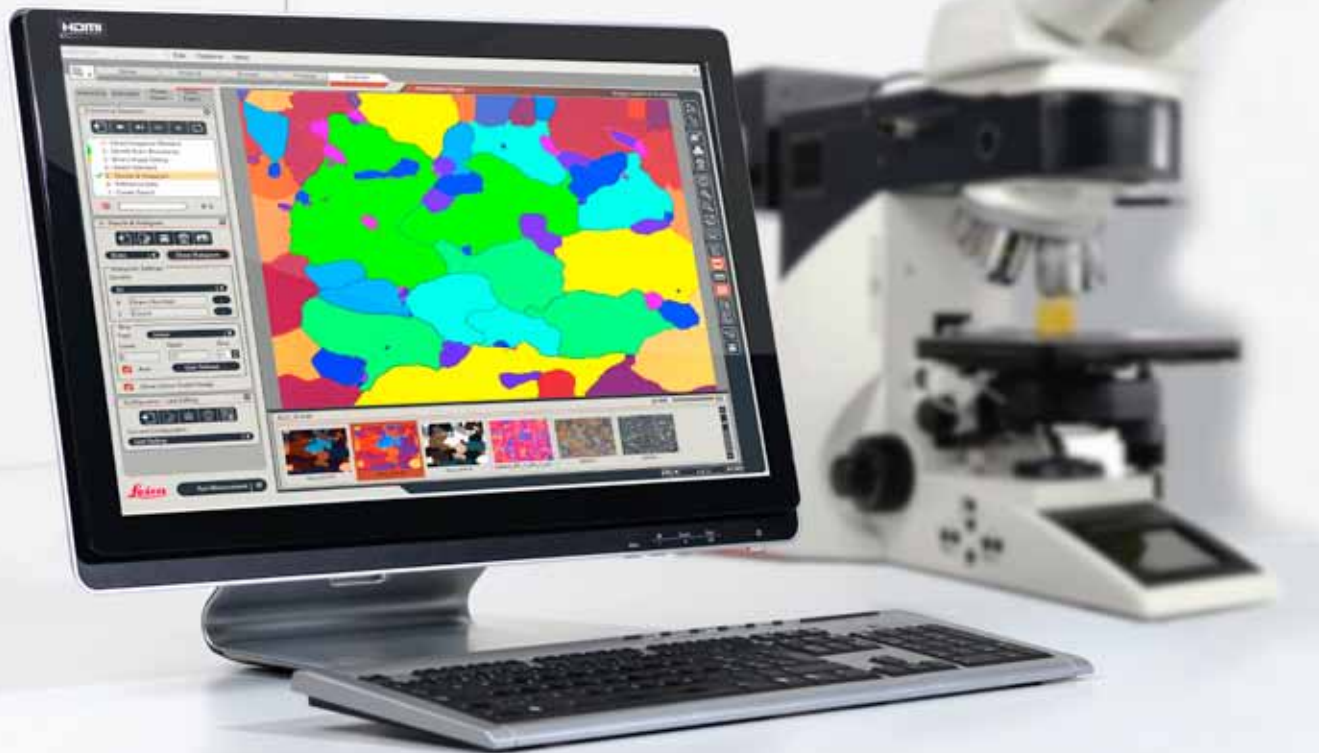


Living up to Life

*Leica*

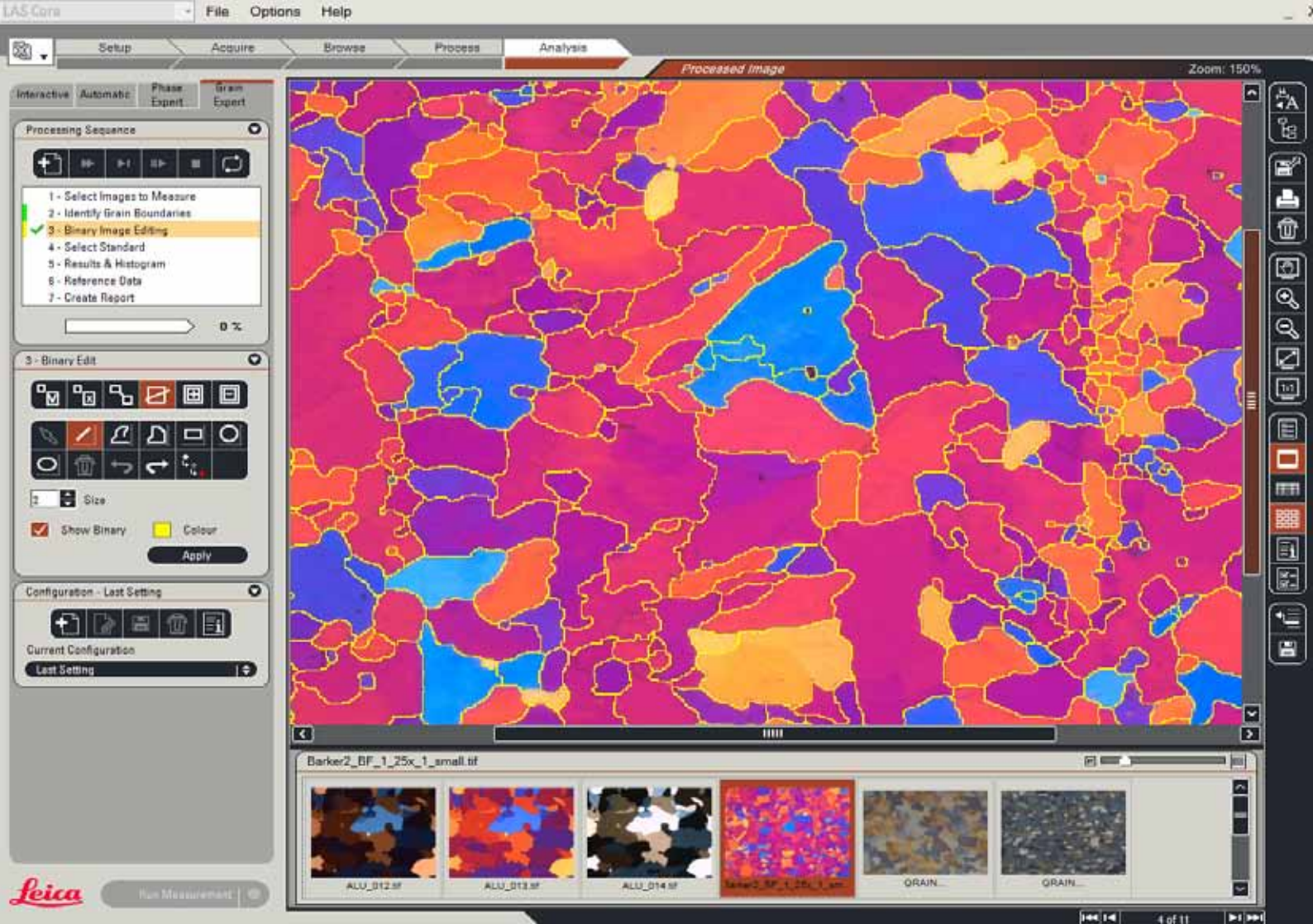
MICROSYSTEMS

INDUSTRY DIVISION



# Leica Grain Expert

Fast and Efficient Software for Grain Size Analysis in Industry



## VARIETY OF EXPERT GRAIN ANALYSIS TECHNIQUES

Leica Grain Expert offers a comprehensive selection of grain size analysis techniques for materials research and metallurgy. Users can be confident that the analysis process conforms to individual laboratory requirements. Leica Grain Expert incorporates industry standards including ASTM E112, JIS G 0551/0552, and ISO 643:2003.

For each standard, the grain counting method can be selected from a variety of technique: Planimetric, Vertical Lines, Horizontal Lines, 3 Circle, and Intercept – Heyn.

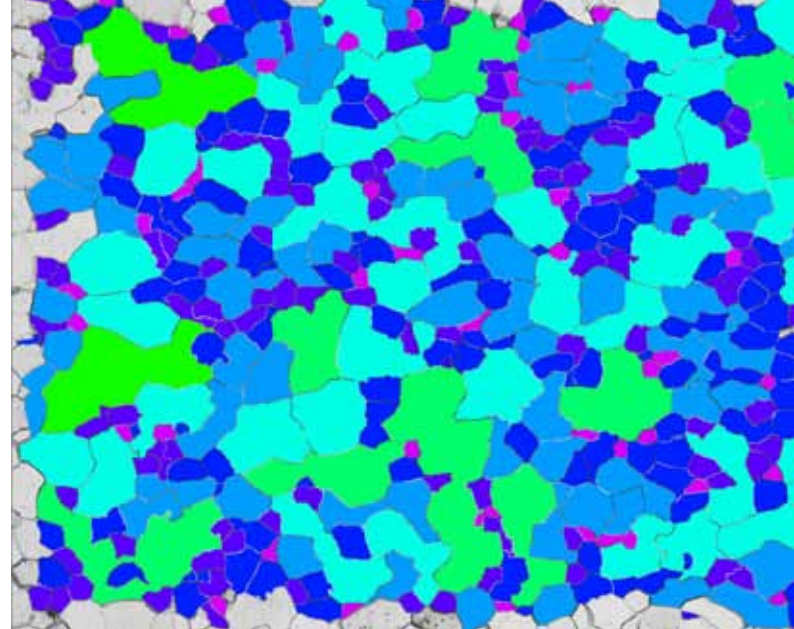
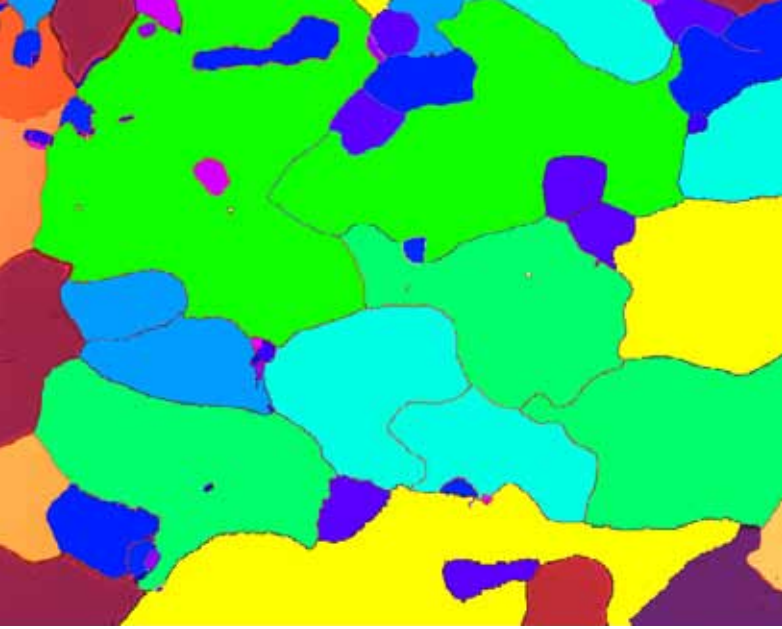
State-of-the-art image processing automatically enhances and accurately detects grain boundaries, and the operator can always modify and confirm the findings. Results from the analysis may be used to qualify material to the specifications determined between purchaser and manufacturer, identify variations in manufacturing processes, and provide data for research about the structure and property of materials.

# Efficient Imaging Environment

Leica Grain Expert evaluates high-quality images provided by a Leica Microsystems microscope. Leica Application Suite (LAS) software intelligently integrates the latest advances in automated microscopy, computing, and digital image analysis. With a wide range of applications designed specifically for materials and metallurgy laboratories, a user can perform routine, yet sophisticated analytical tasks rapidly, efficiently, and economically.

This common micro-imaging environment provides solutions to many industry - standard and custom materials applications such as grain, steel, phase, and cleanliness analysis. These applications combine the understanding of specialists in the field into expert analysis tools dedicated to these specific tasks.

Leica Grain Expert performs automatic, objective, and repeatable grain size analysis to industry standards. Grain size analysis is used to evaluate of the properties of materials to help determine the characteristics of a final product.



# Leica Grain Expert Features

## AUTOMATICALLY IDENTIFY GRAIN BOUNDARIES

- › Various grain identification methods are available to suit a wide range of preparation methods
- › The user selects the one closest to the sample image from a gallery of typical images
- › The sensitivity of the algorithm can be interactively adjusted to match the grain size
- › The reconstruction result is shown nearly instantly as an overlay on the original image

## ADAPT TO DIFFERENT GRAIN TYPES

- › Analyze color images, such as rock thin sections in polarized light
- › True color from contrast methods such as polarization
- › Monochrome images from reflected brightfield or darkfield
- › Boundaries of bi-modal grain sample can be identified
- › For dual phase material, such as alloys, one phase can be removed from the grain boundary reconstruction by setting a threshold to identify the phase of interest.
- › Interactive boundary editing is performed by drawing lines using the mouse
- › Instant false boundary removal with a single click

## DOCUMENTATION OF RESULTS

- › All standard measurement parameters of individual grains are available to discover more about an alloy's microstructures
- › Measurement results of individual grains or samples can be displayed as histograms or tables
- › The grain overlays are coloured according to their binary index colour in the histogram
- › All raw measurement data and selected images can be exported into a Microsoft® Excel™ template
- › The template can be customized to meet local documentation standards
- › Exported data includes the reference data, all raw data, as well as all grain measurements and field data
- › Once the settings for sample type are established, they can be saved as a named configuration that can be recalled and immediately applied in the future.

# Benefits and Advantages

Leica Grain Expert is designed to increase laboratory productivity and improve the accuracy of analysis, automating many of the manual processes required for materials analysis. As the analysis is unbiased, the results are inherently more reproducible.

## TOTALLY INTEGRATED SOLUTION

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With the combination of Leica Microsystems microscopes, microscope cameras, image analysis expertise, and automation, laboratories benefit from a truly integrated solution from one manufacturer.

## VERSATILE REPORTING

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Report templates can be configured to laboratory requirements using Microsoft® Excel™. Results are stored along with images, which allows all elements of the data to be recalled for detailed analysis. All your data is always available and traceable.

## STEP-BY-STEP OPERATION

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The application wizard quickly guides a user through the necessary image processing and analysis steps, for consistent, repeatable results with minimum effort. Once the workflow is defined, these settings can be recalled for repetitive tasks.

## COMFORT FOR THE OPERATOR

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LAS is simple to use due to its unified method of image acquisition, calibration, and peripheral control. Image analysis reduces the tedium associated with manual measurements while providing improved statistical results.

## REPRODUCIBILITY

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Obtain reproducible results by automatically controlling imaging conditions with automated microscopes and cameras in combination with predefined image processing settings.

## CONFIDENCE IN CONFORMITY

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Leica Microsystems' materials analysis solutions comply with the widest range of appropriate standards available including ASTM, JIS, and ISO, which gives users increased confidence in their results. Instrument capability: Leica Grain Expert software performs calculations that derive measurement parameters from digital images and follows procedures that comply with the standards mentioned.\*

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\*The accuracy of the measurements and the compliance of the entire system to these standards strongly depends on a) the optical, electronic, and mechanical components used, b) the working conditions and sample preparation process, and c) the individual and specific interpretation of the results produced. These are the responsibility of the user of the equipment, and Leica Microsystems disclaims any liability in that context.

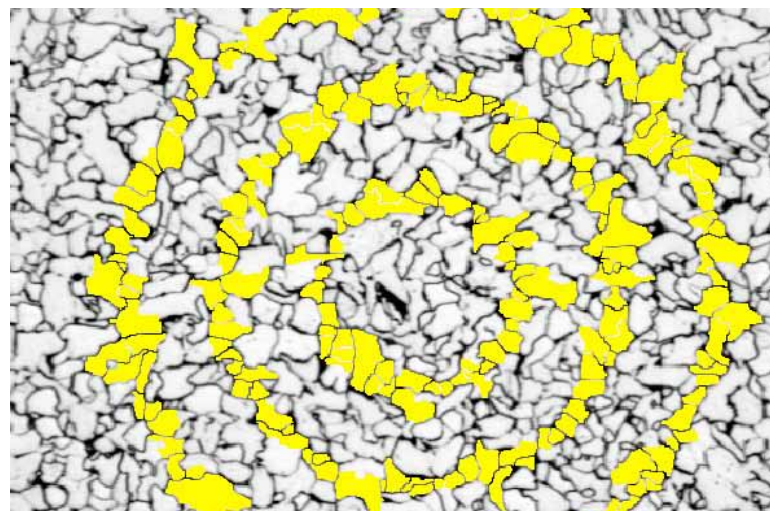
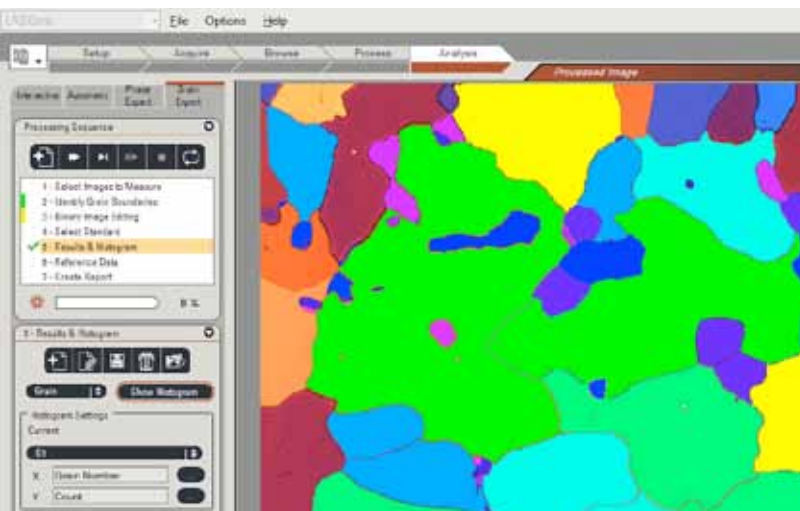
# Image Acquisition Using LAS

Fast and precise.

The first stage of grain analysis is to acquire a selection of digital images using LAS and to save these images to the computer's hard drive. The advantage of this approach is that the original images are always available to check results later or to measure them again using a different standard.

The ability of Leica Grain Expert to give precise results assumes, that the sample chosen is a good representation of the sample being analyzed, and that the sample is prepared in a manner that optimizes the clarity of the grain boundaries.

- › LAS acquires calibrated images, involving camera and microscope, calibrates the microscope and camera to ensure accurate definition of the image size.
- › The imaging conditions, such as microscope settings and camera exposure, are automatically recorded when using automated microscopes. The data is stored with the image and can be used to exactly reproduce the imaging conditions of a particular analysis.
- › Images are named and saved in to a Windows® folder from where they are easily located.
- › Images can be annotated with a calibrated scale bar customized to specific requirements and labelled with time, date, image name, and descriptions.
- › Optionally capture images at pre-defined XY positions using a motorized stage, which ensures no bias in region selection.
- › Optional recall of microscope and cameras settings from an existing image, which ensures the imaging conditions match previous settings.

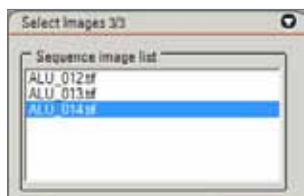


# Image Acquisition Using LAS

Fast and precise.

## 1. SELECT IMAGES TO MEASURE

Numerous images can be processed in rapid succession simply by selecting their thumbnails in the Gallery and adding them to the Sequence image list.



## 2. IDENTIFY GRAIN BOUNDARIES

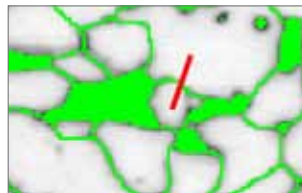
A range of reconstruction techniques are available to help simplify and speed up the task of identifying grain boundaries. Typical images are shown, and the one that resembles the sample image is selected. Boundaries are immediately drawn on the image. Further refinement can then be achieved with the Threshold and Sensitivity controls.



## 3. BINARY IMAGE EDITING

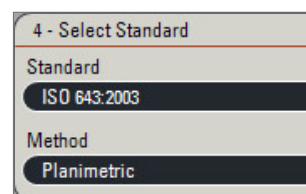
The image showing the grain boundaries may include spurious boundaries due to

surface scratches or boundaries that are not sufficiently etched to be identified by the software. The Image Editing step allows the operator to use the computer mouse to add or remove boundaries. In the example below, removing a boundary is as easy as clicking on it.



## 4. SELECT STANDARD

At this step, the required standard and the appropriate counting method are selected. The choice will depend on the local protocol of the laboratory. The count can be made of individual grains or by intercepts with one of the grid styles shown.



## 5. RESULTS AND HISTOGRAM

The results are displayed in tabular form for each image, and summary statistics are derived. The distribution of the size of

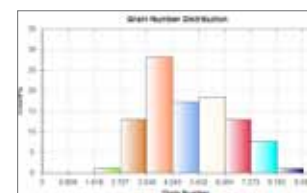
individual grains can be displayed graphically as histograms, bar, and pie charts. This comprehensive detail is invaluable when close study of the materials is required.

## 6. REFERENCE DATA

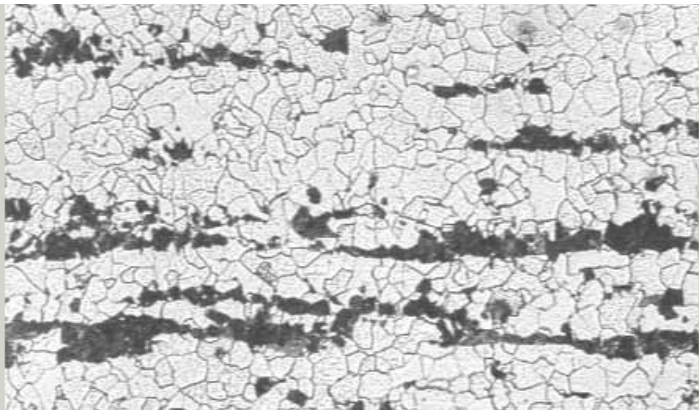
User and analysis references can be added and customized to make the results fully product and company specific. The data entered is automatically transferred to the report.

## 7. CREATE REPORT

Reports are created using a Microsoft® Excel™ template. A standard template is supplied with Leica Grain Expert and can be customized to fit the needs of an organization. In addition to the overview data shown in the example, all detailed analysis results are stored in the spreadsheet for further evaluation.







Dual phase, brightfield

OK

Cancel





# Table of Grain Parameters

## MEASUREMENTS FROM THE GRAIN IMAGE

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Grain Number . . . . .	According to selected standard
Mean Grain Area (mm <sup>2</sup> ) . . . . .	Calculation of the mean from field data
Mean Linear Intercept (mm) . . . . .	Total area /Number of intercepts
Grain Specific Surface (mm <sup>-1</sup> ) . . . . .	Surface area per unit volume of grain
Phase Percentage (%) . . . . .	100 × Grain Area / Image Size
ALA Grain Size . . . . .	Estimated largest grain
Minimum Grain Size . . . . .	Grain size of smallest grain in the image

## MEASUREMENTS ON INDIVIDUAL GRAINS

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Area (μm <sup>2</sup> ) . . . . .	Calibrated number of pixels in grain
X Center of Gravity . . . . .	Position along the image x-axis
Y Center of Gravity . . . . .	Position along the image y-axis
Horizontal Projection . . . . .	Number of vertical intercepts
Vertical Projection . . . . .	Number of chords in the feature
Length (μm) . . . . .	Corresponds to the longest diameter
Breadth (μm) . . . . .	Corresponds to the shortest diameter
Aspect Ratio . . . . .	Length / Breadth
Perimeter (μm) . . . . .	Estimated perimeter grain
Convex Perimeter (μm) . . . . .	Circumscribed perimeter of grain
Orientation . . . . .	Angle of longest diameter
Equivalent Circle Diameter . . . . .	Diameter of circle with area of grain

## STATISTICS FOR BOTH TYPES OF MEASUREMENTS

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Total
Mean
Standard Deviation
Standard Error
Maximum
Minimum
2-S Range
95% Confidence Interval
Relative Accuracy

RELATED PRODUCTS



**LEICA DM2500 M**

The efficient Leica DM2500 M microscope for materials analysis and quality control.



**LEICA DMI3000 M**

The Leica DMI3000 M inverted, manual microscope for materials science, industrial quality inspection and assurance, and new materials research and development.



**LEICA DM6000 M**

The universal microscope for all common incident light methods (brightfield, darkfield, polarization, interference contrast, fluorescence contrast).



**LEICA DFC450**

The Leica DFC450 microscope camera contains a high quality 5 Mpixel CCD sensor for sharp, brilliant images for documentation and analysis in life science, clinical and industry applications.

The statement by Ernst Leitz in 1907, “with the user, for the user,” describes the fruitful collaboration with end users and driving force of innovation at Leica Microsystems. We have developed five brand values to live up to this tradition: Pioneering, High-end Quality, Team Spirit, Dedication to Science, and Continuous Improvement. For us, living up to these values means: Living up to Life.

**INDUSTRY DIVISION**

The Leica Microsystems Industry Division’s focus is to support customers’ pursuit of the highest quality end result. Leica Microsystems provide the best and most innovative imaging systems to see, measure, and analyze the microstructures in routine and research industrial applications, materials science, quality control, forensic science investigation, and educational applications.

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