NEW Aesthetix sharpness measurement using developed using perception studies of multiple human observers, with results that correlate to visual perception.

Sharpness Interpretation

Sharpness Scale

Sharpness Units	Description
0-20 SU	Very low sharpness, indicating a highly blurred reflection with indistinct e dges.
21-40 SU	Low sharpness, where the reflected image is somewhat blurry but edges are more discernible.
41-60 SU	Moderate sharpness, with clearer edges and a more distinct reflected ima ge.
61-80 SU	High sharpness, showing a very clear and distinct reflected image with sh arp edges.
81-100 SU	Very high sharpness, indicating an exceptionally clear reflection with extr emely sharp and well-defined edges.

Relationship Between DOI and Sharpness

While both DOI and sharpness are measures of image clarity in reflections, they focus on slightly different aspects:

- DOI evaluates the overall clarity and distinctness of the entire reflected image.
- Sharpness specifically assesses the clarity and definition of the edges within the reflected image.

Distinctness of Image DOI

Distinctness of Image

Distinctness of Image (DOI) refers to the measure of how clearly and distinctly an image is reflected off a surface.

The ASTM definition of DOI, or Distinctness of Image, refers to a measure of the sharpness and clarity of a reflected image on a surface.

This is particularly used in contexts like automotive finishes, where the visual quality of a surface is critical.

DOI quantifies the extent to which a surface can reflect an undistorted image. A higher DOI value indicates a clearer, more distinct reflection, whereas a lower DOI value indicates a more blurred reflection caused by surface irregularities like orange peel texture.

DOI measurement was specified in the 1950's using fixed sensor which measured the spread of light at fixed angles.

A narrow spread indicates a sharp image, while a wider spread indicates a blurred image.

The physical limitation of sensor placement reduces the sensitivity of this measurement for very high quantity surfaces, sharpness measurement adjusts according to the reflectance profile of the surface. Sharpeness is

DOI measurement cannot be used for non-flat surfaces.

DOI %	Description
0-35	Very low sharpness, indicating a highly blurred reflection with indistinct edges.
35-60	Low sharpness, where the reflected image is somewhat blurry but edges are more discernible.
60-85	Moderate sharpness, with clearer edges and a more distinct reflected image.
85-85	High sharpness, showing a very clear and distinct reflected image with sharp edges.
95-100	Very high sharpness, indicating an exceptionally clear reflection with extremely sharp and well-defined edges.

Limitations of DOI (Distinctness of Image) -quantifying orange peel.

DOI has often be used to indirectly quantify orange peel on paint surfaces. However, it has the disadvantage that other surface effects, such as surface micro-texture, can reduce DOI independently of the presence of orange peel.

For improved measurement of Orange Peel- Waviness is recommended.

Sharpness and DOI Interpretation

DOI Units	Description
0-50 %	No discernible reflected image.
50-70 %	Low DOI, a reflected image is barely visible.
70-90 %	Moderate DOI, a distinct reflected image is visible.
90-95 %	High DOI, showing a very clear and distinct reflected image.
95-100 %	Very high DOI, indicating an exceptionally clear reflection.

What are sharpness and DOI?

How does Aesthetix these values? How do these values compare, which one should i use for my application? How Can I visualise DOI/Sharpness Using Appearance Elements? How can I change the DOI and Sharpness of a surface?

Sharpness and DOI

Sharpness and Distinctness of Image (DOI) are related measurements that quantify the clarity and definition of reflections on a surface.

Sharpness

Sharpness specifically assesses the clarity and definition of edges within a reflected image. It is measured on a scale from 0 to 100 Sharpness Units (SU), where higher values indicate clearer, sharper reflections[^1].

Distinctness of Image (DOI)

DOI evaluates the overall clarity and distinctness of the entire reflected image. It quantifies how clearly and undistorted an image is reflected off a surface[^1].

Aesthetix Measurement Method

The Aesthetix measures sharpness by:

1. Capturing a high-resolution image of a light source reflected on the sample surface using its camera sensor
2. Analyzing the sharpness of edges in this reflected image
3. Deriving a sharpness value that correlates with human visual perception[^1]

For DOI, the Aesthetix likely uses a similar image-based approach, analyzing the overall clarity of the reflected image rather than focusing specifically on edge sharpness.

Comparison and Usage

Sharpness is generally considered more advanced and sensitive than traditional DOI measurements, especially for high-quality surfaces[^1].

- Sharpness provides more detailed information about edge clarity in reflections
- Sharpness correlates better with human visual perception
- Sharpness can detect subtle differences in very high-quality surfaces that DOI may miss

For most modern applications, especially those involving high-gloss or high-quality surfaces, sharpness is recommended over DOI. However, DOI may still be used for backwards compatibility with existing specifications or standards[^1].

Visualizing in Appearance Elements

To visualize sharpness/DOI in Appearance Elements:

1. Use the live view feature from the gloss camera
2. Switch to the gloss camera view using the switch camera icon
3. Use auto-exposure to optimize for the surface's reflectivity
4. Manually adjust exposure if needed

5. Control the specular light source, line light, and spotlight as needed[^2]

The software will display sharpness/DOI values and may provide visual representations of the reflected image quality.

Changing DOI and Sharpness

To improve DOI and sharpness of a surface:

1. Enhance surface smoothness through finer polishing or sanding techniques
2. Optimize coating formulations to promote better leveling and flow
3. Improve application methods to minimize orange peel and other texture issues
4. Ensure proper curing conditions to allow coatings to level optimally
5. Use high-quality basecoats or primers to create a smoother foundation
6. For plastic parts, optimize molding conditions to reduce surface defects
7. Consider using flow additives in coatings to promote better leveling

Remember that changes to improve sharpness/DOI may affect other surface properties, so consider the overall impact on the product's appearance and performance[^1].

Effects Finish Module

Effect Finish Module quantifies the sparkle and graininess visible in materials containing effect pigments.

Graininess

Graininess is a visual texture perceived as a non-uniform, granular pattern on a surface when viewed under diffuse lighting conditions.

It appears as a subtle variation in lightness or darkness across the surface, giving it a grainy or coarse look.

This texture is particularly noticeable in materials with effect pigments, which scatter light in various directions, creating an uneven appearance.

Graininess	Surface	Description/Perception
<1	Smooth Appearance	Very little Graininess- surface looks like a solid colour in diffuse lighting conditions
1-3	Fine Grain	A fine grain is visible in diffuse conditions.
3-6	Coarse Appearance	Graininess apparent under diffuse lighting conditions
6+	Very Grainy Appearance	Highly coarse, mottled appearance

Measurement Method A single image of the surface that represents its intrinsic colour, independent of lighting conditions, shadows, and other effects like reflections or shading is derived.

The graininess is quantified by analysing the spatial variation in the luminance factor of the derived image, focusing on intermediate spatial frequencies that capture the local reflectance variations.

The graininess scale includes a factor that accounts for the average luminance of the surface, making it possible to compare the graininess of materials with different levels of reflectance. This scale has been psycho metrically tested and shown to correlate well with subjective human perception, providing a reliable measure of the graininess of various materials.

Sparkle

Sparkle refers to a visual texture observed when mirror like elements within a surface reflect light it is seen as tiny, bright points of light that appear strikingly brighter than their surroundings, akin to stars in the night sky or sunlight glittering on water.

The term is often used to describe materials with effect pigments that create this vivid, shimmering appearance under directional illumination.

Sparkle tends to decrease with the shift towards diffuse illumination and disappears under completely diffuse conditions.

Sparkle Density

Sparkle Density

Sparkle density is a measure of the concentration of visible sparkle points on a surface when viewed under directional lighting conditions. It quantifies how many of these bright points are visible on average in the 100mm2 (10mmx10mm) field of measurement in each of the six images.

Sparkle Visibility

Visibility

The Aesthetix reports sparkle visibility- an average intensity value for any sparkling elements which have been identified as visible in the material. Note- The visual visibility of sparkle elements is proportionate to the luminosity of the light source- for example elements are seen as brighter and more visible in strong sunlight compared to LED spotlights.

Sparkle Area

Area The Aesthetix reports sparkle area corresponding to the field of measurement (10x10mm) as an average size value for any sparkling elements which have been identified

as visible.

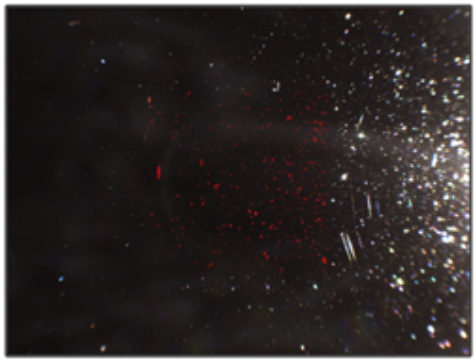
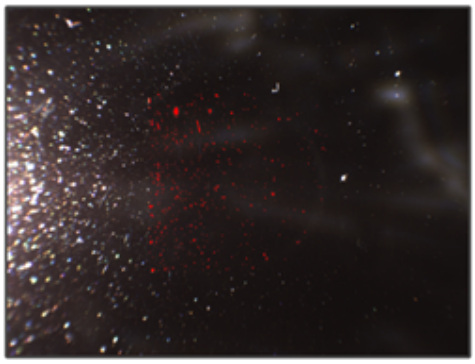
Each visible element is identified and its size in pixels is calculated and converted into

Sparkle Color

SpR, SpG, SpB Color values in RGB for the average color of the sparkling elements in th field of measurement

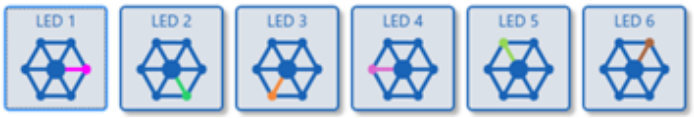
Measurement Method

Image Acquisition Six images of the surface are captured, each lit with one of the 45° ring lights.

e.g., from the right (LED 1)	and from the left (LED 4)
 LED 1	 LED 2

The images record the brightness of each point on the surface under each specific directional illumination (LED 1-6) in a 10x10 rectangle (Red area)

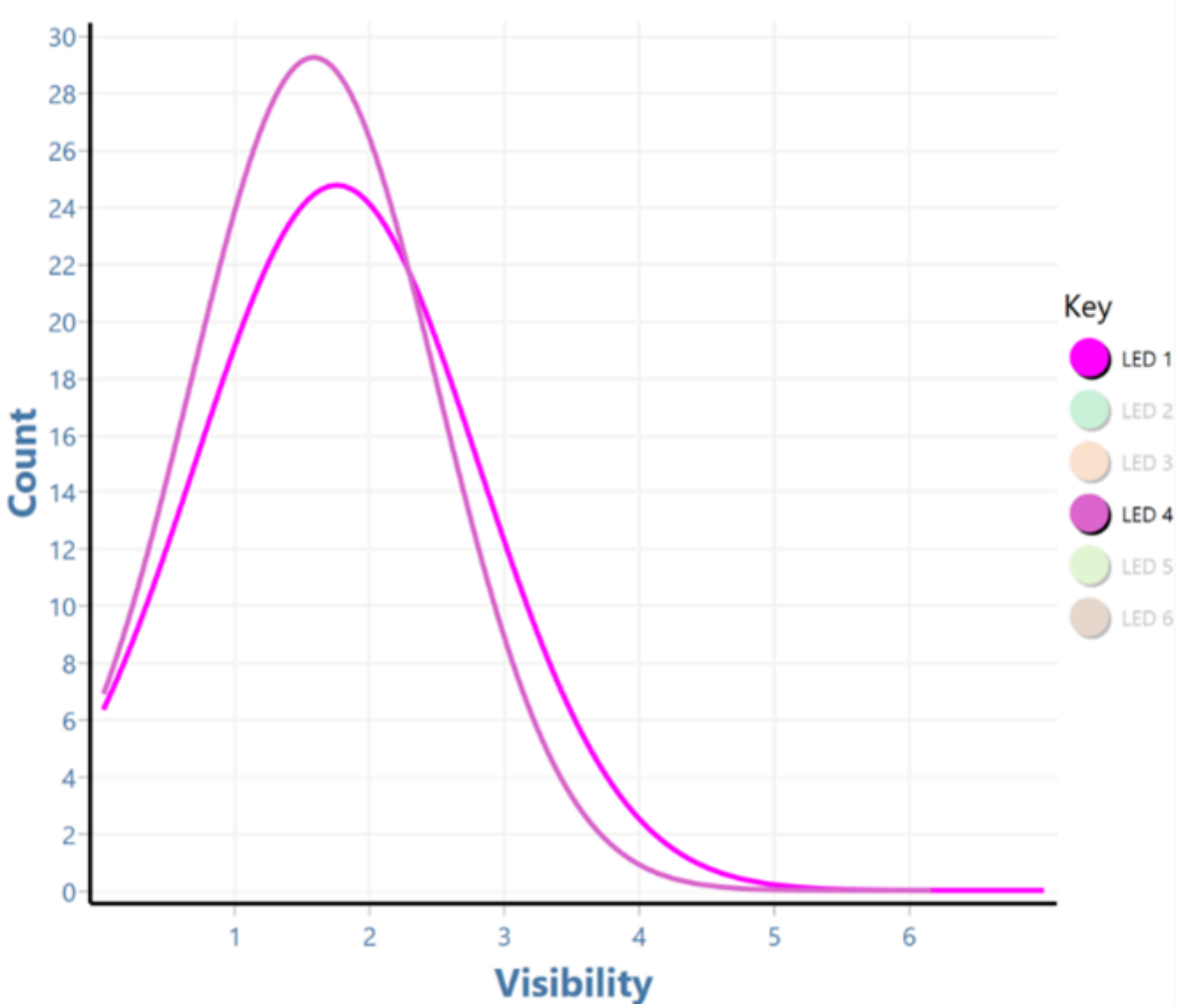
The LEDs are color coded in the graphs as given in the selection boxes below, with similar colors being opposite LEDs, e.g., Magenta (LED 1 and LED 4)



LED selection

Identification of Sparkle Points The sparkle points are identified in the image by distinguishing areas that have a brightness significantly higher than their surrounding

background.



Sparkle visibility graph

A sparkle point is considered "visible" if its contrast relative to the background exceeds a certain threshold.

The threshold has been determined by a visibility formula that incorporates factors like the luminance of the sparkle point, the background luminance, the size of the sparkle point, and the viewing distance.

Counting Visible Sparkle Points Once the visible sparkle points are identified, the total number of these points within the image is counted.

Taking a Measurement (Effects Finish)

How to measure Sparkle and Graininess

The measurement button is used to start single or multiple measurement that are sent directly to the table.

1. Ensure the sensor is calibrated.
2. To access the multiple readings feature, right click on the measurement button.
3. Press the measurement button to start.

Measurement button

How to measure sparkle and graininess using the interactive measurement feature

The interactive measurement function is a "live" view of the sample surface.

The surface camera is used to identify particular areas of interest on the surface before starting a measurement.

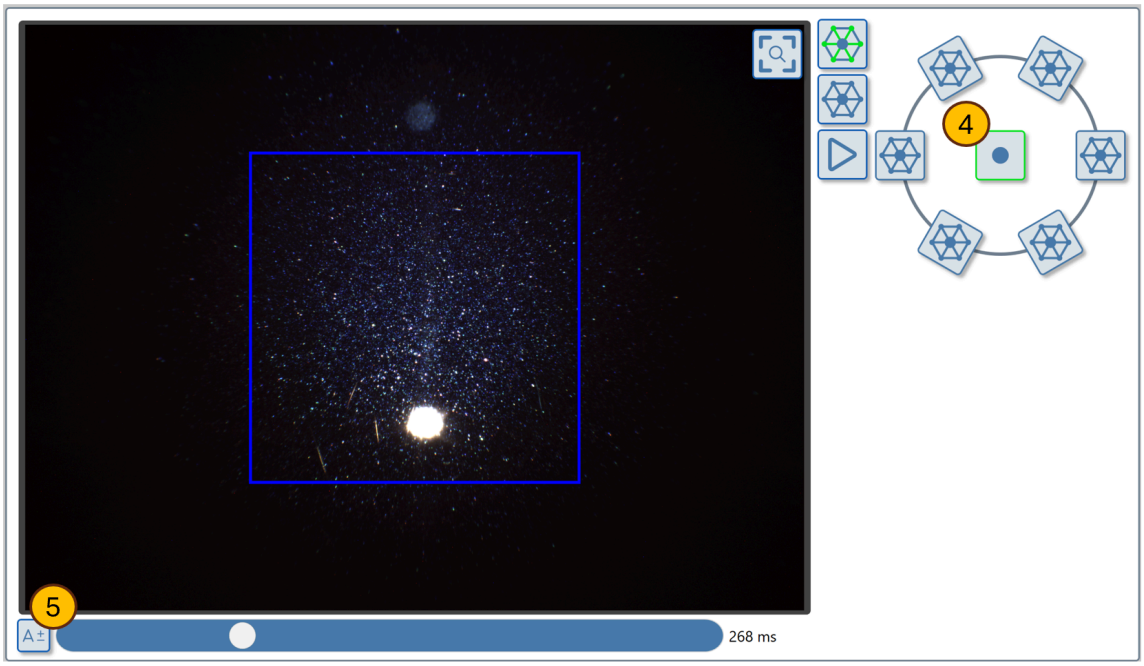
Measurement Procedure

1. Ensure the sensor is calibrated.
2. Press the button to activate the interactive measurement feature.

Interactive button

Effects 1

3. Adjust the light sources as required, recommended setting are 45 Degree Light Sources- all illuminated (3), or single spot light only (4) illuminated.



Effects 2

4.

5. Use the auto-exposure button to optimize the camera exposure for the surface's reflectivity.

6. Manually adjust exposure if needed using the slider or input box.

7. The blue square (1) indicates the measurement area for this module.

8. To measure the sparkle and graininess of an identified area on the surface move the sensor until the required area is enclosed by the blue square (1).

> Adjusting the exposure settings do not affect measurements. This control is used to get a clear surface image for positioning purposes.

Interpreting Results- Effect Pigment Module

How Does Aesthetix Measure Sparkle and Graininess?

The Aesthetix measures **sparkle** and **graininess** using advanced imaging techniques that capture surface reflectance under specific lighting conditions.

- **Sparkle Measurement**: Sparkle is quantified by identifying and analyzing bright points of light (sparkle points) that are significantly brighter than their surroundings under directional illumination. The system captures high-dynamic-range images using multiple light sources at 45° and a single image at 10° angles. The visibility, density, and size of these sparkle points are calculated based on contrast thresholds, luminance, and spatial distribution.
- **Graininess Measurement**: Graininess is assessed under diffuse lighting conditions. The software analyzes the spatial variation in the luminance factor of the surface, focusing on intermediate spatial frequencies. This captures the non-uniform, granular texture perceived as graininess.

Measurements Provided by Aesthetix for Sparkle and Graininess

Sparkle Metrics:

1. **Sparkle Density**: Number of visible sparkle points per 100 mm^2.
2. **Sparkle Visibility**: Average intensity of visible sparkle points relative to the background.
3. **Sparkle Area**: Average size of individual sparkle points in square micrometers.

Graininess Metrics:

1. **Graininess Value (G)**: Quantifies the perceived coarseness of a surface under diffuse lighting, adjusted for luminance levels.

Comparison and Application:

- Use **Sparkle Density** and **Visibility** for applications where the brightness and concentration of sparkle points are critical (e.g., automotive coatings or cosmetics).
- Use **Graininess Value** for assessing surface uniformity in diffuse lighting, especially in applications like interior finishes or textured coatings.

For most applications, both metrics provide complementary insights into surface appearance. Choose based on whether directional (sparkle) or diffuse (graininess) lighting conditions dominate in the product's end-use environment.

Visualizing Sparkle and Graininess Using Appearance Elements

The Rhopoint Appearance Elements software allows detailed visualization of sparkle and graininess:

1. **Sparkle Visualization**:
    - Open the "Sparkle View" tab to see a high-resolution image of sparkle points.
    - Adjust thresholds to highlight visible sparkle elements.
    - Use color-coded overlays to differentiate between sparkle density and visibility.
2. **Graininess Visualization**:
    - Switch to the "Graininess Map" view to see a luminance variation map.
    - Analyze spatial frequency data to understand the granularity distribution.
3. **Interactive Tools**:
    - Use zoom and pan tools to inspect specific regions.
    - Compare multiple samples side-by-side to evaluate consistency.

Adjusting Sparkle and Graininess

To modify sparkle or graininess:

1. **For Sparkle**:
    - Increase pigment size or concentration in coatings to enhance sparkle density.
    - Optimize application methods (e.g., spray angle or curing conditions) to improve uniformity.
    - Use directional additives or effect pigments for more pronounced sparkle effects.
2. **For Graininess**:
    - Adjust pigment dispersion or particle size during formulation to reduce graininess.
    - Ensure even application thickness to minimize texture inconsistencies.
    - Use finer polishing techniques or smoother substrates for a more uniform appearance.

By leveraging Aesthetix measurements, manufacturers can fine-tune processes to achieve desired visual effects while maintaining consistency across production batches.

Texture Module

The Rhopoint Aesthetix Texture Module provides objective analysis of the surface characteristics critical to visual perception and quality control for textured surfaces.

Textured surfaces are those with irregular or patterned finishes, differing from smooth or flat surfaces. These textures can be natural or manufactured and include features like ridges, grooves, bumps, or grains that affect the material's tactile and visual properties.

Examples include:

1. **Leather-like Surfaces**: Found in automotive interiors and furniture, mimicking natural leather.
2. **Coated Surfaces**: Textured paint or powder coated surfaces on metal or plastic, influencing appearance and feel.
3. **Plastic pars**: Moulded textures in consumer electronics and automotive components for grip and aesthetics

Textured surfaces are crucial in many industries for their impact on product aesthetics, functionality, and consumer perception, such as automotive, powder coating and leather manufacture, ensuring enhanced quality control, product development, and consistency across global supply chains.

Using Aesthetix, the user can reduce subjective errors associated with visual inspection, ensuring measured surfaces have the required perceived quality and good harmony with adjacent parts.

Measurement Method

RGB colour, gloss, reflectivity, and 3D topography measurements are combined into a single measurement, delivering precise and repeatable results. The Aesthetix uses utilizes photometric stereo techniques to estimate surface normals and calculate 3D topography, providing a detailed height map of the surface.

A watershed algorithm is then applied to segment the topography into cells, allowing for the analysis of cell size and area.

60° gloss is measured and reported, fully compliant with international norms ASTM D523 & ISO 2813.

RGB colour is measured using 45°c:0° geometry and the reported values are calculated using the average RGB pixel value of the 14.25x14.25mm area captured by the observer camera.

Reflectance parameters are calculated using the gloss camera & reflectance differences measured using the observer camera.

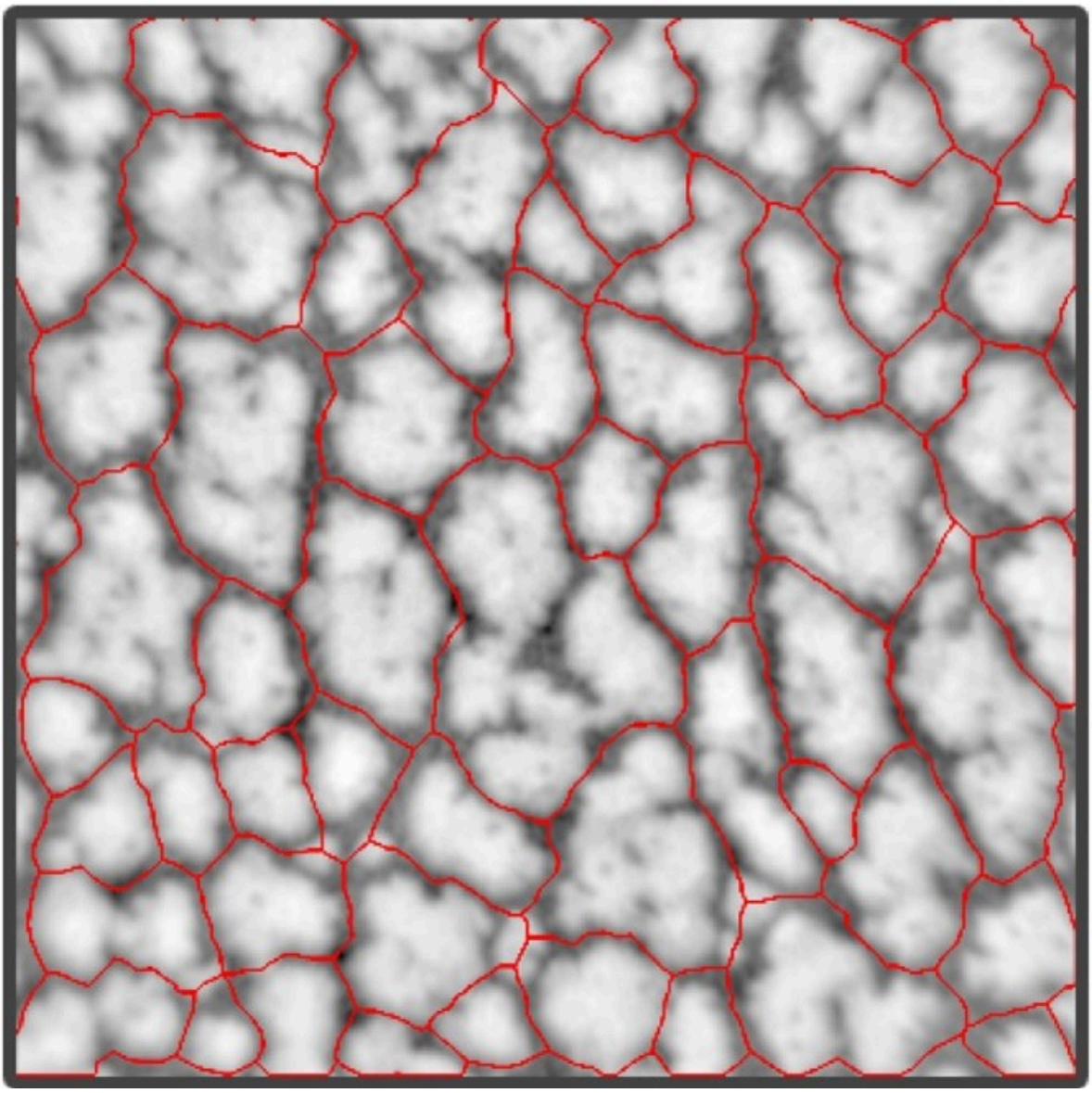
Texture feature properties (watershed methodology)

Watershed Overview

To separate features on the surface, a so-called “watershed algorithm” is applied to the topographic height map.

A flooding analogy can be used to understand the watershed principle. The measured topographical map can be treated like a landscape of hills and valleys. When water is poured into the landscape, and the water level rises, the valleys (which are the local minima of the gradient image) start filling up with water, separating the hills as islands (“features”). When water from two different valleys meet and merge, a dam (or watershed line) is constructed to prevent merging. These watershed lines effectively become the boundaries between different regions in the image.

The result is a segmented image where each region is separated by watershed lines, corresponding to different features within the surface.



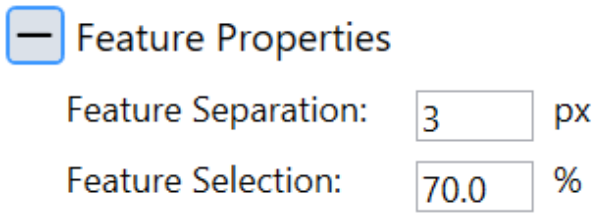
Topographical height map

Topographical height map of surface with watershed analysis applies

Control over how the watershed lines are constructed in Appearance Elements is given in the “Feature Properties” settings.

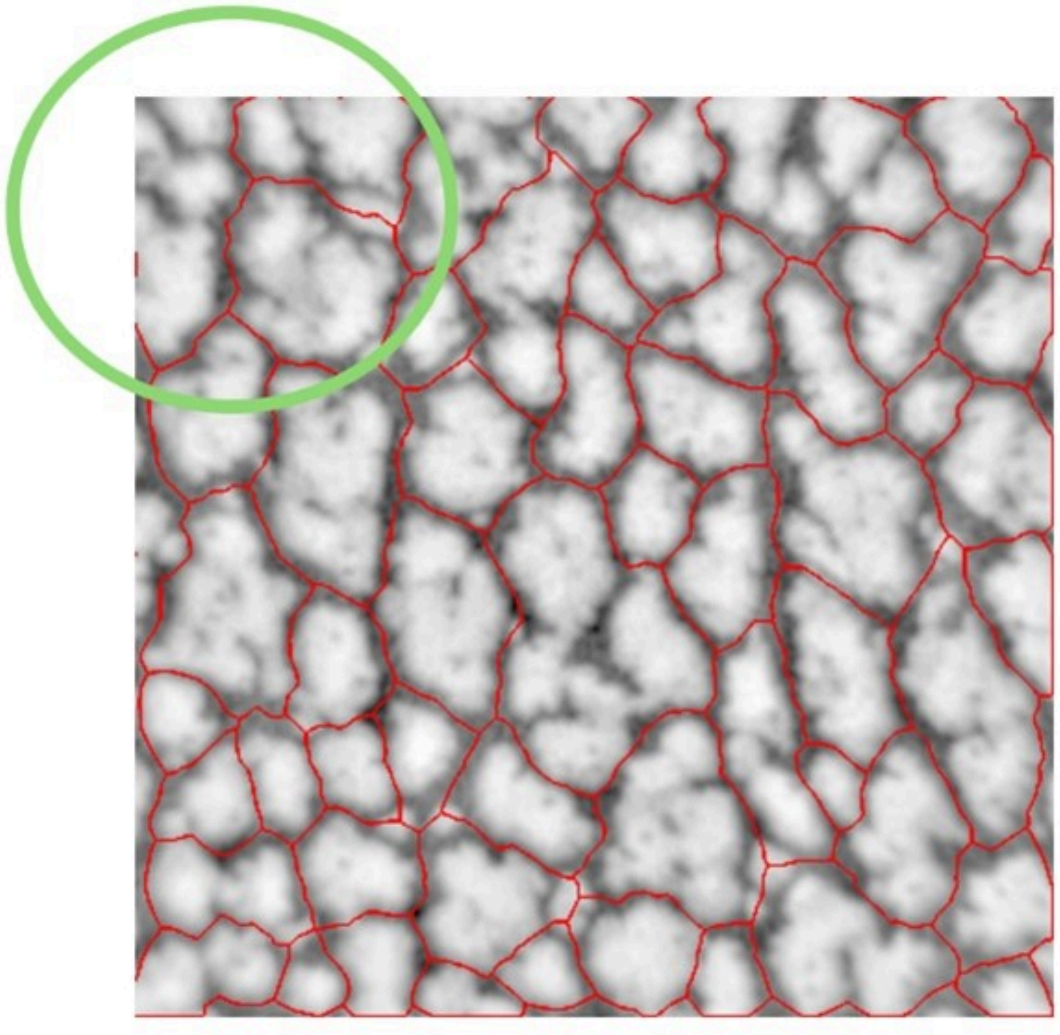
Adjusting the Feature Properties (Watershed parameters)

Manual Adjustment of the Feature separation



Feature properties

1. **Visual Inspection** Start by visually inspecting the height image and the initial segmentation results by using the default settings *(Default: Feature separation: 3px, Feature selection: 70%)*.



Watershed map with selection

In the image above, the default settings have not segmented the whole map successfully- by visual inspection we can see that some features are not separated. In

this example features are separated by low areas (valleys) and represent distinct high areas or hill.

2. **Adjust Thresholds** Modify the watershed parameters in “Feature properties” and observe the effect on the feature detection. Adjust Feature properties and test different values, then evaluate their impact on the segmentation.

Feature Separation (Watershed Morphology)

This parameter increases the gap between the found features (hills) by the separation value (number of pixels) Increasing the amount of Pixels used will separate some touching features, and thus increase the number of detected features (hills).

> ⚠ Note that if the value is too high smaller features (hills) can be completely eroded and will no longer be detected.

Feature Selection (Watershed Selection Percentage)

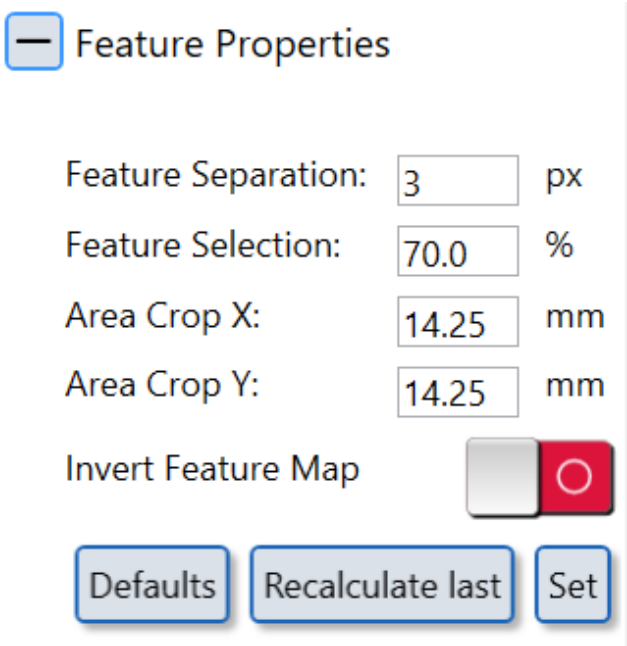
This value from 0% to 100% determines which size of features (hills) are included in the evaluation after separation. While increasing this number will exclude smaller unwanted features, it should be reduced for smaller shapes.

In the analysis the watershed algorithm has not separated all the features (hills)- the feature separation parameter “Feature selection” should be increased.

Watershed parameter adjustment

To adjust the areas selected by the watershed.

- Click the settings button on the right side menu.
- Click the plus button to expand “Feature properties”.

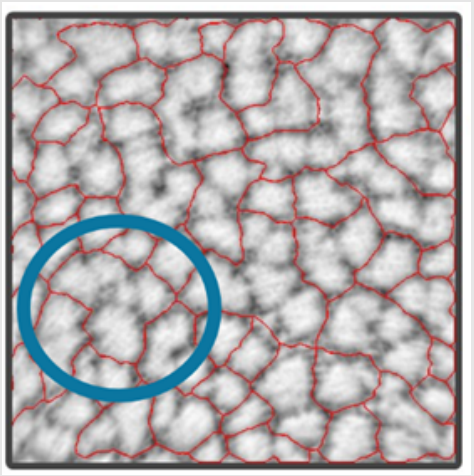
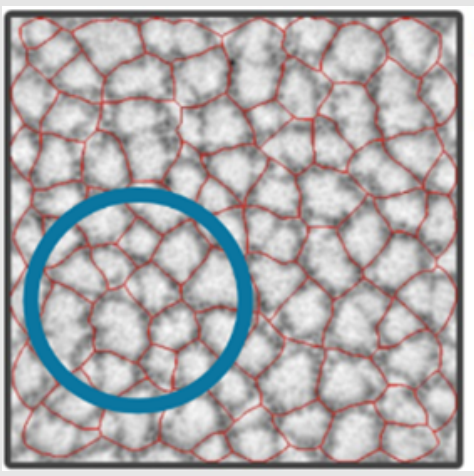


Feature properties settings

Adjust “Feature Separation” (watershed morphology) and “Feature Selection” (Watershed Selection Percent) parameters.

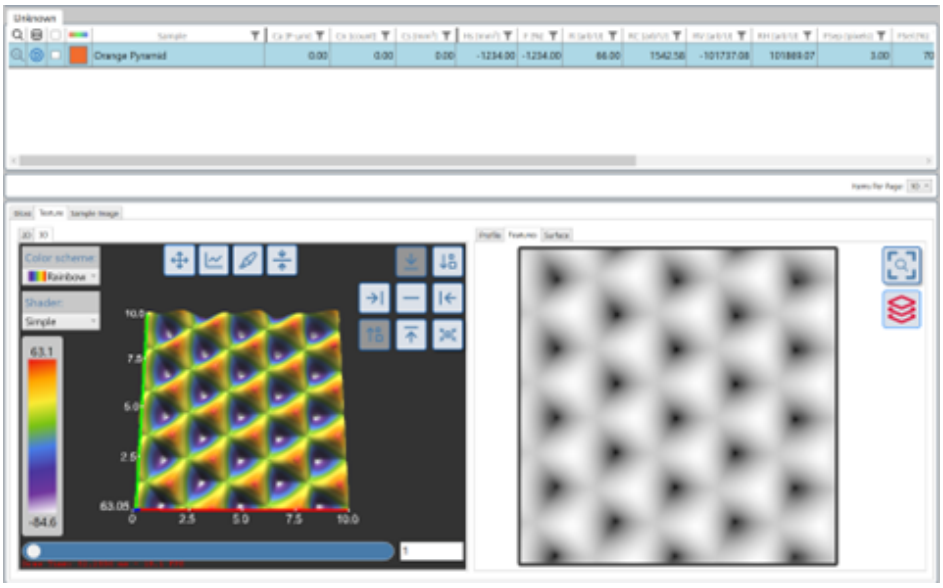
- Press "Set" button.
- Press "Recalculate last" button.

Increased Feature Separation value will now correctly analyse the shapes.

 **Feature separation—before**	 **Feature separation—after**
Before	After

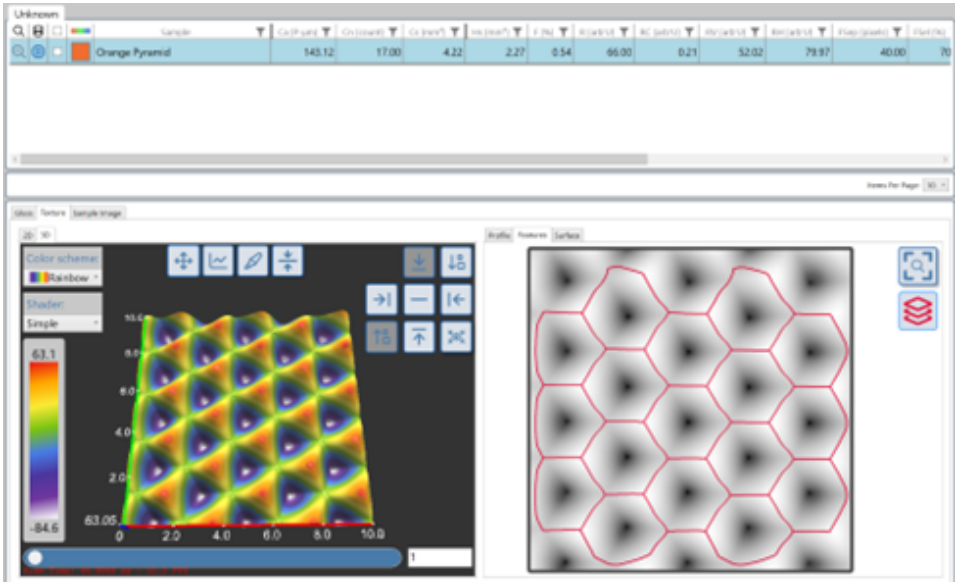
Invert feature map algorithm

Standard textures and Leather are described by hills which are spatially separated by valleys. Some technical textures, however, form the actual texture by hills (along their maxima). For these textures, the standard algorithm will not yield a good or none result, in which case the algorithm has to be “inverted”. When this happens, please use the “Invert Feature Map” setting, set and recalculate. Example: the measurement of a technical laser texture does not yield any reasonable results, no matter what is set up in feature selection.



Invert feature before

After selection of “Invert Feature Map” and setting appropriate values, the results become reasonable.

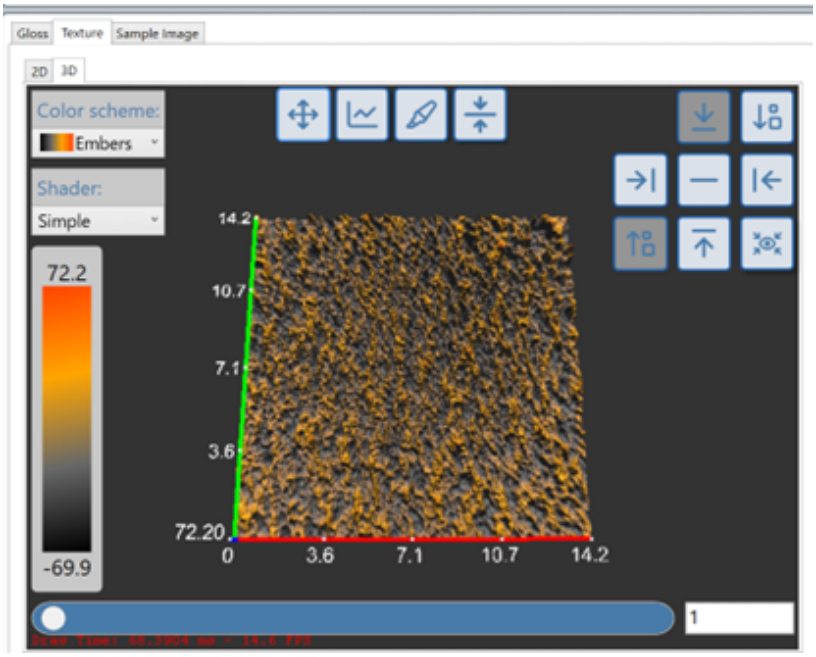


Invert feature after

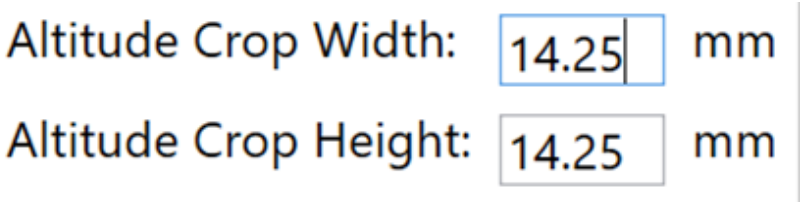
Cutting the area of interest

For some applications it might be advisable that the area of interest is cut to a smaller region than the default (14.25mmx14.25mm), e.g., for steel or metallized surfaces. This helpful in those cases were there are damages or over illumination due to material albedo at the edges.

In this case, you cut to a more specific region, defining an area by width and height (X and Y) distance, around the centre point of the image (0/0). For example, Standard setup 14.25mmx14.25mm, from centre point 7.125mm to the left and to the right, as well as 7.125mm up and 7.125mm down.

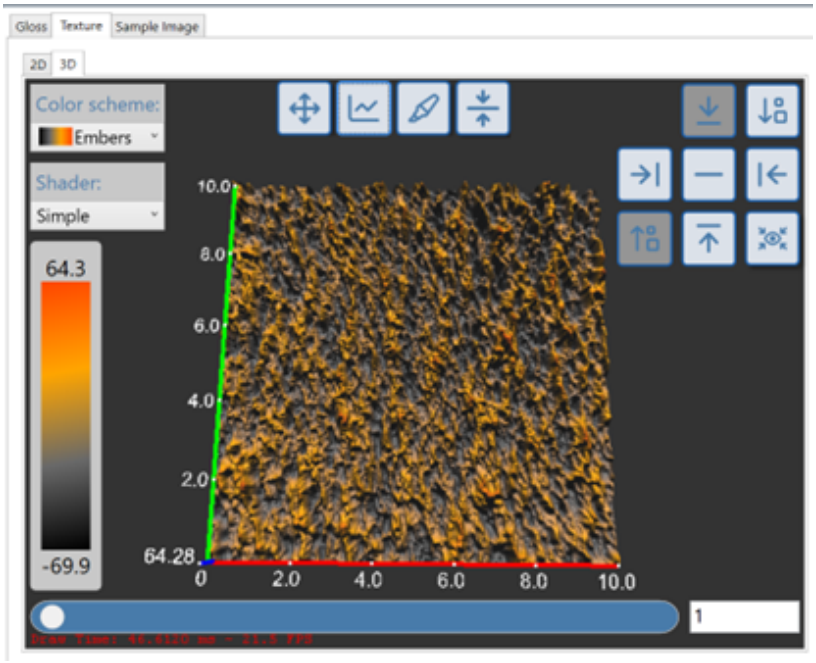


texture-preview-1425

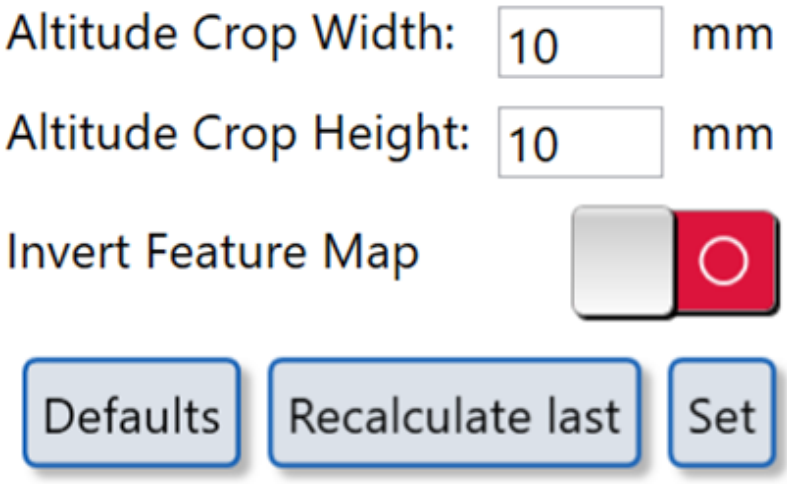


texture-preview-1425-settings

Cut to 10x10, or 5mm in all directions: enter 10mm Width and Height, “Set” and “Recalculate last”.



texture-preview-1000



texure-preview-1000-settings

> ⚠ This has a direct influence on the texture parameters except gloss, so be careful and check your results.

Texture Parameters

Each of these indices provided in the Texture Module gives detailed information about the surface's reflectivity characteristics and topographical features, allowing for a

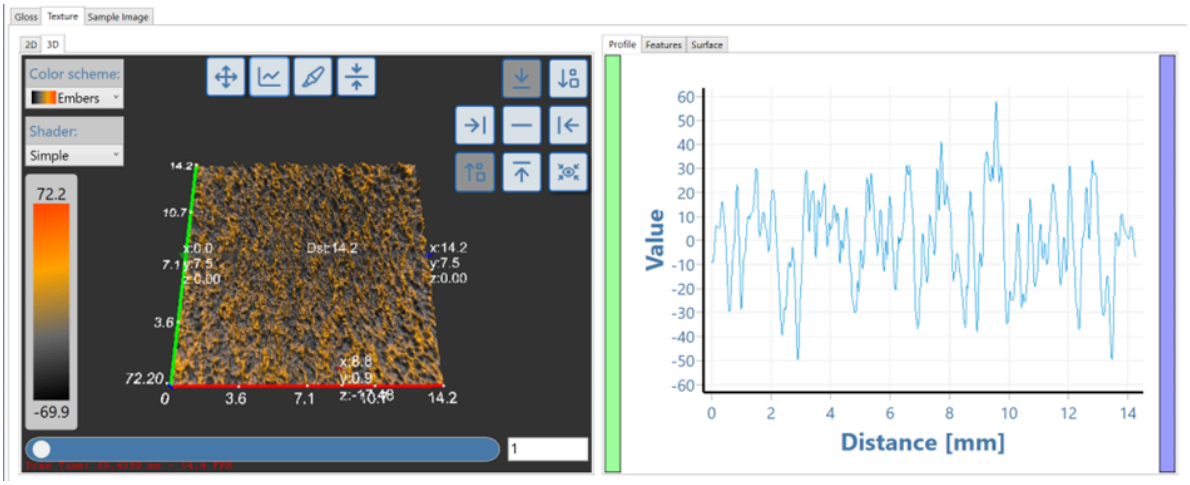
comprehensive analysis of its physical and optical properties.

Gloss 60°

The standard 60° Gloss value, given in GU.

Roughness "SA Rough"

Sa Rough is the standard deviation of amplitude for all measured pixels in the 14.25x14.25 field of measurement, unfiltered and raw.



Heightmap perceived altitude

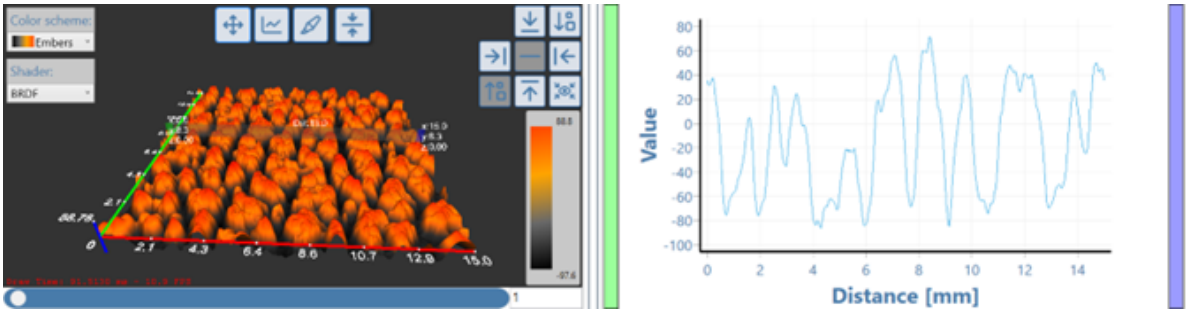
The heightmap shows the perceived altitude of the surface, the profile the perceived altitude over the distance measured.

The controls in the topographic map include:

Map controls

- **Cursor**: this needs to be activated when you want to rotate and pan the topographic view
- **Profile**: activate this feature when you want to measure a profile or a distance in the map
- **ROI cut**: not active yet

- **Plane reference set**: switch between “average” and “zero” plane for profile height reference



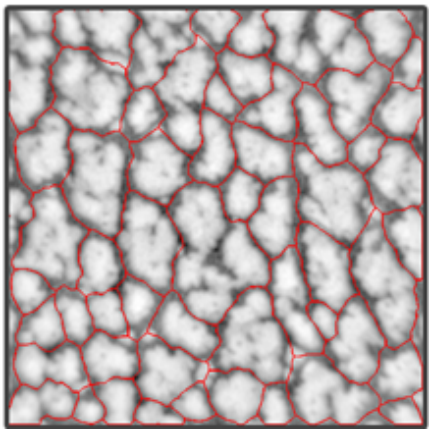
Screenshot watershed

The heightmap shows the perceived altitude of the surface.

Ca- Cell Amplitude

Ca (reported in [p-µm] (perceived microns)) is defined as the average amplitude of all cells features identified within the texture of a material.

It quantifies the difference between the highest and lowest points, (Average Height of cells- Average Depth of valleys) providing a measure of the vertical dimension of the texture. This parameter is used to understand the depth and relief of the surface texture, which directly influences visual and tactile perception.



Watershed cells

Higher cell amplitude indicates a more pronounced texture, lower values will be measured on smoother materials.

Cn- Cell Number

Cn refers to the total number of distinct cells or surface features identified within the 14.25 x 14.25mm field of measurement depending on the watershed parameters set. This measurement is crucial for understanding the density and distribution of the texture features, which influence visual and tactile qualities.

Cell Size Indices

Understanding cell size and distribution helps in evaluating the uniformity, coarseness, and overall appearance of the surface, which is essential for quality control and ensuring consistency in product manufacturing. All Cs indices are reported in [mm^2].

Cs—Mean Cell Size

Mean Cell Size is the average size of the cells included in the analysis, measured in square millimeters [mm^2]. To find this value, the areas of all included cells are measured, and their mean (average) value is calculated. It provides an overall sense of the typical size of the structural features on the surface.

CsMin—Minimum Cell Size

Cell Size Minimum represents the size of the smallest cell among all those included in the data analysis. It gives insight into the minimum limit of the structural features present on the surface.

CsMax—Maximum Cell Size

Cell Size Maximum is the size of the largest cell among all those included in the data analysis. It helps in understanding the upper limit of the structural feature sizes present on the surface.

CsDev—Cell Size Standard Deviation

The Cell Size Standard Deviation reflects the variation in cell sizes across the surface. By dividing the standard deviation by the mean cell size, the resulting value is normalized, allowing for comparability between different types of structures. This index indicates how much the sizes of the cells vary from the average, helping to understand the consistency of the surface structure.

Hs—Hill Size

This is the average cross-sectional area of the hills within the analyzed cells, measured in square millimetres [mm^2]. The algorithm detects the cross-sections of the hills and

calculates the mean area. The threshold height used to define the cross-sections is parameterized, meaning it can be adjusted based on specific analysis requirements. Understanding hill size helps in evaluating the distribution and prominence of these elevated features.

F—Fill Factor

The Fill Factor index represents the ratio of the mean hill size to the mean cell size, expressed as a percentage. It provides a measure of how much of the cell area is occupied by hills, indicating the density of the elevated structures on the surface or distance between structures.

Reflectivity Indices

Reflectivity is an absolute measurement but uses a non-standard unit (arbitrary units [arb'U]) specific to the measurement system. A higher R value indicates a glossier surface.

R—Reflectivity

The Mean Reflectivity index R represents the average reflectivity value of the surface, or a value for how the surface interacts with light, contributing to its visual characteristics such as gloss and brightness.

RC—Reflective Contrast

This index quantifies the difference in reflectivity between the hills and valleys of the surface topography. The algorithm separates the surface data into valleys and hills using a parameterized threshold height. It then calculates the mean reflectivity values for both areas and uses the contrast formula:

`contrast = (hill + valley) / (hill - valley)`

This provides a measure of how much the reflectivity differs between the elevated and depressed areas of the surface.

RV—Reflectivity in Valleys

This index represents the average reflectivity value for the areas classified as valleys. It helps in understanding the reflectivity properties of the lower, depressed regions of the surface.

RH—Reflectivity on Hills

This is the average reflectivity value specifically for the areas classified as hills. It provides insight into the reflectivity characteristics of the elevated parts of the surface.

Color (RGB)

Average Values of R-G-B pixels in the field of measurement.

Unit: Perceived Microns [pμ]

The unit "perceived" is calculated from Photometric Stereo Topographical maps from the surface slopes and facets that are visible to the camera and calibrated using a 100μ artifact.

Our optical system works best for surfaces with a texture amplitude of 0-1500 (1.5mm) microns with homogeneous reflectivity- in this range the Aesthetix measurement system is linear and obtains results highly correlated to other systems.

> ⚠ Note that as the texture gets bigger the measurement system becomes less linear-this is because the peaks and valleys of these large structures are less in focus, we also capture shadows in deep valleys that make it difficult to resolve the topography in those areas.

Taking a Measurement (Texture)

How to measure Surface Texture

The measurement button is used to start single or multiple measurement that are sent directly to the table.

1. Ensure the sensor is calibrated.
2. To access the multiple readings feature, right click on the measurement button.
3. Press the measurement button to start.

Measurement button

How to measure surface texture using the interactive measurement feature

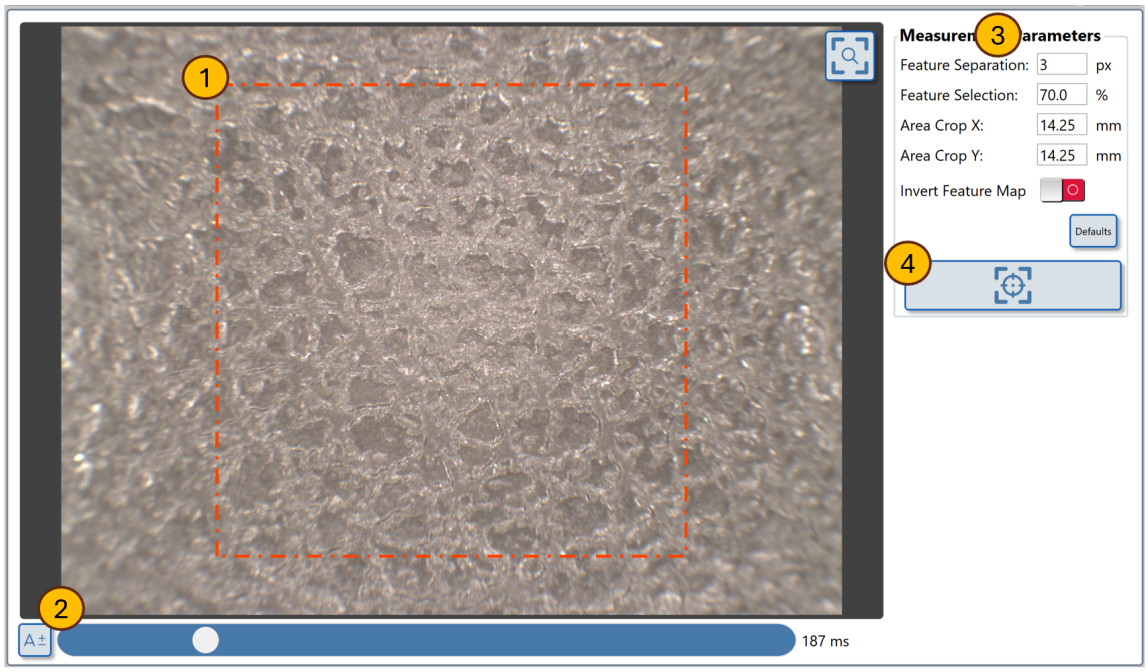
The interactive measurement function is a "live" view of the sample surface.

The surface camera is used to identify particular areas of interest on the surface before starting a measurement.

Measurement Procedure

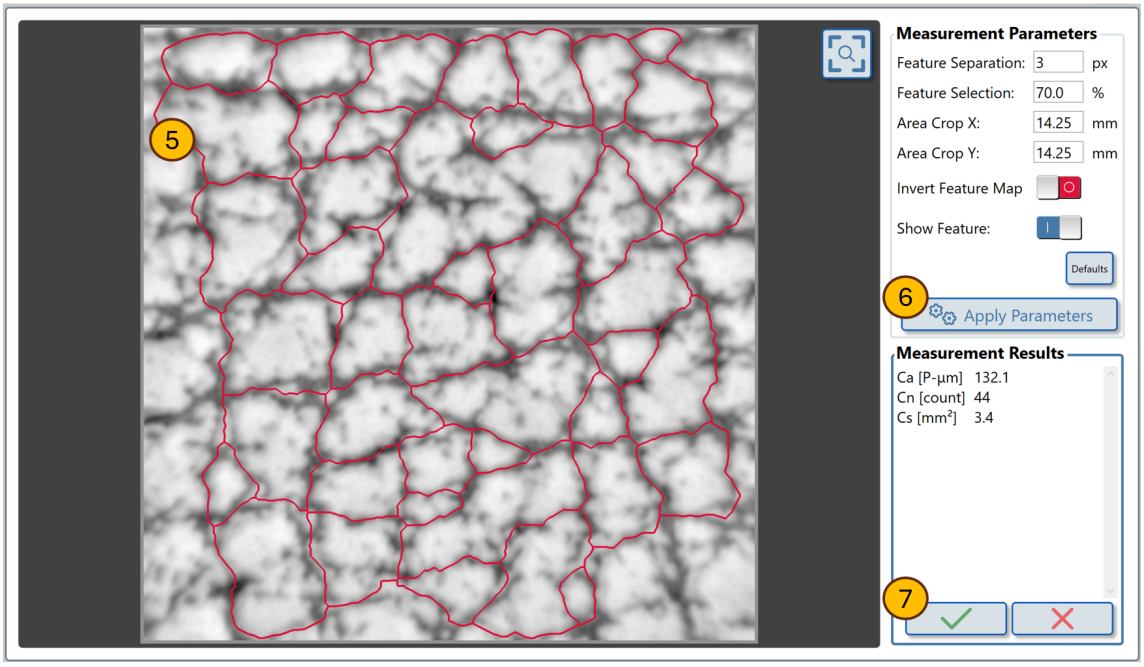
1. Ensure the sensor is calibrated.
2. Press the button to activate the interactive measurement feature.

Interactive button



Texture 1

3. Use the auto-exposure button to optimize the camera exposure for the surface's reflectivity.
4. Manually adjust exposure if needed using the slider or input box.
5. The red dashed square (1) indicates the measurement area for this module.
6. To measure the texture of an identified area on the surface move the sensor until the required area is enclosed by the blue square (1).
7. Press the measurement button (4) to take a preview measurement.



Texture 2

8. The feature map (5) displays the identified features.
9. The measurement parameters can be adjusted to change the profile of identified features. Read more. (Adjusting Texture Parameters)
10. Once measurement parameters have been adjusted press Apply Parameters button (6) to reprocess the analysis.
11. When the analysis is acceptable, press the "tick" button (7) to save the measurement in the data table.
12. Pressing the cross will restart the interactive measurement process.

> Adjusting the exposure settings in this view do not affect measurements. This control is used to get a clear surface image for positioning purposes.

Interpreting Results- Surface Texture

How Does Aesthetix Measure Surface Texture?

The Aesthetix uses advanced optical and computational techniques to measure surface texture. It employs **photometric stereo imaging** to estimate surface normals and create detailed 3D topographical maps. These maps represent the height variations across the surface, allowing precise analysis of texture features. The system uses a **watershed algorithm** to segment the surface into distinct cells (hills and valleys), enabling the quantification of structural features such as height, size, and distribution.

Key steps in the measurement process:

1. **Image Capture**: The system captures multiple images under different lighting conditions to calculate surface normals.
2. **3D Topography**: A height map is generated to represent the vertical variations of the surface.
3. **Segmentation**: The watershed algorithm separates features into cells, identifying hills, valleys, and their boundaries.
4. **Analysis**: Metrics such as roughness, cell amplitude, cell size, and reflectivity are calculated from the segmented data.

Measurements Provided by Aesthetix for Surface Texture and Reflectivity

The Aesthetix provides a comprehensive set of metrics to describe surface texture and reflectivity:

Texture Metrics

- **Sa (Roughness)**: Standard deviation of amplitude (height variations) across the surface.
- **Ca (Cell Amplitude)**: Average height difference between hills and valleys, measured in perceived microns (p-µm).

- **Cn (Cell Number)**: Total number of distinct cells or features within the measurement area.
- **Cs (Cell Size)**: Includes mean, minimum, maximum, and standard deviation of cell sizes (mm^2).
- **Hs (Hill Size)**: Average cross-sectional area of elevated features (mm^2).

Reflectivity Metrics

- **R (Reflectivity)**: Average reflectivity value of the surface in arbitrary units.
- **RC (Reflective Contrast)**: Difference in reflectivity between hills and valleys.
- **RH/RV**: Reflectivity values specific to hills and valleys.

Comparison and Application

- Use **Sa** for general roughness analysis when evaluating overall surface smoothness.
- Select **Ca** for assessing depth or relief of textures that influence tactile or visual perception.
- Use **Cn** and **Cs** for understanding feature density and uniformity, critical for textured coatings or molded parts.
- Reflectivity metrics like **RC** are ideal for determining how texture impacts visual contrast or glossiness.

Choose metrics based on your application:

- For functional surfaces requiring uniformity (e.g., automotive interiors), focus on **Cn**, **Cs**, and **RC**.
- For aesthetic surfaces where depth or relief matters (e.g., leather-like finishes), prioritize **Ca** and **Sa**.

Visualizing Surface Texture Using Appearance Elements

The Rhopoint Appearance Elements software enables users to visualize and analyze surface texture in detail. Follow these steps to effectively examine the surface's 3D

structure, depth, and features:

1. **Open the 3D View in the Left Window**:
    - Navigate to the left-hand panel of the software and select the "3D View" tab.
    - The surface's topographical map will be displayed as a 3D model, color-coded to represent height variations.
    - Use the mouse or navigation tools to rotate, zoom, and pan the 3D map for a comprehensive view of the surface.
2. **Use the Profile Tool in the Map Window**:
    - Switch to the "Map View" in the central window to view a 2D representation of the surface's height map.
    - Select the "Profile Tool" (typically represented by a line icon).
    - Click and drag across the map to draw a line indicating your region of interest. This line will serve as a cross-section for further analysis.
3. **Open the Profile View in the Right Window**:
    - Navigate to the right-hand panel and select the "Profile View" tab.
    - The profile view will display a cross-sectional graph of the surface along the drawn line, showing height variations in **perceived microns (p-µm)**.
    - Peaks represent hills or elevated areas, while valleys indicate depressions or lower regions on the surface.
4. **Analyze Cell Size Using the Features Window**:
    - Open the "Features Window" in the right-hand panel.
    - This window provides detailed information about identified surface features, including hills, valleys, and cells segmented by a watershed algorithm.
    - Metrics such as cell size (mean, minimum, maximum), cell amplitude (height differences), and cell number are displayed. These values help evaluate texture uniformity, density, and depth.
5. **Adjust Visualization Settings**:

- Modify watershed parameters (e.g., feature separation or selection) in the settings menu to refine feature detection and segmentation.
- Use color scales or visual overlays to enhance specific areas of interest.

By combining these tools, you can gain a detailed understanding of your surface's texture, including its depth, uniformity, and structural features. This visualization process is essential for quality control, product development, and ensuring consistency across manufacturing processes.

Adjusting Surface Texture or Reflectivity

To modify surface texture:

1. **Surface Preparation**:
   - Sanding or polishing can reduce roughness (**Sa**) and improve smoothness.
   - Texturing processes like embossing or chemical etching can enhance relief (**Ca**) or create specific patterns.
2. **Tool Design or Wear**:
   - Cell size is fixed during tool design and manufacture, Reflectivity and cell depth can be effected by tool wear. (**Cn**, **Cs**) and reflectivity (**R**, **RC**).

By selecting appropriate processes based on Aesthetix measurements, you can achieve desired aesthetic or functional outcomes while maintaining consistency across production batches.

Adjusting Texture Parameters

Adjusting Parameters for Effective Feature Selection

Adjusting texture measurement parameters allows specific cells visible in the pattern to be identified and counted.

1. Feature Separation (Watershed Morphology)

- **Purpose:** This parameter controls the "erosion" of segmented blobs by increasing the gap between detected features (e.g., hills) on the surface. It helps separate touching features, ensuring distinct detection.
- **How It Works:**
  - Increasing this value will separate closely connected features, increasing the number of distinct features identified.
  - However, if set too high, smaller features may be entirely eroded and lost from the analysis.
- **Adjustment Steps:**

1. Start with a moderate value and visually inspect the segmentation results.
2. Gradually increase the value to separate touching features while ensuring small, meaningful features are not eliminated.
3. Recalculate the analysis after each adjustment to evaluate its impact.

2. Feature Selection (Watershed Selection Percentage)

- **Purpose:** This parameter determines the minimum size of features (hills) to include in the analysis after separation.
- **How It Works:**
  - A higher value excludes smaller, unwanted features, focusing only on larger, significant ones.

- A lower value includes smaller features, which might be noise or irrelevant depending on your application.

- **Adjustment Steps:**

1. Start with a low percentage to include all potential features.
2. Gradually increase the value to exclude smaller, less relevant features until only meaningful ones remain.
3. Visually inspect the results to ensure no critical features are excluded.

3. Invert Feature Map

- **Purpose:** Selecting this option inverts the feature map
- **How It Works:**
  - The map is virtually flipped upside down, hills become valleys and visa versa.
  - This is used to segment surfaces in which the borders between the features are positive rather than negative.
  - This is often used for surfaces with raised edges between the features.

Practical Workflow for Parameter Adjustment

1. **Visual Inspection:** Begin by inspecting the initial segmentation results to identify areas where features are not well-separated or where irrelevant small features are included.
2. **Adjust Feature Separation:**
   - Increase this parameter incrementally to improve separation of touching regions.
   - Avoid setting it too high to prevent losing smaller but important features.
3. **Adjust Feature Selection:**
   - Modify this parameter to filter out small, insignificant features while retaining larger ones relevant to your analysis.
4. **Invert Feature Map:**

- Select this control if segmentation is not replicating the borders between visible features, often required for complex geometric patterns or materials with negative features.

5. **Recalculate and Evaluate:** After each adjustment, recalculate the segmentation and recheck the results for accuracy and completeness.

Key Tips for Optimal Results

- Use a balanced approach: Adjust both parameters iteratively rather than focusing on one in isolation.
- Test different combinations of values to find an optimal setting for your specific surface texture and feature requirements.
- Always visually inspect results after adjustments to ensure meaningful segmentation.

By carefully tweaking these parameters, users can achieve precise feature selection tailored to their surface analysis needs.

Cross-cut Module

Aesthetix Cross-cut Module replaces the subjective visual analysis of cross-cut panels with reproducible imaging measurement.

In the paint and coatings industry, adhesion is a critical property that determines the durability and performance of a coating under various conditions.

In the paint and coatings industry, adhesion is a critical property that determines the durability and performance of a coating under various conditions. The Cross-cut Test, standardized by ISO (International Organization for Standardization) under ISO 2409, is a widely recognized method for evaluating the adhesion of a coating to a substrate.

Why Cross-cut Testing is Important

Adhesion as a Key Quality Indicator

Coatings are applied to protect surfaces from environmental damage, corrosion, or wear, and to enhance aesthetics. A coating's ability to adhere strongly to a substrate ensures it performs its intended function over time without peeling, flaking, or detaching.

Reliability Across Industries

Cross-cut testing is used globally to ensure coatings meet consistent quality and performance standards. It helps manufacturers, contractors, and end-users to validate product reliability, regardless of the substrate type or environmental conditions.

Ease and Precision

The test involves making a grid of cuts (cross-cuts) through the coating down to the substrate using a specialized cutting tool. After the grid is created, adhesive tape is applied and removed to assess the coating's adhesion based on the extent of detachment or flaking observed in the cut areas. The results are graded on a numerical scale, making it a simple yet precise evaluation method.

Standardized Benchmarking

By following the ISO 2409 standard, the test provides a clear benchmark for comparing coating performance. This helps in quality control, product development, and ensuring compliance with industry regulations.

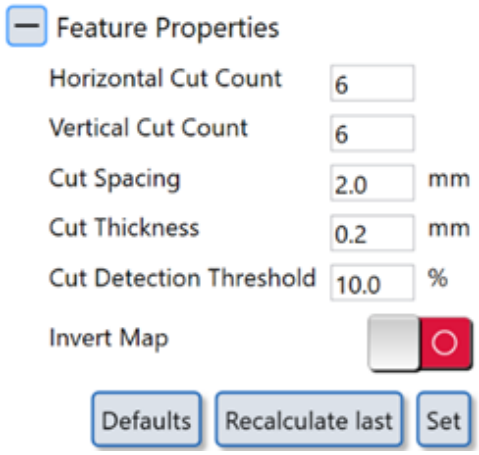
Cross-cut Testing with Aesthetix

The Aesthetix device leverages the principles of the ISO Cross-cut Test to provide accurate and repeatable measurements of cross-cuts, not being subject to daily form. With Aesthetix, users can efficiently and neutrally assess the durability of their coatings, ensuring they meet both performance expectations and industry standards. This empowers paint and coating professionals to achieve superior product performance and durability.

Cross-cut Properties

The standard method for ISO 2409 proposes to cut six horizontal and six vertical lines.

The Default setting for Appearance Elements is to use this setup with a cut spacing of 2.0 mm, a cut thickness of 0.2mm and a detection threshold of 10%.

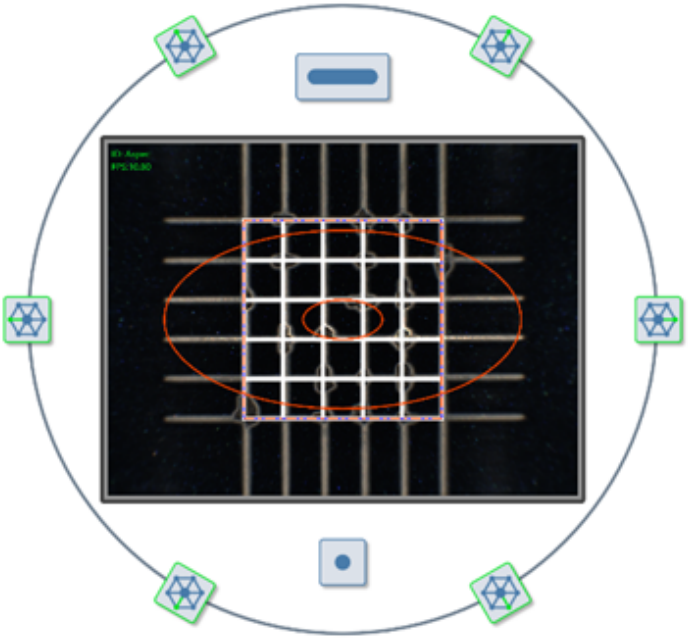


Crosscut default properties

Cut Spacing, also called line spacing, is the setting for the space between the centre of cut lines, while Cut Thickness is the actual thickness of the line cuts. Modify the Cut Detection Threshold to separate remaining coating from removed coating.

Manual Measurement Method

After setting the properties of the cross-cut detection, the preview will display the cross-cut grid.

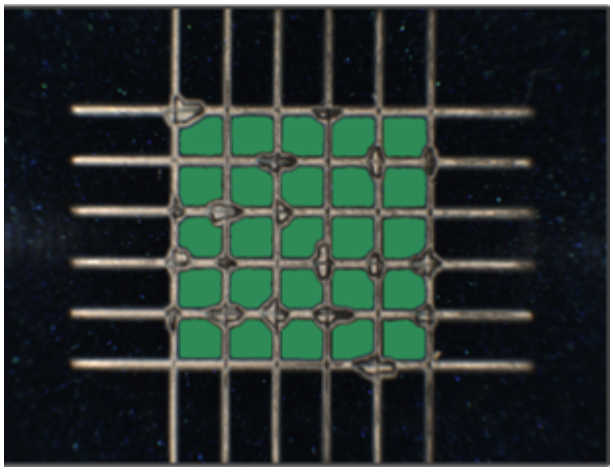


Crosscut preview with grid

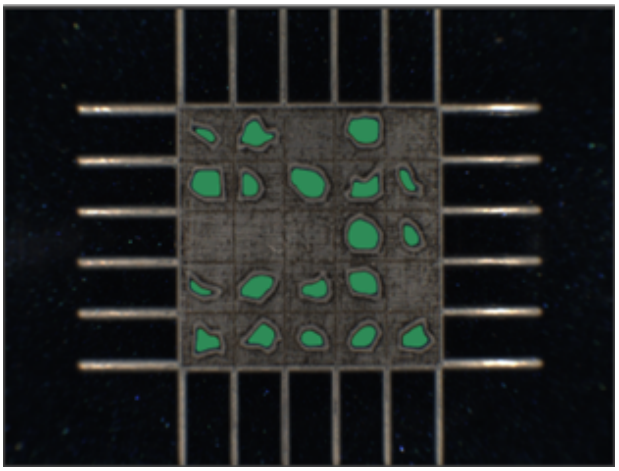
> ⚠ The white grid in the preview will mirror the settings in properties and will only appear after you have taken at least one measurement.

Please arrange the grid and the cross-cut image as close as possible, as only a matching overlay would ensure a perfect result. If you see that your grid does not match, please modify the properties accordingly.

Ideal results should look like as in the images below; note that the images show detected remaining coating in green overlay color:



Crosscut example 1



Crosscut example 2

If you are experiencing issues with the selection of remaining coating, please adjust the Cut Detection Threshold until the resulting overlay is covering the area correctly.

Testing Coatings with Low Absorption Against the Substrate

For samples having a brighter coating compared to the substrate, you might be experiencing issues.

In this case, it might help to use the “Invert Map” setting, to differentiate the cross cut by inverting the image and then performing the analysis.

Taking a Measurement (Cross-cut)

How to measure Cross-cut Adhesion

The measurement button is used to start single or multiple measurement that are sent directly to the table.

1. Ensure the sensor is calibrated.
2. To access the multiple readings feature, right click on the measurement button.
3. Press the measurement button to start.

Measurement button

How to measure surface texture using the interactive measurement feature

The interactive measurement function is a "live" view of the sample surface.

The surface camera is used to correctly align the cross-cut area before measurement.

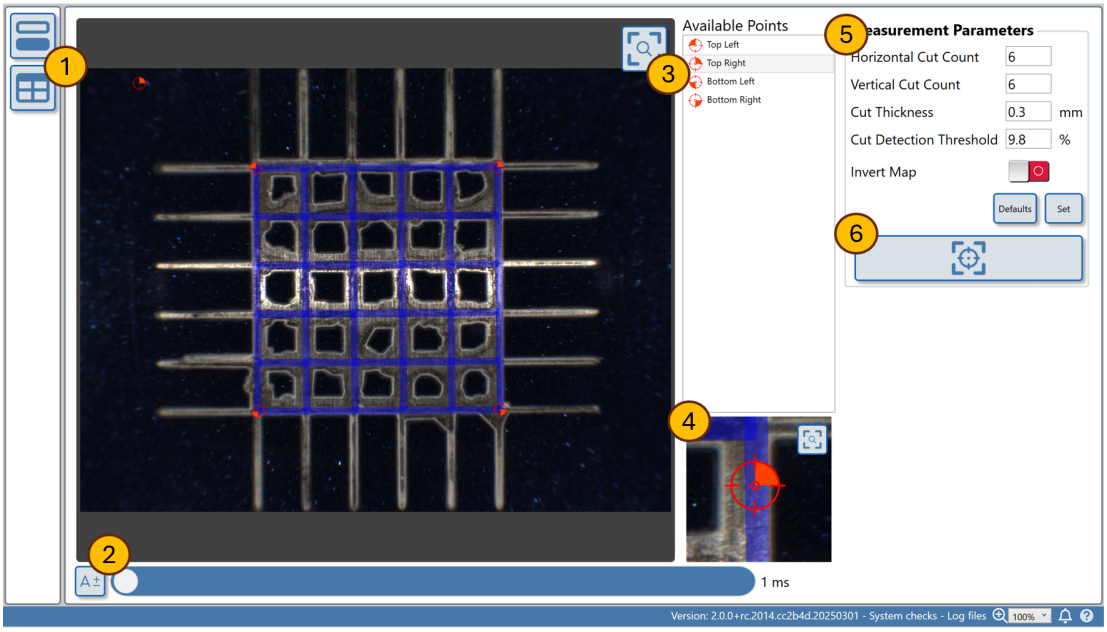
1. **Activate Interactive Measurement**
   - Press the interactive measurement button.

Interactive button

2. **Optimize Camera Exposure**

- Use the **Auto-Exposure** button to optimize the camera exposure for the surface's reflectivity.
- If necessary, manually adjust the exposure using the slider or input box (2).

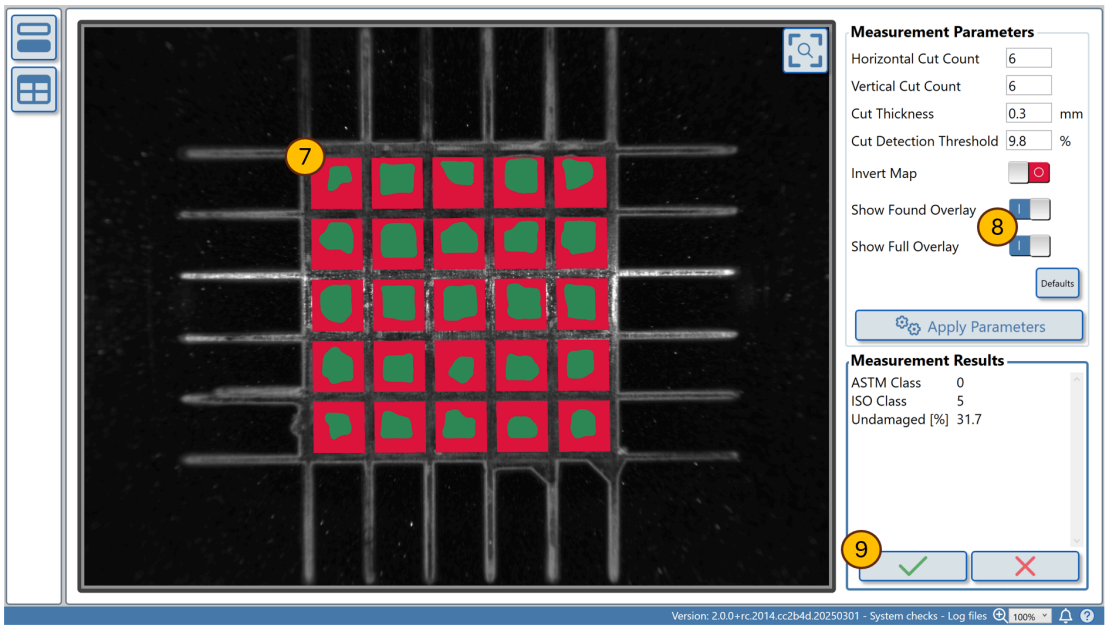
3. **Select Cross-Cut Corners**
   - In the analysis window (1), click on the four corners of the cross-cut area to be evaluated.
     - Placement order: **Top Left**, **Top Right**, **Bottom Left**, **Bottom Right**.
     - Use the zoom feature (4) if needed to ensure precision. The cross-hair should be placed at the center of each intersection between horizontal and vertical cuts.
   - To adjust a selection, click on one of the available points (3).
4. **Set Grid Parameters**
   - Select the number of cuts in the square (5).
   - Press the **SET** button to draw a grid on the surface.
5. **Check Line Thickness**
   - Verify that the thickness of the drawn lines matches the thickness of the cuts on the surface. Adjust if necessary using control (5).



Cross Cut

6. **Preview Measurement**

- Press the **Preview Measurement** button (6).



Cross Cut2

7. **Review Analysis Results**

- Visually compare the analysis result with the image by toggling on/off the analysis overlays (8).

8. **Adjust Parameters if Necessary**

- If cuts are darker than the paint color:
  - Select "Invert Image" and press (6) to apply parameters.
- If cut areas are mistakenly identified:
  - Reduce the cut detection threshold.
- If areas of paint are not correctly identified:
  - Increase the cut detection threshold.

9. **Reprocess Analysis**

- Once adjustments are made, press the **Apply Parameters** button (6) to reprocess the analysis.

10. **Save or Restart Measurement**

- When satisfied with the analysis, press the "Tick" button (7) to save the measurement in the results table.
- To restart and redo the interactive measurement process, press the "Cross" button.

Interpreting Results- Cross-cut Adhesion Module

How Does Aesthetix Measure Cross-cut Adhesion?

The Aesthetix measures cross-cut adhesion using its **Cross-cut Module**, which is designed to evaluate coating adhesion strength based on the ISO 2409 standard. This involves creating a grid of cuts through the coating down to the substrate and analysing the extent of coating detachment after adhesive tape is applied and removed.

Measurement Process:

1. **Grid Creation**: The Aesthetix creates a standardised grid with six horizontal and six vertical cuts, spaced 2.0 mm apart, with a cut thickness of 0.2 mm.
2. **Image Capture**: High-resolution images of the cross-cut area are captured.
3. **Analysis**: The software analyses the grid for coating detachment, identifying areas where the coating has peeled or flaked.
4. **Quantification**: Results are expressed as the percentage of remaining coating within the grid, providing an objective measure of adhesion.

This automated process ensures repeatable and accurate results, eliminating subjective errors often associated with manual evaluations.

Measurements Provided by Aesthetix for Cross-cut Adhesion

The Aesthetix provides several metrics to quantify cross-cut adhesion:

1. **Remaining Coating Percentage**: The percentage of intact coating remaining within the cross-cut grid after testing.
2. **Cut Detection Threshold**: Adjustable sensitivity for distinguishing adhered and detached coating areas.

3. **Grid Overlay Accuracy**: Ensures precise alignment of the measurement grid with the cross-cut area.

Comparison and Application:

- Use **Remaining Coating Percentage** for general adhesion strength assessment.
- Adjust the **Cut Detection Threshold** for coatings with varying contrast or brightness relative to the substrate.
- For coatings with low absorption or challenging substrates, use the **Invert Map** setting to improve detection accuracy.

For most applications, the **Remaining Coating Percentage** is sufficient for quality control purposes, while threshold adjustments are useful for specific materials or substrates.

Visualising Cross-cut Adhesion Using Appearance Elements

The Rhopoint Appearance Elements software provides tools to visualise cross-cut adhesion:

1. **Open Cross-cut View**:
   - Navigate to the "Cross-cut Module" in the software.
   - View a live image of the cross-cut area with an overlaid grid.
2. **Analyse Remaining Coating**:
   - Use colour-coded overlays (e.g., green for adhered areas, red for detached areas) to visualise adhesion performance.
   - Adjust grid alignment or detection thresholds if needed.
3. **Detailed Metrics Display**:
   - Access quantitative results in a dedicated results panel, including remaining coating percentage and cut spacing/thickness parameters.
4. **Export Results**:
   - Save images and data for reporting or further analysis.

Improving Coating Adhesion

To improve coating adhesion:

1. **Surface Preparation**:
   - Clean surfaces thoroughly to remove contaminants like oils, dust, or residues.
   - Use surface treatments such as sanding, etching, or priming to enhance mechanical bonding.
2. **Coating Formulation**:
   - Adjust binder content in paint formulations to improve adhesion properties.
   - Include additives that promote better wetting and bonding with substrates.
3. **Application Process**:
   - Ensure consistent application thickness and uniformity.
   - Avoid application in high humidity or extreme temperatures that could affect curing.
4. **Curing Conditions**:
   - Follow recommended curing times and temperatures to ensure proper film formation and bonding.
5. **Substrate Compatibility**:
   - Select coatings compatible with specific substrate materials (e.g., metals, plastics).

By combining these adjustments with precise measurements from Aesthetix, manufacturers can enhance coating performance and ensure compliance with quality standards.

Polishing Quality Module

An advanced tool to quantifies surface defects such as scratches, holograms, and swirls on high-gloss finishes.

It simultaneously measures gloss, haze, sharpness, DOI, and orange peel, providing a comprehensive evaluation of surface quality.

This feature is invaluable to coatings manufacturers assessing abrasion resistance, polishing material producers benchmarking product effectiveness, or OEM car manufacturers optimizing polishing processes and evaluating spot repairs.

Polishing Module Tools

Gloss

Gloss is the standard measurement for reflective appearance but should not be used for optimizing the polishing process. It is insensitive to imperfections such as scratches, swirls, and haze, which detract from a surface's visual appeal.

Go to Gloss Section (Gloss)

Haze

Haze refers to the scattering of light by a surface, reducing the contrast of the reflected image and causing a milky appearance that diminishes the perceived depth of the finish.

It is caused by the nano-structure of the surface material, leading to near-specular reflections.

Haze can also result from weathering or oxidation of high-gloss paint. Measuring haze before polishing can help quantify the effectiveness of a paint correction process.

During the polishing process, haze is introduced using large grit size compounds then reduced and eliminated in subsequent steps as the grit size of the polish is reduced. Haze measurement allows manufacturers to benchmark the performance of polishing compounds and materials and optimize both polishing time and technique.

In conjunction with physical test instruments haze measurement is an effective and sensitive measurement of abrasion and car wash resistance of high gloss coatings.

The preferred Aesthetix parameters used to measure this process are Log Haze Compensated (LogH C) or Visual Haze Outdoor (VisHH-in)).

Go to Haze Section (Haze)

Polishing Defect Profiling

The Polishing Quality Module quantifies linear defects on the surface of the paint, such as holograms, scratches, and polishing marks, using a high-intensity light source. The severity of these defects is assessed based on their size and length.

The defects are detected because they reflect light from the high intensity light source and appear bright against the background, this modules is only suitable for polishing defects which are brighter than than the background when illuminated.

Measuring these defects is important for OEM polishing quality- due to the low visibility of these defects in standard light these can be overlooked during repairs or polishing in factory, first seen only to be seen by the customer in sunny condition.

Taking a Measurement (Polishing Quality)

How to measure Polishing Quality

The measurement button is used to start single or multiple measurement that are sent directly to the table.

1. Ensure the sensor is calibrated.
2. To access the multiple readings feature, right click on the measurement button.
3. Press the measurement button to start.

Measurement button

How to measure polishing quality using the interactive measurement feature

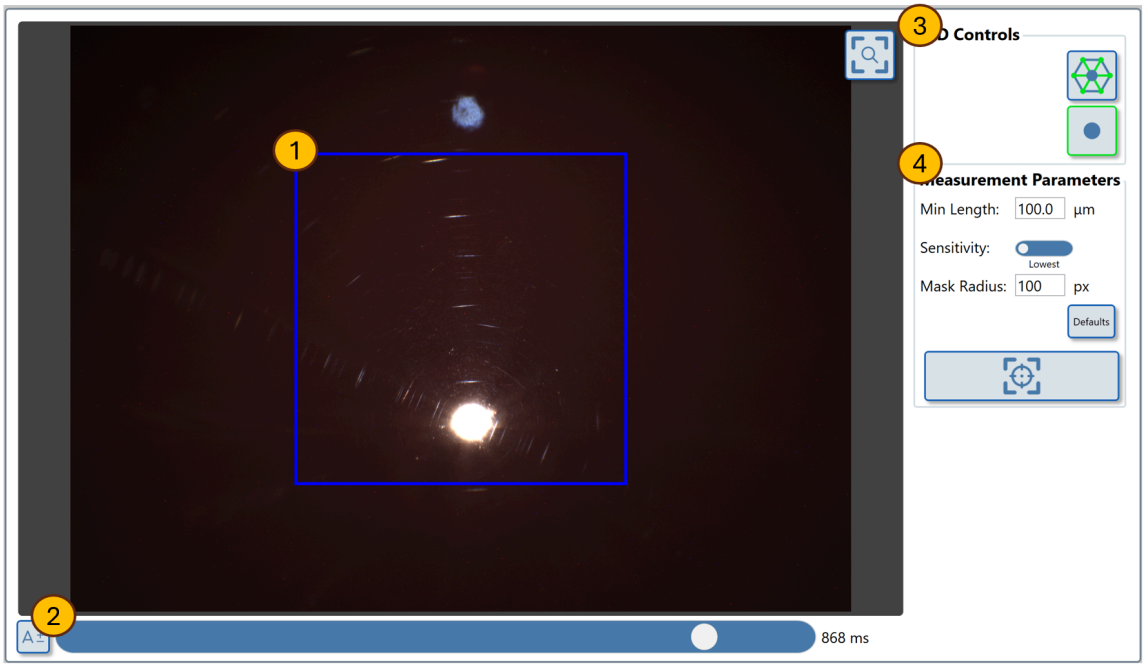
The interactive measurement function is a "live" view of the sample surface.

The surface camera is used to identify particular areas of interest on the surface before starting a measurement.

Measurement Procedure

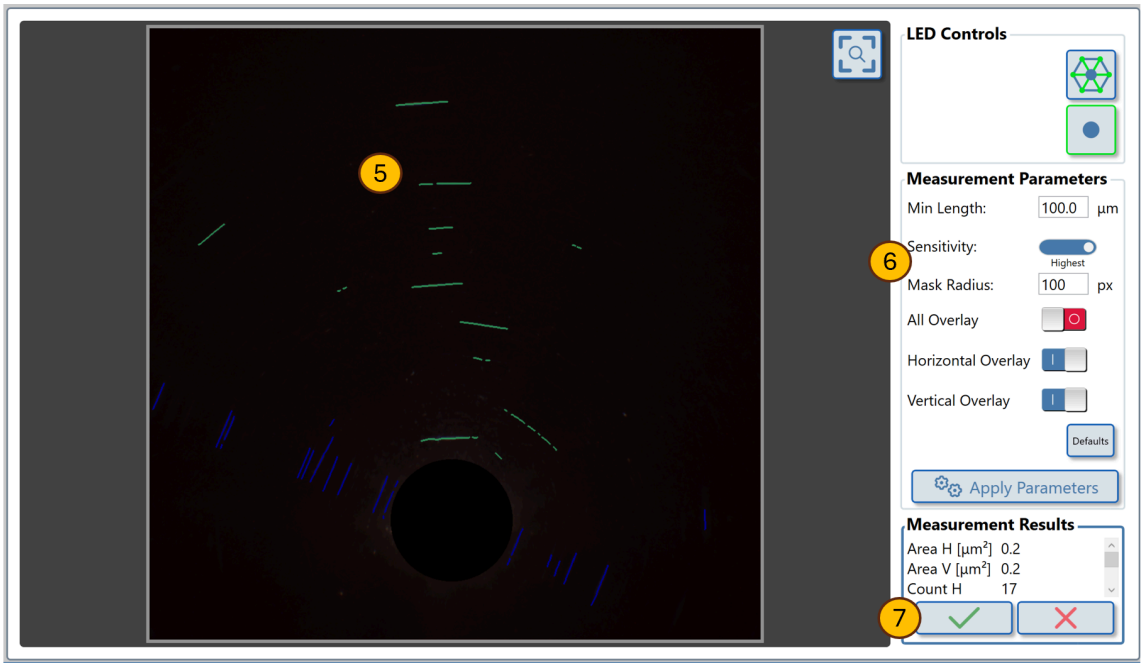
1. Ensure the sensor is calibrated.
2. Press the button to activate the interactive measurement feature.

Interactive button



Polish

3. Use the auto-exposure button to optimize the camera exposure for the surface's reflectivity.
4. Manually adjust exposure if needed using the slider or input box.
5. The blue square (1) indicates the measurement area for this module.
6. To measure the texture of an identified area on the surface move the sensor until the required area is enclosed by the blue square (1).
7. Press the measurement button (4) to take a preview measurement.



Polishing 2

8. The feature map (5) displays the identified elements.
9. The measurement parameters can be adjusted to change the profile of identified features. Read More. (Adjusting Polishing Quality Parameters)
10. Once measurement parameters are adjusted press Apply Parameters button (6) to reprocess the analysis.
11. When the analysis is acceptable, press the "tick" button (7) to save the measurement in the data table.
12. Pressing the cross will restart the interactive measurement process.

> Adjusting the exposure settings in this view do not affect measurements. This control is used to get a clear surface image for positioning purposes.

Interpreting Results- Polishing Quality Module

How Does Aesthetix Measure Polishing Quality (Scratches, Swirls, and Holograms)?

The Aesthetix evaluates polishing quality by using **high-resolution imaging and advanced algorithms** to detect and quantify surface defects such as scratches, swirls, and holograms. These imperfections are identified based on their unique visual characteristics under specific lighting conditions.

Measurement Process:

1. **Directional Illumination**: The Aesthetix uses multiple light sources, including a **10° point light** and a **45° ring light**, to illuminate the surface. These lighting setups enhance the visibility of defects like scratches, swirls, and holograms.
2. **High-Resolution Imaging**: A camera captures detailed images of the illuminated surface. Scratches appear as linear features, swirls as concentric circular patterns, and holograms as elongated streaks starting from the light source.
3. **Image Analysis**: The system applies image segmentation algorithms to isolate and quantify these defects. Metrics such as defect length, width, density, and orientation are calculated.

This approach ensures precise detection of polishing defects that are often difficult to identify under standard inspection conditions.

Additional Measurements Provided by Aesthetix

In addition to detecting scratches, swirls, and holograms, the Aesthetix provides several advanced metrics to further analyse surface quality:

1. **Sharpness**:
    - Measures the clarity and definition of edges in reflected images.

- Higher sharpness values (measured in Sharpness Units [SU]) indicate clearer reflections with well-defined edges.
- Useful for assessing overall surface quality and how well the surface reflects fine details.

2. **Distinctness of Image (DOI)**:
   - Evaluates the overall clarity of reflected images.
   - Higher DOI values indicate less distortion in reflections, making it ideal for applications requiring smooth finishes (e.g., automotive coatings).
3. **LogHaze C**:
   - Quantifies technical haze caused by light scattering around a specular reflection.
   - Important for identifying micro-textures or contaminants that reduce clarity.
4. **Visual Haze Outdoor (VHout)**:
   - Adjusts haze measurements to match human perception under outdoor lighting conditions.
   - Critical for applications where products are viewed in bright sunlight or high-intensity lighting environments.

Comparison and Application:

- Use **Sharpness** for high-gloss surfaces where edge clarity is critical (e.g., automotive finishes or polished metals).
- Choose **DOI** when assessing the overall distinctness of reflections is more important than edge sharpness.
- Select **LogHaze C** for technical analysis of haze caused by micro-textures or contaminants.
- Opt for **Visual Haze Outdoor** when evaluating surfaces intended for outdoor use, ensuring defects like holograms or haze are not visible under sunlight.

Each metric provides unique insights into surface quality; selecting the right one depends on your specific application requirements.

Visualising Polishing Quality Using Appearance Elements

The Rhopoint Appearance Elements software enables detailed visualisation of polishing quality:

1. **Open Defect View**:
    - Navigate to the "Defect View" tab in the software.
    - Use directional lighting options (e.g., 10° point light) to highlight surface imperfections.
2. **Analyse Defects**:
    - Scratches appear as linear features in the captured images.
    - Swirls are displayed as circular patterns, while holograms appear as elongated streaks.
    - Colour-coded overlays can be applied to distinguish between defect types.
3. **Visualise Advanced Metrics**:
    - Access additional views for Sharpness, DOI, LogHaze C, and Visual Haze Outdoor.
    - Compare these metrics side-by-side with defect visualisations to correlate numerical values with observed imperfections.
4. **Quantitative Analysis**:
    - View metrics such as scratch density, swirl intensity, sharpness units (SU), DOI values, and haze levels in the results panel.
    - Compare multiple samples side-by-side for consistency checks.
5. **Export Results**:
    - Save annotated images and data for reporting or further analysis.

Improving Polishing Quality (Reducing Visibility of Scratches, Swirls, and Holograms)

To improve polishing quality and reduce visible defects:

1. **Optimise Polishing Techniques**:
   - Use finer abrasives or polishing compounds to minimise scratches.
   - Avoid excessive pressure during rotary polishing to reduce swirl marks.
   - Use dual-action polishers instead of rotary tools to prevent holograms.
2. **Control Environmental Factors**:
   - Ensure a clean workspace to avoid introducing dust or debris during polishing.
   - Maintain consistent temperature and humidity to optimise compound performance.
3. **Use High-Quality Materials**:
   - Select premium polishing pads and compounds designed for specific surface types.
   - Ensure compatibility between pads, compounds, and coatings.
4. **Inspect Regularly During Polishing**:
   - Periodically check surfaces under directional lighting to identify defects early.
   - Adjust techniques or materials as needed based on real-time feedback.
5. **Apply Protective Coatings**:
   - Use sealants or ceramic coatings after polishing to protect against future scratches or defects.

By leveraging precise measurements from Aesthetix alongside these improvement strategies, manufacturers can achieve consistently high-quality finishes with minimal visible imperfections while ensuring alignment with human perception under various lighting conditions.

Adjusting Polishing Quality Parameters

This module identifies swirls, whirls, and holograms in paint surfaces by analyzing an image of a reflected high-intensity spot positioned at 10 degrees. The algorithm selects visible linear defects based on their contrast against the background luminosity.

1. Sensitivity

- **Purpose:** Controls the threshold for detecting linear defects based on their visibility (contrast against the background).
- **Options:** Lowest, Low, Moderate, High, Highest
- **How It Works:**
  - Higher sensitivity detects more subtle defects but may include false positives.
  - Lower sensitivity focuses on more prominent defects, potentially missing subtle ones.
- **Adjustment Steps:**

1. Start with "Lowest" sensitivity.
2. If important defects are missed, increase the sensitivity.

2. Minimum Length

- **Purpose:** Sets the smallest size of defects to be included in the analysis, measured in microns.
- **How It Works:**
  - Larger values exclude smaller defects, focusing on more significant imperfections.
  - Smaller values include finer defects but may increase detection of irrelevant marks.
- **Adjustment Steps:**

1. Begin with a moderate value based on your quality standards (Default is 100 microns).
2. Decrease the value if you need to detect shorter defects.
3. Increase the value to focus only on larger imperfections.
4. Adjust based on the typical size of defects relevant to your product quality criteria.

3. Mask Radius

- **Purpose:** Excludes the direct reflection of the high-intensity spot from the analysis.

1. The default radius removes the spot reflection in smooth mirror like surface.
2. Increase the radius if surface haze or polishing marks are increasing the reflected spot size and interfering with defect detection.

Software Development Kit (SDK)

This SDK is designed to simplify the integration of our measurement devices into your software applications.

Whether you're building custom solutions for data acquisition, analysis, or automation, this SDK provides the tools and resources you need to communicate with our devices seamlessly.

What Is This SDK?

Our SDK is a robust software development kit that allows developers to:

- Connect to Measurement Devices: Establish secure and reliable communication with our devices.
- Retrieve Measurement Data: Access measurement data with ease.
- Control Devices: Send commands to configure and control device settings programmatically.
- Streamline Workflows: Automate repetitive tasks and integrate measurement workflows into your systems.

Key Features

- Cross-Platform Compatibility: Works on Windows, macOS, and Linux (specific compatibility details in the requirements section).
- Language Support: SDK libraries and examples are available C# but can be adapted to any other language as well.
- Extensive Documentation: Step-by-step guides, examples, and API references to get you started quickly.

Who Is This For?

This SDK is intended for:

- Software Developers: Build custom applications or integrate our measurement devices into your existing systems.
- Engineers and Researchers: Automate data collection and analysis workflows.
- System Integrators: Seamlessly connect our devices with third-party platforms or bespoke solutions.

Support and Resources

- Documentation: Comprehensive guides and API references are available in this documentation.
- Examples and Tutorials: See code samples and walkthroughs for common tasks.
- Technical Support: Need help? Contact our support team for assistance.

RAE File Format

The RAE file format is an open and flexible format to transport any kind of measurement.

It consists of three main parts:

- The "magic string" at the beginning of the file for file identification.
- The container properties (the file header)
- The actual data.

The data containers are RFC 8949 Concise Binary Object Representation (CBOR) encoded (https://cbor.io/ (https://cbor.io/), https://en.wikipedia.org/wiki/CBOR (https://en.wikipedia.org/wiki/CBOR)). CBOR is a compact, efficient binary serialization format, designed to be easily parsed and interoperable. It is ideal for transmitting structured data. There are a lot of free implementations for reading/writing CBOR for every widely used programming language like C#, C++, Java, or TypeScript: https://cbor.io/impls.html (https://cbor.io/impls.html)

- File Identification (File Identification)
- MIME Type (MIME Type)
- File Header (File Header)

File Identification

The RAE file format begins with a specific sequence of bytes to uniquely identify the file type and its version. This sequence is known as the magic string. The purpose of the magic string is to allow software tools to quickly recognize and validate the file format before attempting to process it.

The magic string structure is as follows: `RAE<version byte>CBOR<0xFF>`

Breakdown of the Magic String

1. `RAE`: A fixed three-character prefix that identifies the file as an RAE format file.
2. **Version Byte** (`<version byte>`): A single byte that specifies the version of the RAE format. This allows for future backward-compatible updates to the format.
    - The current version is `0x01`, indicating the initial version of the RAE format.
3. `CBOR`: A variable length string indicating that the file's data container uses the CBOR (Concise Binary Object Representation) encoding format.
4. **Terminator Byte** (`<0xFF>`): A single byte with the value `0xFF`, marking the end of the magic string and the start of the file header. This ensures unambiguous parsing and serves as a delimiter for file processing tools.

Example

An example of the magic string in a hexadecimal representation for the current version (`0x01`) would look like this: `52 41 45 01 43 42 4F 52 FF`

- `52 41 45`: ASCII for "RAE".
- `01`: Version byte (current version).
- `43 42 4F 52`: ASCII for "CBOR".
- `FF`: Terminator byte.

This sequence is the first part of the file and ensures that any system or tool attempting to

parse the file can quickly verify its format, version, and encoding type.

MIME Type

The MIME type for the RAE file format is: `application/vnd.rhopoint.rae+binary`

A MIME (Multipurpose Internet Mail Extensions) type is a standardized way to describe the nature and format of a file's content. The assigned MIME type for the RAE file format indicates that it is a proprietary binary file created and managed by Rhopoint Instruments. Below is a breakdown of the MIME type components:

1. **`application`**: This denotes that the RAE file is an application-specific binary file rather than text or multimedia content.
2. **`vnd.rhopoint`**: The `vnd.` prefix specifies that this is a vendor-specific MIME type, followed by `rhopoint`, which identifies Rhopoint Instruments as the creator and maintainer of the format.
3. **`rae`**: This refers to the specific file format name, "RAE," associated with Rhopoint's measurement system.
4. **`+binary`**: The `+binary` suffix indicates that the file content is encoded in a binary format, as opposed to text-based formats like JSON or XML.

Usage

The MIME type `application/vnd.rhopoint.rae+binary` is critical for ensuring proper handling and identification of RAE files in various systems. It is used in the following scenarios:

- **File Transfer**: To specify the file type during HTTP communication (e.g., as the `Content-Type` or `Accept` header in REST APIs).
- **File Storage**: To associate the correct file type metadata with stored RAE files.
- **File Parsing**: To ensure applications recognize and process RAE files with the appropriate decoders and parsers.

By adhering to this MIME type, systems and software can reliably identify RAE files and process them correctly in accordance with Rhopoint's specifications.

File Header

The file header, encoded using the CBOR format, contains critical metadata about the RAE file and its content. Below is an explanation of the properties in the `RaeBinaryFile` class:

Decompression and parsing of data

The `Data` byte array may be compressed using the `gzip` algorithm. Once decompressed, it is a CBOR container containing a collection of `MeasurementComponentMetaTuple` objects.

Steps to parse the data

1. **Decompress** the `Data` byte array (if `Compression` is not `"none"`).
2. **Deserialize** the decompressed data using a CBOR parser.
3. **Interpret** the data based on the `Format` value. For now, this is always a collection of `MeasurementComponentMetaTuple`.

Data Types

Take a look at the specific types in the subtopics.

FileBinaryData

Declaration

FileMetadata

Declaration

FileReferenceData

Declaration

Identifiable

The base record for all structures that need to be identifiable.

Declaration

IMeasurementComponent

For more details, see MeasurementComponent (MeasurementComponent).

Declaration

IMeasurementData

Declaration

IMeasurementSource

Declaration

IMetadata

Declaration

MeasurementComponent

The `MeasurementComponent` class describes the individual components of a measurement. Below are its key properties:

MeasurementComponent Properties

- **Identifier (`id: string?`)**: A unique identifier for the measurement-item. Usually set by the database in which it is stored.
- **Version (`ver: int32?`)**: The version of the measurement component.
- **SourceIdentifier (`srcId: string?`)**: A unique identifier for the measurement. This is set by the client that creates the measurement. This field is identical to the `SourceIdentifier` of `MeasurementMeta`.
- **Type (`type: MeasurementTypes?|string?`)**: Specifies the type of the current `MeasurementComponent`, for example, `Composite`, `Single`, or `File`. See `MeasurementTypes` for more details.
- **Name (`name: string?`)**: A descriptive name for the component. Usually used to name the concrete metric, for example `"gloss"` or `"visualGloss"`.
- **Timestamp (`time: DateTime?|string?`)**: The timestamp when this component was created. It is usually set only in the root component
- **SourceTimestamp (`srcTime: DateTime?|string?`)**: The original timestamp from the source device or the agent taking the measurement. It is usually set only in the root component
- **Data (`data: IMeasurementData?`)**: Contains the raw or processed data container for this measurement component. Check `IMeasurementData` for more details.
- **Metadata (`meta: IMetadata<MeasurementComponent>?`)**: Additional metadata for this component.
- **Source (`src: IMeasurementSource?`)**: Details about the source of this measurement component (for example, device identifier or location). Check `IMeasurementSource` for more details.

- **Components (`comp`)**: A list of sub-components that belong to this measurement. These form the substantial part of the composite structure
- **SourceSignature (`srcSig: string?`)**: A signature generated by the source device.
- **Signature (`sig: string?`)**: A signature created by the measuring agent or a third-party signature system.

Declaration

MeasurementComponentMetaTuple

The `MeasurementComponentMetaTuple` is a data structure that consists of metadata about a measurement and its associated measurement components. It has two main properties:

Properties

- **Meta** Metadata about the measurement, represented by the `MeasurementMeta` class.
- **Component** The actual measurement data, represented by the `MeasurementComponent` class.

Declaration

MeasurementData

Declaration

MeasurementMeta

The `MeasurementMeta` class provides detailed information about a measurement. Below are the key properties:

Properties

- **Identifier (`id: string?`)**: A unique identifier for the meta-item (not the actual measurement). It is usually set by the database in which it is stored.
- **Version (`ver: int32?`)**: The version of the meta-container.
- **SourceIdentifier (`srcId: string?`)**: A unique identifier for the measurement. This is set by the client that creates the measurement. This field is identical to the `SourceIdentifier` of `MeasurementComponent`.
- **MeasurementIdentifier (`mId: string?`)**: The unique identifier of the `MeasurementComponent` dataset. It is usually set by the database in which it is stored.
- **ModuleIdentifier (`modId: string?`)**: Identifies the module that performed the measurement.
- **MeasurementType (`mType: MeasurementTypes?|string?`)**: Specifies the type of the root `MeasurementComponent`, for example, `Composite`, `Single`, or `File`. See `MeasurementTypes` for more details.
- **Timestamp (`time: DateTime?|string?`)**: The timestamp when the measurement was taken/saved.
- **SourceTimestamp (`srcTime: DateTime?|string?`)**: The original timestamp from the source device or the agent taking the measurement.
- **Name (`name: string?`)**: A descriptive name for the measurement.
- **Project (`proj: string?`)**: The associated project for the measurement.
- **Batch (`bat: string?`)**: The associated batch for the measurement.
- **Customer (`cust: string?`)**: The customer related to the measurement.
- **Comments (`com: string?`)**: Any comments or notes about the measurement.

- **Tags (`tag: string?`)**: A list of tags to help categorize or identify the measurement.
- **SearchableText (`search: string?`)**: A concatenated string of searchable text fields.

Declaration

MeasurementSource

Declaration

MeasurementTypes

The `MeasurementTypes` enumeration defines the various types of components that can be represented within the RAE file format. This enum provides a structured way to classify components based on their format, structure, and purpose.

MeasurementTypes Usage

The `MeasurementTypes` enum is used to classify and interpret measurement data within the RAE format. Depending on the type, the structure of the associated data and the parsing logic may differ. When working with this enum:

- Ensure the correct type is assigned based on the measurement data's format and purpose.
- Use type-specific processing methods to handle each measurement type appropriately.

MeasurementTypes Values

Composite

Represents a measurement that is composed of multiple sub-components. Each sub-component may itself be a specific `MeasurementType`, forming a hierarchical structure.

- **Example Use Case**:
  - A composite measurement where multiple attributes (e.g., color, gloss, texture) are recorded together.
  - A super-measurement or a collection of merged measurements that contain multiple measurements within a single container (e.g., multiple measurements of the same material).

Single

Represents a single, standalone measurement value. This type is used when the measurement consists of a singular data point without any additional components or sub-structures.

- **Example Use Case**:
  - A single gloss or color value recorded during a measurement.

Continuous

Represents a time-based continuous measurement, such as a stream of data points collected over time.

- **Example Use Case**:
  - A measurement of temperature or humidity sampled continuously over a fixed time interval.

Graph

Represents a measurement that is stored as a series of data points that can be plotted on a graph. This type is typically used for measurements involving relationships between variables (e.g., X-Y data).

- **Example Use Case**:
  - Reflectance curves or spectrograph data where intensity values are plotted against wavelength.

File

Represents a measurement that is stored as a file within the system. The file itself contains the measurement data in a specific format.

- **Example Use Case**:
  - A raw image or binary file containing data collected from a measurement device.

FileReference

Represents a reference to an external file that contains measurement data. Instead of embedding the file directly, this type provides a pointer to its location.

- **Example Use Case**:

- A database entry or a URL pointing to a file stored on a remote server or file system.

Array

Represents a measurement that consists of an array of values. This type is used when multiple related measurements are grouped together in a linear structure.

- **Example Use Case**:
  - An array of measurements taken at different spatial positions, such as a grid of gloss measurements across a surface.

Declaration

Metadata

Declaration

RaeBinaryFile

The `RaeBinaryFile` is the root record for the RAE file format in its binary representation.

Properties

- **Format** (required): Identifies the data format contained within the file. For now, only `"MeasurementComponentMetaTuple[]"` is supported.
- **Version** (required): Indicates the version of the file format. The current version is `1`.
- **Compression** (optional): Specifies the compression algorithm used for the `Data` byte array. If not set, it defaults to `"none"`. Currently, only `"gzip"` is supported.
- **EncryptionAlgorithm** (optional): Specifies the encryption algorithm applied to the data (if any). This is not implemented in the current version.
- **HashAlgorithm** (optional): Describes the hashing algorithm used to validate data integrity. For example, `sha256`.
- **Hash** (optional): A hash string used for data integrity checks. This is calculated using the algorithm specified in `HashAlgorithm`.
- **DataContainer** (required): Indicates the format of the data inside the file after decompression. Currently, this must be `"MeasurementComponentMetaTuple[]"`.
- **DataSize** (required): The size of the `Data` byte array in bytes.
- **Data** (required): The actual measurement data stored as a byte array. The data is compressed using the specified compression algorithm (or left uncompressed if `Compression = "none"`) and contains a CBOR-encoded container matching the `Format`.

Declaration

RaeJsonFile

The `RaeJsonFile` is the root record for the RAE file format in its JSON representation.

Properties

- **Format** (required): Identifies the data format contained within the file. For now, only `"MeasurementComponentMetaTuple[]"` is supported.
- **Version** (required): Indicates the version of the file format. The current version is `1`.
- **DataContainer** (required): Indicates the format of the data inside `Data`. Currently, this must be `"MeasurementComponentMetaTuple[]"`.
- **Data** (required): The actual measurement data stored as a list of MeasurementComponentMetaTuple.

Declaration

SingleMeasurementData

Declaration

Metrics properties

Meta properties

Unique identifier	Property name	Node	Data type	Description
MStr0001	Batch	generalInfo	string	User-defined batch name.
MStr0002	Name	generalInfo	string	User-defined name of the measurement
MStr0003	Comments	generalInfo	string	User-defined comments.
MStr0005	SourceIdentifier	generalInfo	string	An identifier set by the measurement device or measurement agent. It must be unique, e.g. a GUID.
MStr0006	ModuleIdentifier	generalInfo	string	The identifier of the module from which the measurement was taken.

Measurement properties

Unique identifier	Property name	Name	Node/Group	Data type	Source property	Unit/Format	Description
Img0001	sampleImage		generalInfo	image	-	Bgr24	An image users can save additionally with the measurement.
Img0002	scratchOverlay		scratch	image	scratch_overlay	Indexed8	The overlay image that shows the detected scratches.
Img0003	scratchImage		scratch	image	scratch_image	Bgr24	The surface image taken from the scratch module.
Img0004	scratchVerticalOverlay		scratch	image	scratch_vertical	Indexed8	The image overlay of the vertical scratches.
Img0005	crossCutImage		crossCut	image	cross_cut_image	Bgr24	The surface image taken from the cross cut module
Img0006	crossCutFullOverlay		crossCut	image	cc_full_overlay	Indexed8	The cross cut overlay showing a perfect area used in comparison.
Img0007	crossCutFound		crossCut	image	cc_found_overla	Indexed8	The cross cut overlay of the undam

	Overlay				y		aged sections.
Img0008	surfaceImage		generalInfo	image	Sur_Image	Bgr24	The image from the top surface camera with all ring LEDs on.
Img0009	sparkleAlbedoImage		sparkle	image	sparkle_albedo	32bit float, grey	Image to display graininess.
Img0010	scratchHorizontalOverlay		scratch	image	scratch_horizontal	Indexed8	The image overlay of the horizontal scratches.
Img0012	cellOverlay		texture	image	Cell_Overlay	Indexed8	The image overlay of the watershed.
Img0013	wavinessImage		waviness	image	waviness_image	Bgr24	Image from 0° camera with line LED on.
Img0014	spotImage		generalInfo	image	Spot_Image	Bgr24	The image from the spot camera.
ImgL0001	ledSparkleImages		sparkle	imageList	sparkle_reduced_n	Bbr24	The sparkle image array based on each ring LED.
ImgL0002	ledSparkleOverlays		sparkle	imageList	sparkle_overlay_n	Indexed8	The sparkle image array of overlays

							based on each ring LED.
DT0001	dateCreated	Date	generalInfo	dateTime		UTC	
Str0001	instrumentSn	Instrument Serial Number	generalInfo	string	serial_number		
Str0002	crossCutClassAstm	ASTM Class	crossCut	string	cross_cut_class_astm		
Str0003	crossCutClassIso	ISO Class	crossCut	string	cross_cut_class_iso		
Dbl0005	scratchSelection	SS	scratch	double	scratch_selection	µm	
Dbl0006	glossValue	Gloss 60°	gloss	double	gloss	GU	Calibrated gloss value.
Dbl0007	visualGlossValue	Visual Gloss 60°	gloss	double	visual_gloss	P-GU	Calibrated visual gloss result.
Dbl0008	sharpnessValue	Sharpness	sharpness	double	sharpness	%	Calibrated sharpness value.

Dbl0009	loghaze	LogH	haze	double	loghaze	logHU	Logarithmic haze value.
Dbl0010	logHazeCValue	LogH C	haze	double	loghaze_c	logHU	Logarithmic haze background compensated value.
Dbl0011	hazeCValue	Haze C	haze	double	haze_c	HU	Haze background compensated value.
Dbl0012	contrastHazeValue	MC H	haze	double	contrast_haze	HU	Calibrated contrast haze value.
Dbl0013	mcDoi	DOI	haze	double	mc_doi	%	
Dbl0014	visualContrastValue	Visual Contrast	haze	double	visual_contrast	%	Calibrated visual contrast value.
Dbl0015	visualHazeIndoorsValue	Visual Haze Indoors	haze	double	visual_haze_indoors	VHU	Visual haze value with indoor viewing conditions.
Dbl0016	visualHazeOutsideValue	Visual Haze Outside	haze	double	visual_haze_outside	VHU	Visual haze value with outside viewing conditions.
Dbl0017	crossCutPercent	X-Cut	crossCut	double	cross_cut_percent	%	

Dbl0018	sparkleGraininess	Graininess	sparkle	double	sparkle_graininess		
Dbl0019	cellAmplitude	Cell Amplitude (Ca)	texture	double	cell_amplitude	P-µm	
Dbl0020	cellNumber	Cell Number (Cn)	texture	double/int	cell_number	count	
Dbl0021	cellSize	Cell Size (Cs)	texture	double	cell_size	mm^2	
Dbl0022	cellMax	Cell Max Size (CsMax)	texture	double	cell_max	mm^2	
Dbl0023	cellMin	Cell Min Size (CsMin)	texture	double	cell_min	mm^2	
Dbl0024	cellStdDev	Cell Standard Deviation (CsDev)	texture	double	cell_std	mm^2	
Dbl0025	hillSize	Hill Size (Hs)	texture	double	hill_size	mm^2	
Dbl0026	fillFactor	Fill Factor (F)	texture	double	fill_factor	%	
Dbl0027	textureR	Reflectivity	texture	double	interior_r	arb'U	Average reflectivity.
Dbl0	texture	Ratio Hill/Value Reflec	text	dou	interior_	arb'U	Ratio of hill and v

028	Rc	tivity (RC)	ure	ble	rc		alley reflectivity.
Dbl0029	textureRv	Valley Reflectivity (RV)	texture	double	interior_rv	arb'U	Valley reflectivity.
Dbl0030	textureRh	Hill Reflectivity (RH)	texture	double	interior_rh	arb'U	Hill reflectivity.
Dbl0031	roughnessSa	Sa Rough	texture	double	roughness_std	P-µm	
Dbl0032	watershedMorphology	Feature Separation (FSep)	texture	double	watershed_morphology	pixels	
Dbl0033	watershedSelectionPercent	Feature Selection Percentage (FSel)	texture	double	watershed_selection_percent	%	
Dbl0034	wavinessValue	Waviness	waviness	double	waviness	WU	
Dbl0035	pciWaviness	PCI Waviness	waviness	double	pci_waviness		
Dbl0036	tension	Tension	waviness	double	tension		
DblL0001	scratchLength	Scratch Length	scratch	doubleList	scratch_length		

DblL0002	scratch Visibility	Scratch Visibility	scratch	doubleList	scratch_vis		
DblL0008	scratch Length Mean	Scratch Length (Mean)	scratch	doubleList	scratch_mean		
DblL0009	scratch Count	Scratch Count	scratch	doubleList	scratch_count	-	
DblL0010	scratch Area	Scratch Area	scratch	doubleList	scratch_area		
DblL0011	scratch Visibility Mean	Scratch Visibility (Mean)	scratch	doubleList	scratch_vis_mean		
DblL0003	surface RgbMean	Mean Surface Color	color	doubleList	surface_colour	(R, G, B)	Average color of surface.
DblL0004	sparkle Density	Sparkle Density	sparkle	doubleList	sparkle_density		
DblL0005	sparkle Rgb45	Mean Sparkle Color (45°)	sparkle	doubleList	sparkle_rgb_45	(R, G, B)	
DblL0014	sparkle Rgb10	Mean Sparkle Color (1	sparkle	doubleLi	sparkle_rgb_10	(R, G, B)	

		0°)		st			
DblL0006	sparkleVisibilityMean	Mean Sparkle Visibility	sparkle	doubleList	sparkle_visibility_mean		
DblL0007	sparkleAreaMean	Mean Sparkle Area	sparkle	doubleList	sparkle_area_mean		
DblL0012	sparkleMonochrome	Sparkle Monochrome	sparkle	doubleList	sparkle_monochrome		
DblL0013	sparkleBrightnessMean	Mean Sparkle Brightness	sparkle	doubleList	sparkle_brightness_mean		
DblLL0001	sparkleVisibilityArray	Sparkle Visibility Array	sparkle	doubleListList	sparkle_visibility_array		
DblLL0002	sparkleAreaArray	Sparkle Area Array	sparkle	doubleListList	sparkle_area_array		
DblLL0003	sparkleBrightnessArray	Sparkle Brightness Array	sparkle	doubleListList	sparkle_brightness_array		
DblLL000	sparkleHueArra	Sparkle Hu	spar	doubleLi	sparkle_hue_arra		

4	y	e Array	kle	stLis t	y		
P000 1	comPix elCoord	Centre of Mass	glos s	poin t	COM		
PA00 01	glossRoi Coords	Gloss Regi on of Inter est	glos s	poin tList	gloss_ro i	x1,y1,x 2,y2: i nt	Position of area u sed for gloss calc ulation.
PA00 02	hazeTop RoiCoor ds	Haze Top R egion of In terest	haze	poin tList	haze_to p_roi	x1,y1,x 2,y2: i nt	Position of area u sed for top haze c alculation.
PA00 03	hazeBot tomRoi Coords	Haze Botto m Region of Interest	haze	poin tList	haze_bo ttom_roi	x1,y1,x 2,y2: i nt	Position of area u sed for bottom h aze calculation.
PA00 04	mcHaze TopRoi Coords	MC Haze T op Region of Interest	haze	poin tList	mc_top_ roi	x1,y1,x 2,y2: i nt	Position of area u sed for top contr ast haze calculati on.
PA00 05	mcHaze CenterR oiCoord s	MC Haze C enter Regi on of Inter est	haze	poin tList	mc_roi	x1,y1,x 2,y2: i nt	Position of area u sed for center co ntrast haze calcul ation.
PA00 06	mcHaze Bottom RoiCoor ds	MC Haze B ottom Regi on of Inter est	haze	poin tList	mc_bott om_roi	x1,y1,x 2,y2: i nt	Position of area u sed for bottom c ontrast haze calc ulation.
Pd3D 0001	texture3 DPlotDa	Texture 3D Plot Data	text ure	plot 3D	-		

	ta						
Pd3D0002	gloss3DPlotData	Gloss 3D Plot Data	gloss	plot3D	-		
-	-	Image Names	-	stringList	image_names		

Metric groups

The API trigger endpoints require the metric group identifier to initiate a measurement.

List of metric groups

ID	Description
cell	
contrastHaze	
crossCut	
gloss	
grit	
haze	
roughness	
scratchLinear	
scratchRadial	
sharpness	
sparkle	
spot	
surface	
visualContrast	
visualGloss	
visualHaze	

waviness	
pciWaviness	
tension	

Parameters

Certain metric groups require parameters, which are explained here.

Sub-properties are separated by a dot (.). For example, `altitude_crop.center.x` and `altitude_crop.center.y` must be passed in the following format:

```
{
  "altitude_crop": {
    "center": {
      "x": 42,
      "y": 42
    }
  }
}
```

Parameters for "cell"

Parameter	Data type	Unit	Description
watershed_morphology			
watershed_selection_percent			
invert_map			
altitude_crop.width			
altitude_crop.height			
altitude_crop.center.x			
altitude_crop.center.y			

Parameters for "scratchLinear"

Parameter	Data type	Unit	Description
scratch_selection		µm	Minimum length.
scratch_sensitivity			
spot_radius			

Parameters for "scratchRadial"

Parameter	Data type	Unit	Description
scratch_selection		µm	Minimum length.
scratch_sensitivity			
spot_radius			

Parameters for "crossCut"

Parameter	Data type	Unit	Description
crosscut.horizontal_lines			
crosscut.vertical_lines			
crosscut.spacing		mm	
crosscut.thickness		mm	
crosscut.threshold			
crosscut.automatic	bool		
crosscut.invert	bool		When coating in brighter than base.
crosscut.corners	integerList		(x1, y1, x2, y2, x3, y3, x4, y4) - 1 is top left, 2 is top right, 3 is bottom left, 4 is bottom right.

Known Issues

Welcome to the 'Known Issues' section of our help guide. Here, you'll find a list of current bugs, glitches, and other technical issues that we've identified in our software.

We believe in transparency and want to keep you informed about any issues you might encounter while using our product. Our team is actively working on resolving these problems, and we appreciate your patience and understanding.

If you encounter an issue not listed here, please don't hesitate to reach out to our support team. Thank you for your continued support and feedback.

###changelog-table###

Log files

This document provides information on how to locate, access, and use log files generated by the Æ Appearance Elements software.

Log files are invaluable tools for troubleshooting and problem-solving and can be retrieved from a specified directory within your system.

The following sections will guide you on how to find these files, understand their naming conventions, and employ them for effective troubleshooting.

Location

The log files for the software are located in your local drive. You can find them in this directory: `%LOCALAPPDATA%\Rhopoint Instruments Ltd\Rhopoint Appearance Elements 2\Logs`.

For example, if your username is `username`, the full path will be: `C:\Users\username\AppData\Local\Rhopoint Instruments Ltd\Rhopoint Appearance Elements 2\Logs`

Accessing Log Files

To access the log files, look at the version display in the bottom right corner of the main application window. Click on this version number to open the log files folder.

Log File Naming

The log files are named according to the date when they were generated. This allows you to easily identify logs from a specific time.

Log File Usage

Please remember that these log files can be highly helpful in troubleshooting any issues you may face. We encourage you to send them to the Rhopoint Instruments Customer Support whenever you seek help regarding any problems. The logs provide our support team with valuable information, aiding them in effectively diagnosing and addressing your concerns.

Device Connection Problems

Cable Length

When connecting devices via USB 3.0, it is recommended to use cables no longer than 3 meters to avoid common issues. Using longer USB 3.0 cables can lead to several problems due to various technical limitations. Here are the key issues:

- **Signal Degradation**
  - Attenuation: As the length of the USB cable increases, the strength of the signal weakens due to attenuation. This can result in data transmission errors or complete failure to communicate.
  - Interference: Longer cables are more susceptible to electromagnetic interference (EMI), which can further degrade the signal quality.
- **Power Delivery**
  - Voltage Drop: Longer cables can cause a drop in voltage, leading to insufficient power being delivered to the device. This can cause devices to malfunction or not operate at all.
  - Current Limitations: The resistance in the longer cables can limit the current, affecting the performance of devices that require more power.
- **USB Specification Limits**
  - Standard Length: The USB 3.0 specification limits the maximum length of cables to 3 meters. Exceeding this length can lead to unreliable performance because the USB standard is optimized for shorter cables.
  - Signal Timing: Longer cables can introduce latency in signal timing, which can disrupt the synchronous data transfer required by USB 3.0.
- **Data Transfer Rates**
  - Reduced Speeds: The high-speed data transfer capabilities of USB 3.0 (up to 5 Gbps) can be compromised with longer cables. This can lead to reduced transfer speeds, making the connection less efficient.

- Error Rates: Increased length can raise the error rates during data transmission, leading to repeated retransmissions and thus lower effective data rates.

Solutions to mitigate USB cable problems

- **Active USB Cables**: These cables have built-in signal boosters or repeaters that help maintain signal integrity over longer distances.
- **USB Hubs with Power**: Using powered USB hubs can help maintain the necessary power levels and signal quality over extended distances by boosting the signal at each stage.
- **Optical USB Cables**: These convert electrical signals to light and back, reducing signal degradation and allowing for much longer cable lengths.

7. Maintenance and Support

Cleaning Routines

To ensure accurate measurements and optimal performance of your Rhopoint glossmeter, follow these cleaning procedures:

1. **Instrument Optics**:
    - Inspect the optics before each calibration.
    - Remove dust or debris using dry, clean air.
    - Never touch the optics without wearing suitable cotton gloves.
    - If permanent marks or scratches are present on the lenses, return the instrument to an authorized Rhopoint service center[^3].
2. **Calibration Tile**:
    - Inspect the calibration standards before each use.
    - Remove fingerprints and dust with the supplied optic cleaning cloth.
    - If the tile is scratched or damaged, it is not suitable for calibration and must be replaced[^3].

Annual Calibration Recommendations

Rhopoint Instruments recommends annual calibration of both the glossmeter and its reference tile:

- Send your glossmeter and tile to a Rhopoint Approved Service Agent yearly.
- Annual calibration ensures accuracy and compliance with current industry standards.
- Calibration maintains optimal performance and helps meet desired aesthetic and quality standards.

Calibration Options:

- ISO 17025 UKAS certified calibration for Rhopoint Instruments glossmeters.
- Traceable calibration for all other glossmeter brands.

Support Contact Details

United Kingdom (Head Office)

Rhopoint Instruments Ltd.

- Address: Rhopoint House, Enviro 21 Park, Queensway Avenue South, St. Leonards-on-Sea, East Sussex, TN38 9AG, UK
- Hours: Monday to Thursday: 08:30 to 17:00 GMT, Friday: 07:30 to 13:00 GMT
- Email: sales@rhopointinstruments.com, support@rhopointinstruments.com

United States

Rhopoint Americas Inc.

- Address: 1000 John R Road, Suite 209, Troy, MI, 48083, United States
- Hours: Monday to Friday: 09:00 to 17:00 (Local time)

Germany

Rhopoint Instruments GmbH

- Address: Am Weiglfeld 28, 83629 Weyarn, Germany
- Hours: Monday to Thursday: 08:00 to 17:00, Friday: 08:00 to 14:00 (Local time)

Additional Support

- Live chat support is available during UK office hours.
- For assistance outside office hours, email support@rhopointinstruments.com.
- Response time for email inquiries is typically within 24 hours.

Remember to regularly maintain and calibrate your Rhopoint glossmeter to ensure accurate and reliable measurements for your quality control processes.

8. FAQs

1. What is the Rhopoint Aesthetix?

   The Rhopoint Aesthetix is an advanced optical surface characterisation tool that measures various appearance characteristics using a camera that mimics visual surface perception.

2. What surface characteristics can the Aesthetix measure?

   It measures gloss, haziness, waviness, reflected image sharpness, surface texture, roughness, RGB color analysis, sparkle, and graininess.

3. Is the Aesthetix compatible with different operating systems?

   The Aesthetix is compatible with Windows 10 and 11 devices.

4. Can the Aesthetix be used for automated workflows?

   Yes, it can be used in conjunction with collaborative robots (cobots) for automated workflows.

5. What type of connection does the Aesthetix use?

   It operates through a USB-3.0 connection.

6. Does the Aesthetix require batteries?

   No, it operates without batteries.

7. What is the on-screen resolution of the Aesthetix?

   It offers an on-screen resolution of 10 µm/pixel, similar to a 100x laboratory microscope.

8. How many light sources does the Aesthetix have?

   It has nine interior light sources, with six arranged in a ring.

9. What software does the Aesthetix use?

   It uses Rhopoint's modular Appearance Elements software.

10. What are the available software modules for the Aesthetix?

    There are three modules: surface brilliance, effect finish, and texture.

11. Can the Aesthetix measure curved surfaces?

    Yes, it comes with a small area and curved surface adaptor.

12. Is non-contact measurement possible with the Aesthetix?

    Yes, it can be used with a stand or laboratory cobot for non-contact measurements.

13. What is the focal distance for non-contact measurements?

The focal distance must be maintained at 10 mm +/- 0.5 mm for non-contact measurements.

15. Can the Aesthetix be used with custom jigs?

Yes, it can be used with 3D-printed jigs for repeatable measurement of small parts or curved surfaces.

16. What industries can benefit from using the Aesthetix?

Industries such as automotive, consumer goods, and those working with textured surfaces and finishes can benefit from the Aesthetix.

17. Does the Aesthetix offer backward compatibility with existing standards?

Yes, it offers backward compatibility with existing international standards.

18. What is the measurement spot size for the standard adaptor?

The standard measurement spot is 9x12mm.

19. What is the measurement spot size for the small area and curved surface adaptor?

The small area and curved surface adaptor changes the measurement spot to 2x3mm.

20. Does the Aesthetix need to be recalibrated when changing adaptors?

Yes, the instrument must be recalibrated after changing adaptors.

21. Can the Aesthetix capture digital images of surfaces under analysis?

Yes, the Rhopoint Appearance Elements software facilitates digital image capture of any surface under analysis.