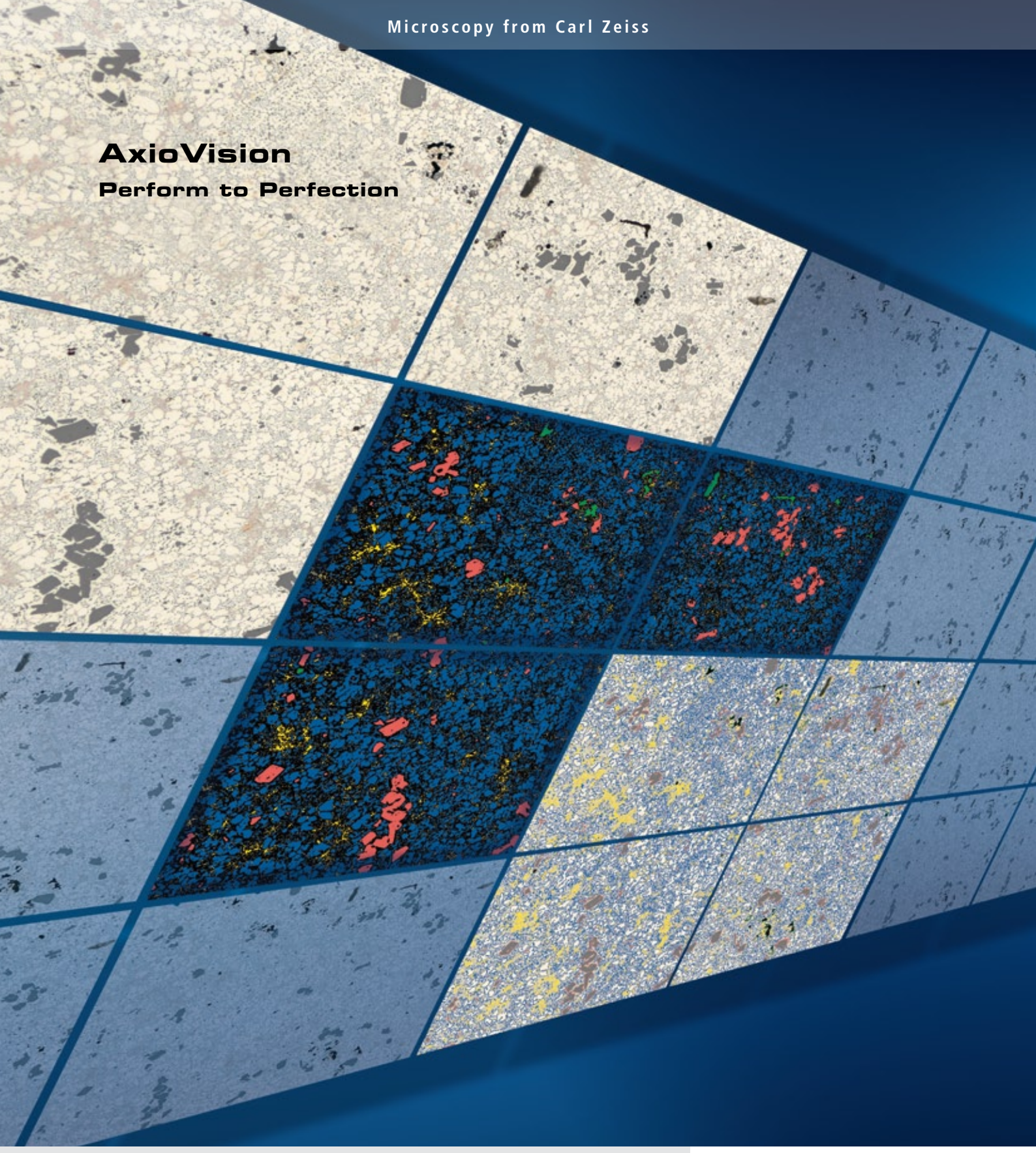
AxioVision

Perform to Perfection



The Microscope Software for Industrial Applications – from Image Acquisition to Image Analysis, It's in a Dimension of Its Own.

ZEISS

We make it visible.

A New Way of Thinking

Whether you are responsible for quality assurance in the aerospace industry or for the development of new materials, whether you work in traditional fields such as materialography and geosciences or in the solar industry, these days digital microscope systems form the crucial basis for your applications. Carl Zeiss is driving this process with new solutions that are continually setting new standards. A major component is AxioVision, the microscope software from the microscope specialist. Thanks to its unique modular architecture, it is suitable for novices and experts alike. Application-specific modules and tailored software packages offer attractive total solutions for defined tasks in science and industry. The AxioVision philosophy is uncompromising: the highest possible performance, easy operation, extreme flexibility, and seamless integration into the Carl Zeiss system world. A homogeneous solution.

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An Easy Decision

Developed in close collaboration with users, AxioVision microscope software impresses with its practical relevance. Highly functional even in the entry-level version, it can be extended by modules available for sophisticated applications, thus satisfying in every detail.

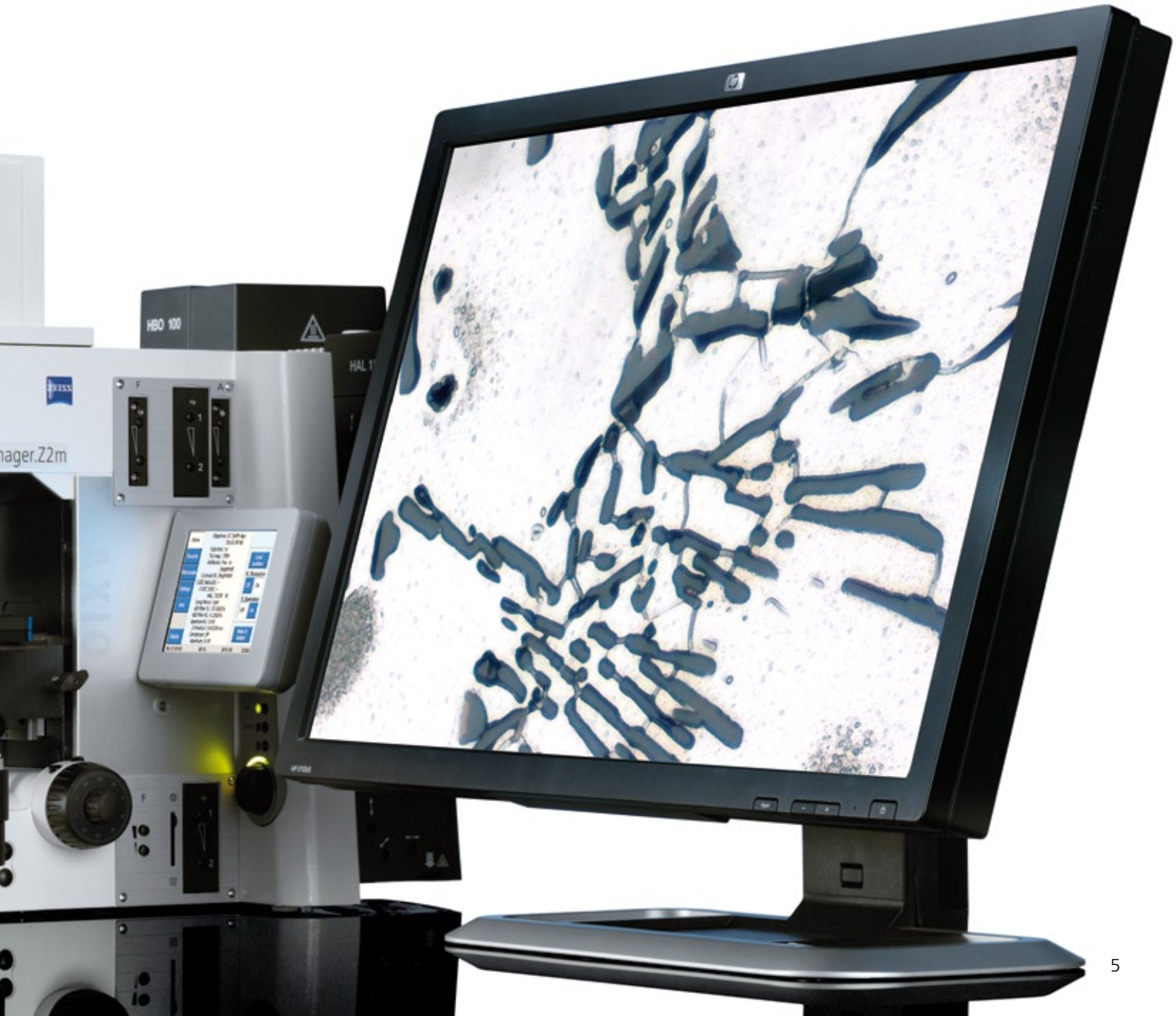
Easy start
AxioVision allows you to achieve outstanding results in digital microscopy and documentation. From image acquisition to processing, measuring, and annotating, to archiving and reporting, you can follow the process from beginning to end.

Easy to use
AxioVision offers you a convincing operating concept: from the basic functions to the highly specialized analysis modules, it is simple and comprehensible. *My AxioVision* allows you to adapt user interfaces and functions to your individual needs, configure your own toolbars, and combine frequently recurring work steps in new dialogs. AxioVision transforms functional diversity and complexity into something quite simple for the user.

Easy ZVI
ZVI is the name of the image format that stores your image data together with image number, acquisition date, microscope settings, exposure data, size and scale data, contrasting techniques used, etc. The advantages are obvious – the image information is available at any time. No annotations are lost and nothing is forgotten. A crucial point to note is that the annotations are not permanently burned in the image, but are stored in a file together with the image data. The image can be reproduced even years later under identical conditions.

Easy economy

Offering the entire performance spectrum for contemporary digital microscopy at an outstanding price-performance ratio, AxioVision also excels from an economic standpoint. The fact that you can expand the system module by module in line with your own requirements means that you only invest in the functions that you really need, while enjoying the security of being at the forefront of technological developments. With AxioVision LE, you even have a universal image viewer for simple image analysis tasks at your disposal that is free of charge.



An Overview of All Modules

HDR Imaging
Extension of the acquired dynamic range

Layer Thickness Measurement
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Calotte Grinding Measurement
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AutoMeasure Plus
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Z-Stack
Acquisition of image series from different focus planes

Imaging Plus
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Interactive Measurement
Expanded interactive measurement techniques

Online Measurement
Interactive measurements in live image

Image Acquisition
Imaging with digital cameras, microscope control

Image Processing
Text and graphics, plus filter techniques and sharpness

Analysis
Interactive measurement with standard parameters

Growing possibilities

The world of materials sciences is constantly changing and evolving and hence requires a software package that can change and evolve with it. AxioVision is very flexible in its design, because with every update and every expansion, Carl Zeiss is at the cutting edge of innovative software developments. In addition, the user interface is customizable. This gives users the ability to make it easy to understand and use for their specific applications. The functions of the basic program – imaging, processing, annotations, archiving, reporting, and microscope control – can be quickly expanded to meet your growing needs by adding further modules. Moreover, new solutions for specific applications are continually being developed. They include additional functions for image processing, interactive measuring, and automated image analysis as well as control modules for light path and motorized stages.

Comparative Diagrams
Comparison of images with comparative diagrams

Topography
Height and roughness measurements

NMI
Measurement of non-metallic inclusions according to international standards

VBA
Integrated development environment

Particle Analyzer Projects
Measurement of particles

Asset Archive
Cataloguing and archiving of images, data sets, etc.

Commander
Recording/Automatic execution of AxioVision commands

Documentation
Image archiving and reporting

Configuration
Customization of user interface

The decision for the basic AxioVision program is a sound investment in digital imaging. The 100 % compatible system solution can be adapted at any time to your changing requirements and demands. A decision that not only protects your investment but guarantees you enormous flexibility.

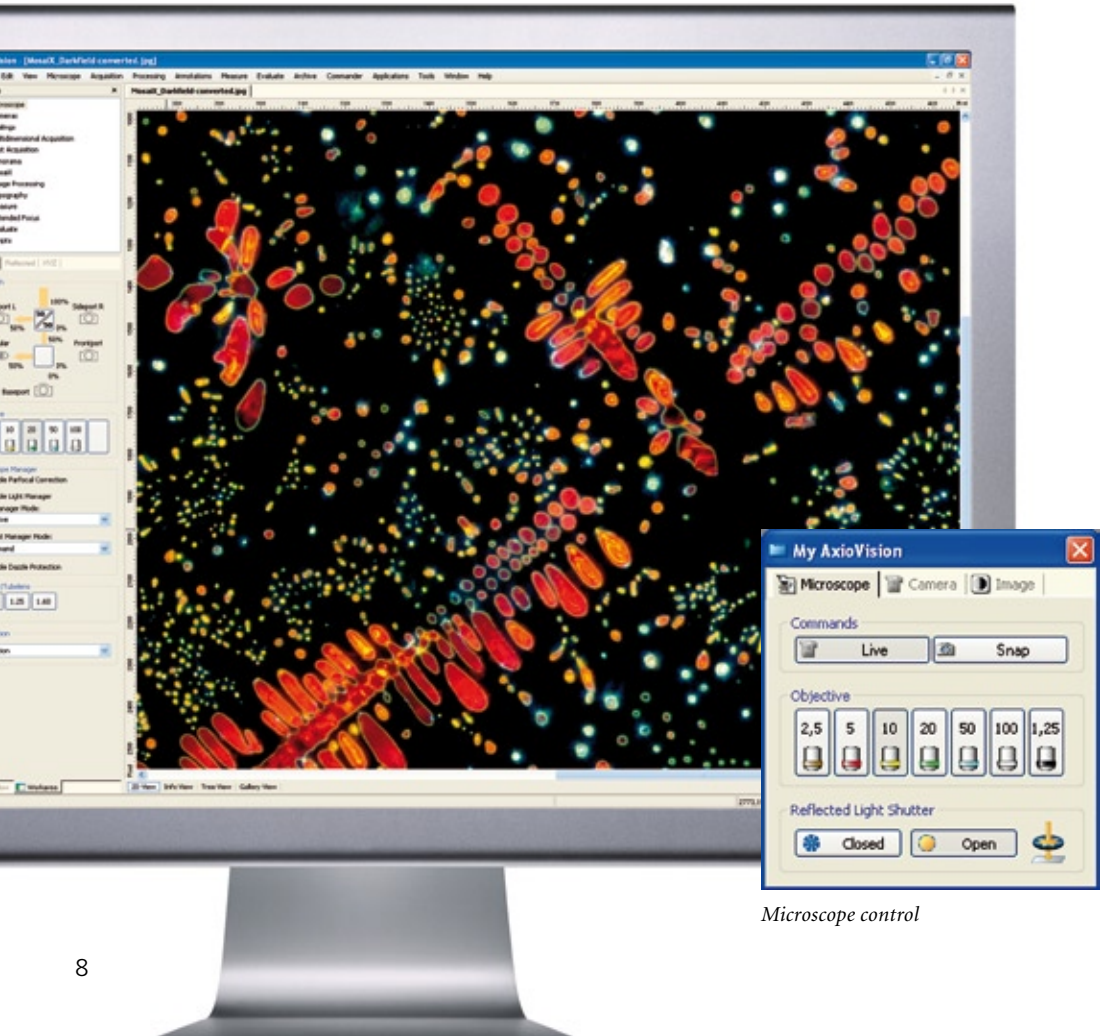
Basic Program

Impressive Range of Functions

You will be amazed at the wealth of functions of the entry-level microscope software offered by Carl Zeiss. Even the basic version delivers a powerful image processing and analysis system and meets all the key requirements of contemporary digital microscopy.

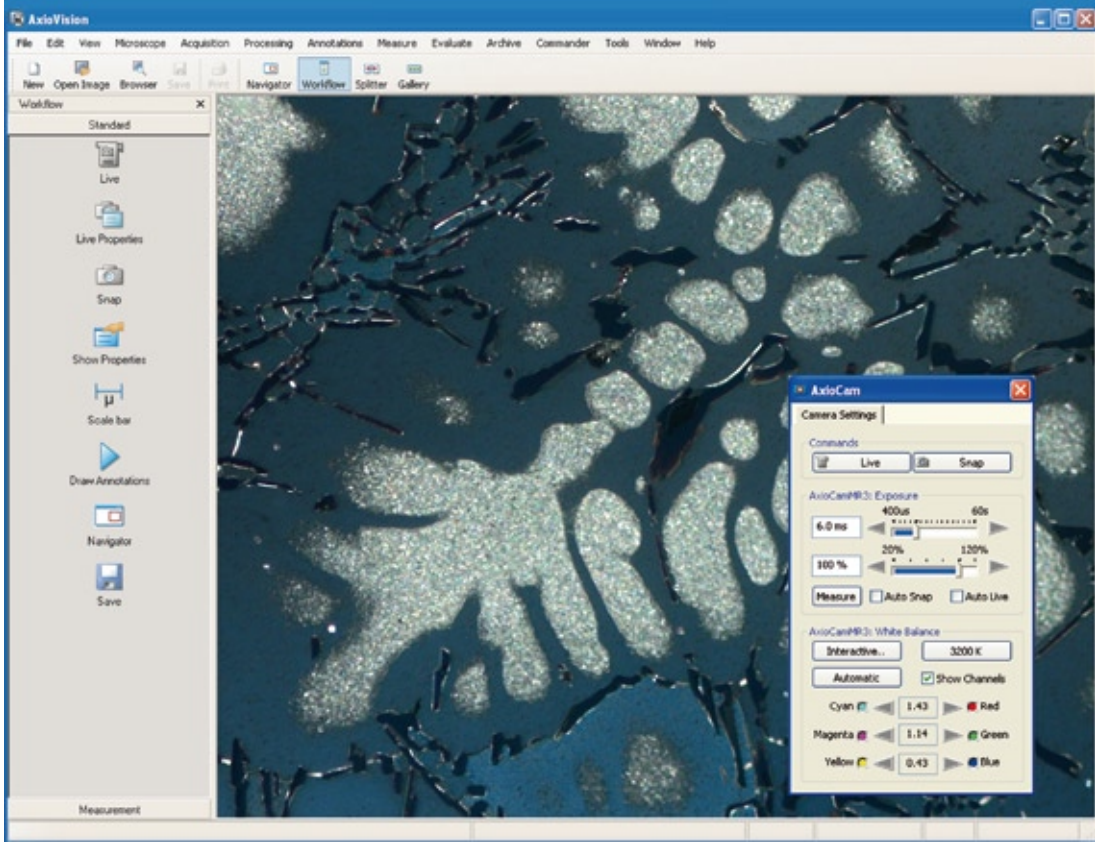
Efficient microscope control

AxioVision allows you to control all motorized microscopes from Carl Zeiss – both automatically and interactively. Of course you can use manual standard microscopes as well. One of the advantages of software control is that you can store desired microscope parameters quickly and easily, ensuring repeatability for subsequent analyses. In addition scaling factors and complex workflows can be recalled during analysis.



Microscope control

Digital camera



Simple, clearly presented user interface for camera control and image acquisition

Flexible camera operation

Thanks to its interfaces for standard technologies, AxioVision allows you to use all types of cameras, from digital consumer cameras up to scientific microscope cameras. This includes the AxioCam family of cameras from Carl Zeiss. The seamless integration of cameras into the AxioVision software enables you to adopt all important image information and – just with a click of your mouse – to document your samples. The cameras from Carl Zeiss can also provide significant advantages concerning speed and resolution, automatic exposure settings, and image acquisition. All cameras in the AxioCam family are controlled by the same operational elements.

Rapid image processing

AxioVision offers you all the tools for:

- Contrast, brightness, and color control
- Noise suppression, smoothing, and contour enhancement
- Enhanced sharpness and detail emphasis
- Correction of illumination conditions and white balance control

AxioCam

Image acquisition

Microscope (manual or motorized)

Basic Program

Impressive Range of Functions

Integration of text and graphic elements

From scale bars and color markings to text and graphic elements – with AxioVision you can add all important annotations to your images using just one program. The corresponding scale is stored with each image, and scale bars can be automatically added at any time.

Precise image measurement

With the entry-level program, you can easily perform interactive measurements, such as length, area, and angles. The measurement data are available in a list, which can be easily exported to most spreadsheet programs, such as Microsoft® Excel.

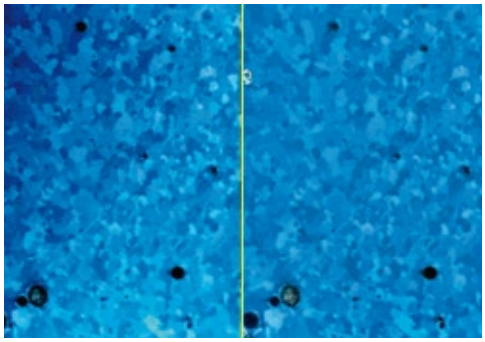
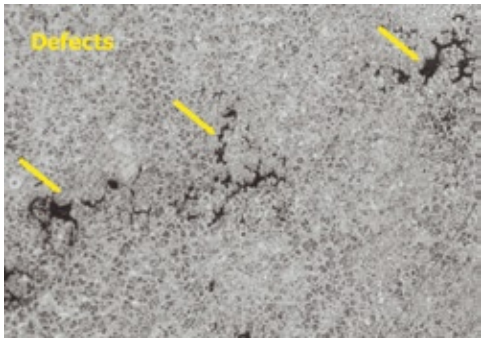


Image processing: correction of illumination error (left: with shading, right: corrected)



Text and graphic elements: labeling of defects

Image measurement: area measurement

Perfect report generation

Whether using individually formatted or predefined layouts, AxioVision gives you all the options you need to generate effective reports or documentations. All information, such as measurement values, analysis results, tables, charts, and images, can be conveniently arranged using predefined layouts or formatting defined by the user – simply at the push of a button.

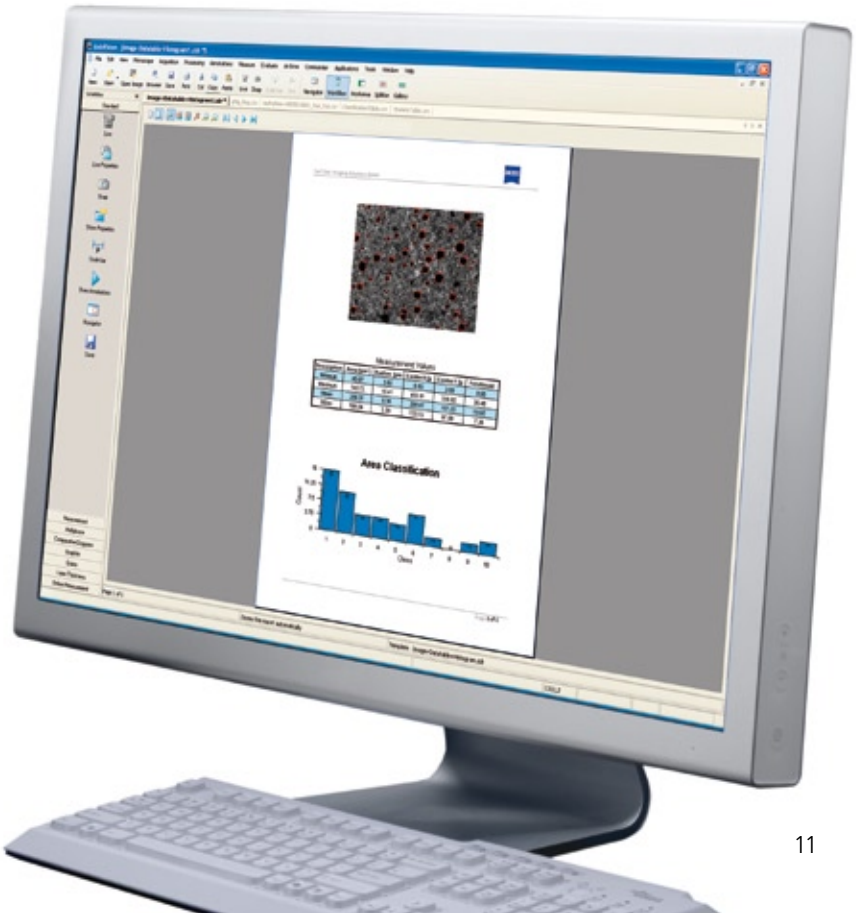


Image Acquisition Modules

Enhanced Performance in Imaging

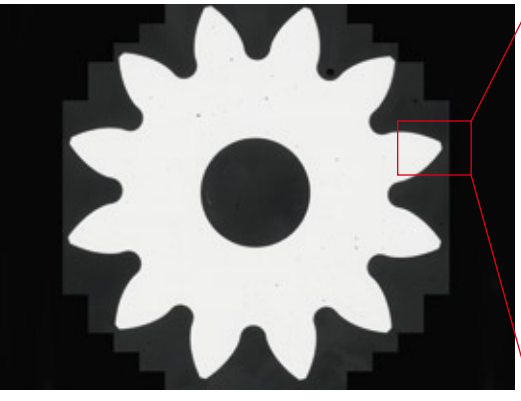
The results of your analyses are only as good as the quality of your acquired images. AxioVision offers you the perfect basis for achieving the required quality with high-performance additional modules, from MosaiX and Autofocus to Z-Stack and HDR Imaging. These modules save the additional information in your images, which is so often crucial.

Autofocus

The Autofocus module calculates the optimal focal position for a sample. The system is calibrated for each objective, hence the software focuses accurately every time or it automatically makes use of default parameters to achieve the correct focusing. In addition, with images that are acquired as a time lapse or at different positions, the system automatically refocuses. The Autofocus module works with all cameras that are directly controlled by AxioVision, provided that a microscope with motorized focus drive is used.

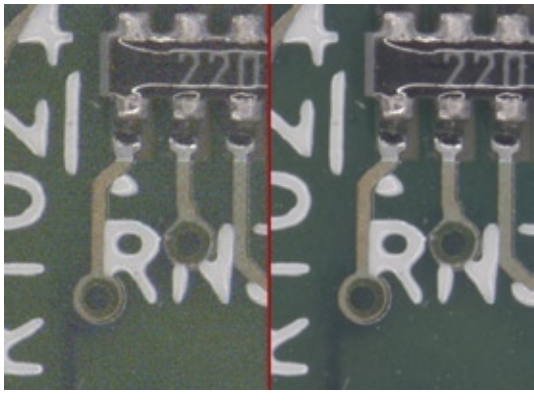
MosaiX

Developed to acquire images of large surfaces, MosaiX scans your samples image by image and then combines these individual images to form a single MosaiX image. In addition, uneven samples can be acquired without difficulty – thanks to the option of automatic focus adjustment. Prerequisites for this are a motorized focus drive and stage. Any loss in image quality caused by the overlapping of individual image tiles is avoided due to an intelligent mechanism that determines – either automatically or interactively – the position of individual image tiles on the basis of the image content, corrects their position and combines them to form a MosaiX image. The image you obtain preserves the high resolution of each individual image. As a result, it is not only suitable for navigating around the sample, but also forms the ideal basis for further analyses. Large objects, such as non-metallic inclusions, can be measured and the number of particles on a filter can be documented with the same ease. Now you are no longer restricted by the limits of an individual image.



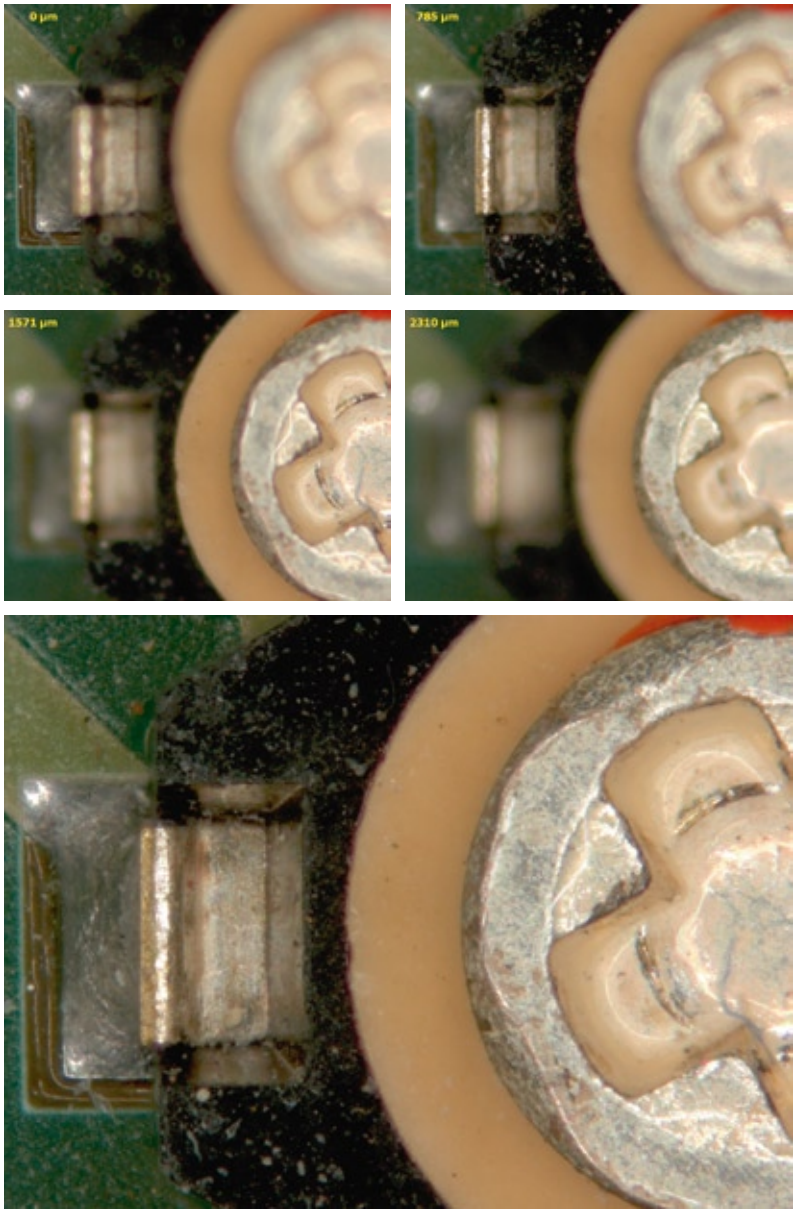
MosaiX image of a gear-wheel, 15x20 tiles

Detailed view: individual tile of the MosaiX image



Images of a printed circuit board – on the left, a single image and, on the right, an HDR image

Single images from different focus planes of an electronic component. With Extended Focus, users can achieve an image that is sharp across the whole field.



HDR Imaging

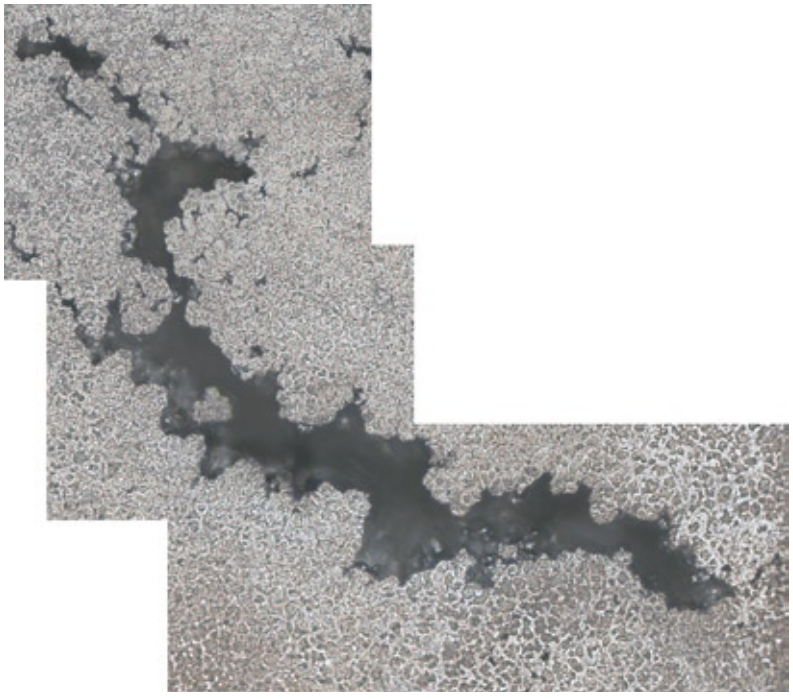
Developed to enable you – when using reflected-light microscopy, among other techniques – to capture all object details on specimens with very high contrast in a single high-resolution image: the HDR Imaging – High Dynamic Range Imaging – module expands the dynamic range of your cameras and increases the brightness gradations in your images measurably. Up to 32 images with different exposure times are acquired one after another and merged to produce one single resulting image. This means reduced noise and improved image quality. Depending on the specimen and the acquisition situation, you will obtain significantly more information and consequently more precise measurement results. This technique will also be an inexpensive alternative if you want to improve the image quality of your camera, as even in the case of a camera with a low dynamic range the results can be seen clearly. For instance, it is an economical way to transform an 8-bit camera into a camera with a 12-bit dynamic range.

Extended Focus

A microscope's depth of field is often not sufficient to obtain a single image which is sharp across the whole field. The software solution to this problem is the Extended Focus module. The principle is simple – while focusing through the sample, you acquire a number of images at different focus positions or use your z-stack images as input data. In both cases the sharp details from each individual image are extracted and a final image is calculated on the basis of state-of-the-art algorithms. The result is an image of first-class quality that is rich and sharp in every detail.

Image Acquisition Modules

Enhanced Performance in Imaging



Panorama: a crack is followed beyond the image field. Only the required images are acquired.

Z-Stack

To enable the automatic generation of z-stack images, the software controls the z-drive of a motorized microscope in precise steps. This is always synchronized with acquisition. You can either determine the focusing interval yourself or have it automatically computed for highest sample accuracy. The advantage of this module is the optimal detection of information in the third dimension. In addition, with the Cut View function, even the entry-level version of AxioVision provides you with a highly effective technique for z-stack analysis.

Panorama

Perfect for objects that do not fit into one single image field – the Panorama module is the manual variant of MosaiX. With the help of a manual mechanical or a coded stage, you can generate high-resolution panorama or overview images from individually acquired images making it possible to follow irregular structures, such as cracks, beyond the edges of the frame. Overlapping images can also be combined with pixel precision ensuring that the important details of your sample are all contained in a single image.

Mark&Find

This module is used to record, store, and automatically revisit different positions on your samples. It requires the use of motorized x-, y-stages. The positions on the sample are stored together with the acquired image. Lists of positions can also be imported. Your advantage: reliability, time saving, and statistical accuracy.

Time Lapse

Investigating changes over time, documenting results clearly – with the Time Lapse module, you can control both camera and microscope precisely. For instance, with the help of a heating stage it is possible to monitor structural changes.

Combinations

MosaiX, Autofocus, Z-Stack, Mark&Find, Time Lapse – all these modules can be freely combined with each other and thus create solutions capable of precisely meeting a wide range of demands. The result is the cost-effective adaptation of individual solutions to a specific application – with no unnecessary investments.

Image Processing Module

Get More from Your Images

All the important digital image processing techniques in a single module – Imaging Plus allows you to process your images for maximum information content and the best analysis results.

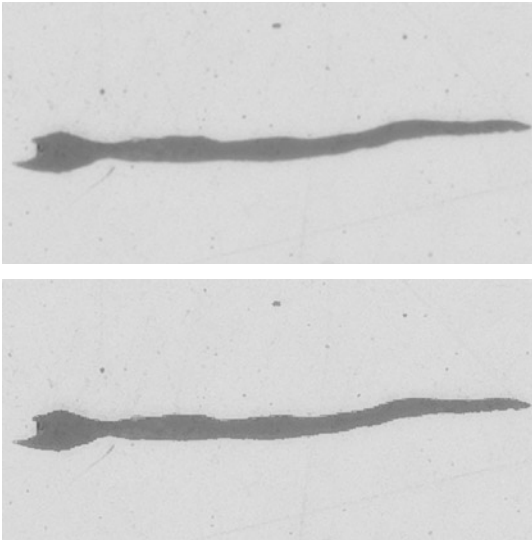
Imaging Plus

- **Image Enhancement**
  In addition to improving contrast, brightness, and color, this function compensates lighting deficiencies and shading. Filters for smoothing, sharpening, and edge detection are included as well as user-definable filter operators.

- **Gray Morphology**
  An ideal tool for grain boundary reconstruction, e.g. to enable you to reconstruct the boundaries of joined objects exactly. The advantage: individual objects can be separated with precision.

- **Image Arithmetics**
  The process of calculating a new image from existing images pixel by pixel: AxioVision Imaging Plus allows the quantitative combination and comparison of images.

- **Elastic Registration**
  The solution to achieving congruence between two images with the same content that cannot be corrected simply by shifting, rotating or adjusting the size of the images.



By enhancing the edges, object boundaries can be detected with greater precision.

Morphology functions permit the exact reconstruction of object borders thus preparing them for automatic measurement.

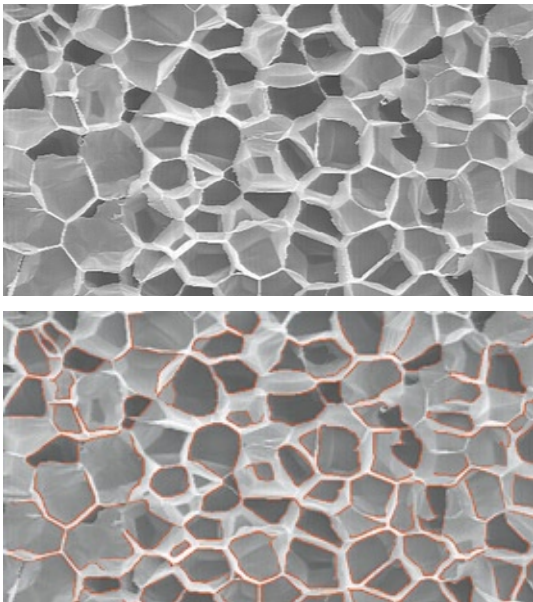
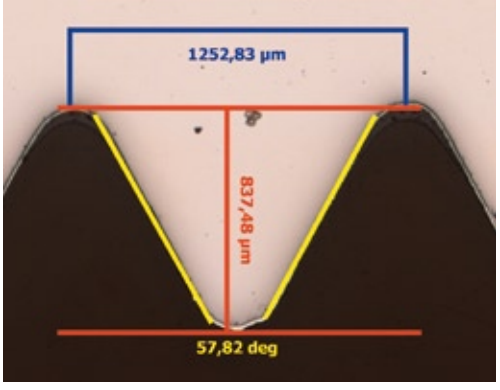


Image Analysis Modules

Uncompromising Precision

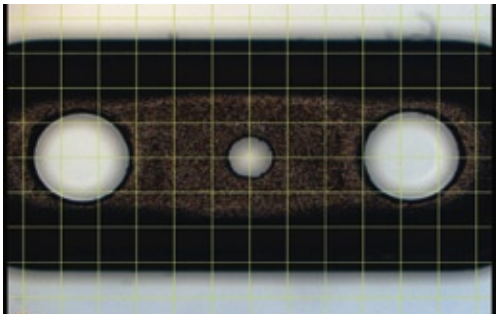
Utilizing all the information of an image: AxioVision offers you a powerful spectrum of additional modules for image analysis. For enormously simplified processes, faster results, uncompromising reliability, and maximum reproducibility.

Interactive Measurement
With this module, parameters describing the specimen can be determined interactively (e.g. size). A measurement program wizard allows users to exactly determine which measurements should be taken. Afterwards, all parameters are then executed in the specified order. As a result, geometric and densitometric parameters are presented in a straightforward measurement list and can be stored with the image in the archive. You can retrieve this information later at any time. In addition, all requested measurement values can be exported (e.g. into Microsoft® Excel).

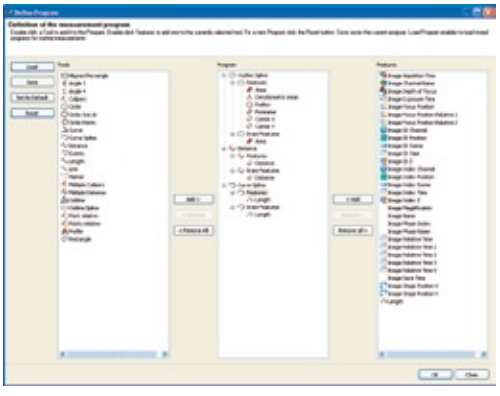


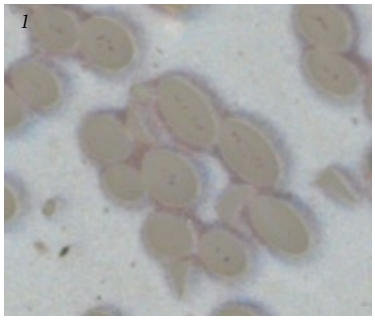
Interactive measurement of distances and angles

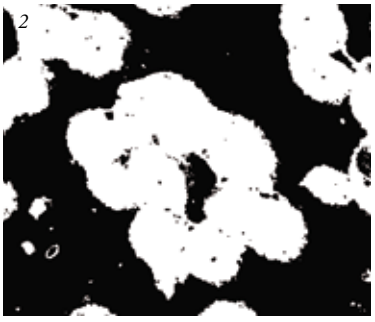
Online Measurement
Measure samples are directly depicted on the monitor without the need to acquire images. With this module you can analyze structures interactively and directly in online images, which means that visual inspections can now be carried out quickly and conveniently on screen. All the measurement tools that you employ for your acquired images can also be used here. You select the desired parameters from a choice of up to 90 options.

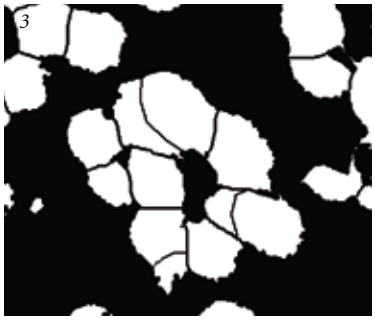

Assessment of hole separation in the online image

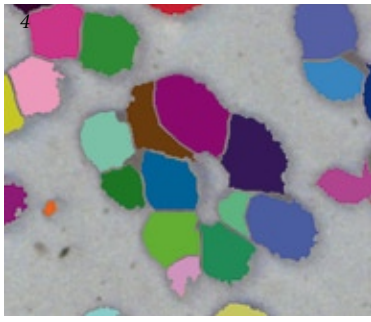
AutoMeasure
If you need to create automatic measuring routines yourself: with the AutoMeasure module you can rapidly obtain precise results – without any complicated programming. With the help of a measurement wizard, AutoMeasure enables you to carry out complicated measurements within a few minutes. Simply define the programs that you need and you can measure an unlimited number of images – while completely controlling the measuring process. You can determine which steps to be conducted. Even automated processes can be interrupted at any time and all parameters can be individually adjusted with the function dialog.


Measurement parameters – list of options









Automatic analysis of a polymer sample (fig. 1): threshold segmentation (fig. 2), correction of the binary image and automatic separation of objects (fig. 3), overlaid display of the measurement in the resulting image (fig. 4)

AutoMeasure Plus

Capturing the entire structure of the image automatically – now possible in a single measurement step with this module. The result: fast, precise and reproducible quantitative analyses. Further advantages are: the direct access to all functions via the menu and the option to combine with the automatic processing module Commander. It enables you to merge the results of repetitive work steps in a single command – ideal for the automatic processing and reproduction of standard lab assignments. The module consists of three functionality groups:

- **AutoMeasure Plus – Segmentation**
  This function offers threshold operators for monochrome and color images that are necessary to identify your objects. The objects can also be identified with a mouse click using "Region Growing". These two methods are supplemented by complex methods for segmentation, including dynamic and automatically generated threshold values as well as edge detection. The result is a binary image in which all specimen pixels are white and all background pixels black.

- **AutoMeasure Plus – Binary image processing**
  Functions for linking, masking, and filling holes ensure that the binary image is optimally prepared for measurement. Artifacts are removed and contours smoothed.

- **AutoMeasure Plus – Automatic measurement**
  This function makes it possible to determine morphometric measurement parameters from the contour of the specimen. The binary image is used as a mask to calculate geometric and densitometric parameters from the original image. The results can be imported into Microsoft® Excel – ideal for generating statistical information about specimen details.

TIC Measurement

The TIC module (TIC – **T**otal **I**nterference **C**ontrast – only in combination with the TIC slider from Carl Zeiss) allows the precise, contact-free and therefore extremely simple determination of the optical height and thickness of object structures over a range from just a few nanometers to several micrometers. The advantage of the TIC interferometric method lies in the combination of short measurement and analysis times with a high degree of accuracy. The use of circularly polarized light makes the orientation of the structures on the sample irrelevant and eliminates the need for stage rotation. It is even possible to analyze samples with large surface areas.

Topography Module

Surface Analysis Using Digital Height Data

Whether you are dealing with height measurements for production control in the automotive industry, roughness measurements or 3D reconstructions for the optical assessment of production tolerances – the Topography module generates height maps of your samples automatically or interactively using a contact-free and non-destructive method.

Functionality

Your work with this module is based on z-stack images of your samples, interactively acquired images from various focus planes or stereo image pairs acquired via both ports of a stereomicroscope. From these, the Topography module generates the following for you:

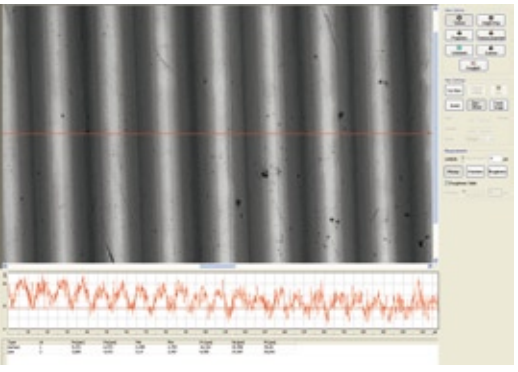
- 3D topographies from various perspectives with texture, grid or surface shading
- Roughness measurements in accordance with EN ISO 4287
- Height measurements

The measurements are performed along a profile line that you have drawn into the topographic image using a measurement tool. Several profiles can be drawn in and simultaneously selected. The measurement results are displayed in a table. The parameters of the primary profile, waviness or roughness are displayed on the basis of the cut-off wavelength (lambda) selected. The module also offers a wide range of functions from the display of sharp regions like a texture image and dynamic flooding in the height image to the possibility of modifying projections and height images via look-up tables. All height information is stored in the image and is available at any time.

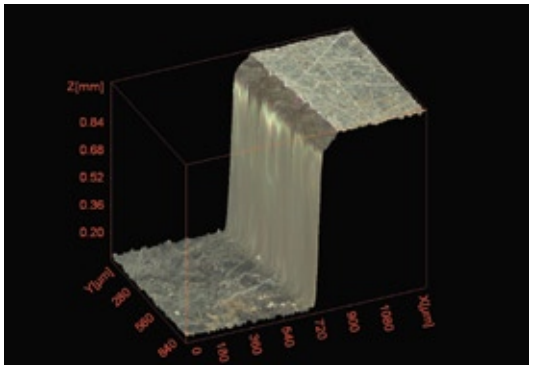
Integrated guidelines

The AxioVision Topography module calculates the following roughness parameters in accordance with EN ISO 4287:

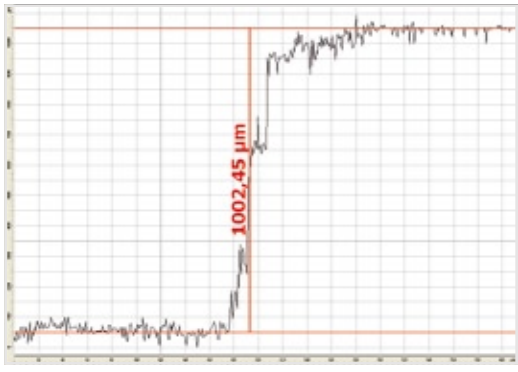
- R_a: arithmetic mean of the profile ordinates
- R_q: quadratic mean of the profile ordinates
- R_{sk}: skewness of the profile
- R_{ku}: steepness of the profile
- R_v: depth of the greatest profile valley
- R_p: height of the greatest profile peak
- R_t: total height of the profile



Roughness measurement in accordance with EN ISO 4287 along a user-selected profile



3D topography (texture projection) of a gauge block



Height profile measurement in a topographic image

Archiving Module

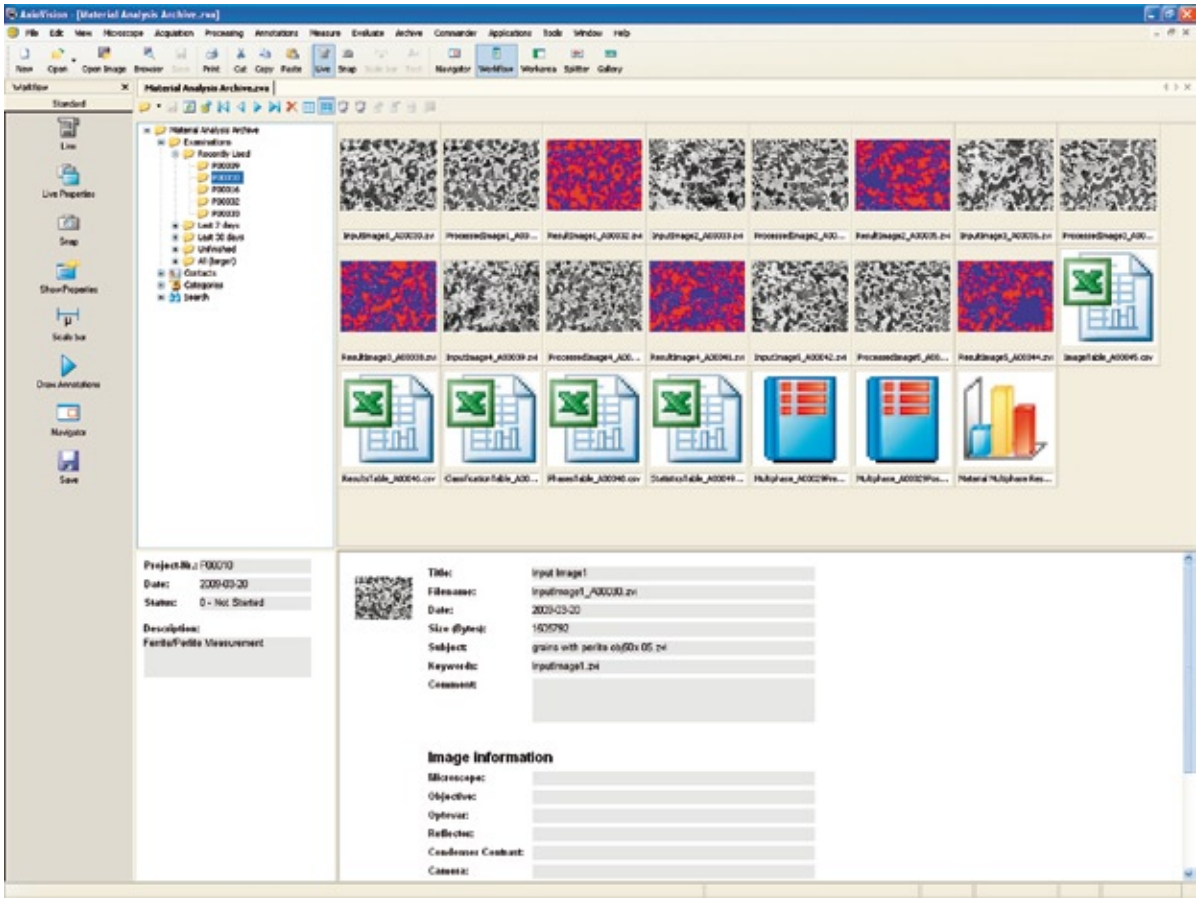
Well-conceived Data Management

Maintain an overview of your images, measurement results, and reports – AxioVision allows you to manage all your data simply, transparently, and completely.

Asset Archive

The powerful AxioVision Asset Archive module allows you to archive not just your images, but also all the associated image data, measurement results, and reports of your analyses – in an extremely simple way under a single project number. This makes the process of finding your way around a large number of data sets significantly easier and quicker. The up-to-date image management software offers a range of benefits:

- Fast, flexible search functions: search by projects carried out for a certain customer/client, by projects carried out within the last week/month, by image or sample name, by date, labels, etc.
- Clear display of all key data acquired with the image
- Logically organized, hierarchical structure: Customer/client ↦➤ Project/assignment ↦➤ Asset
- Management of customer data/contacts/projects

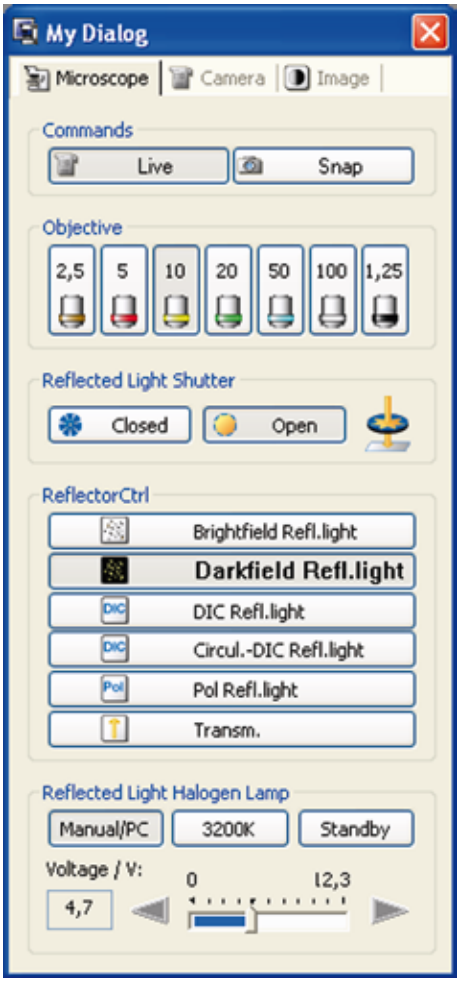


Asset Archive: structured storage of related images, measurement results, and reports in one project

Configuration Modules

Automatically Faster

With *My AxioVision* even the entry-level version of AxioVision offers you all kinds of methods for creating individual operating windows. These possibilities can be expanded almost infinitely with the help of two additional modules, and even offers you the opportunity to develop your own programs within AxioVision.



User-defined dialog for operating the microscope and camera

My AxioVision

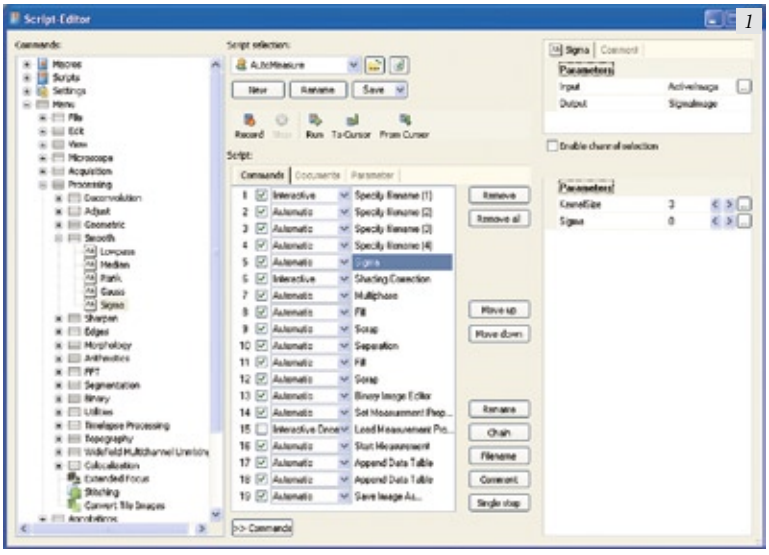
My AxioVision is the design concept behind the AxioVision architecture. It forms the basis for the almost unlimited freedom that AxioVision gives you for adapting the powerful microscope software to your own particular requirements or for several different users. AxioVision stands out thanks to the unique range of options it offers for designing customized user interfaces and functions. It is perfectly suited for simplifying, optimizing and increasing the efficiency of your digital microscopy using comprehensible workflows. Even in the entry-level version the Carl Zeiss software offers you plenty of scopes to structure your individual work environment: you can configure your own toolbars and combine relevant elements for camera and microscope control in your own new dialogs. Elements can be removed or added – depending on what you require for your work process.

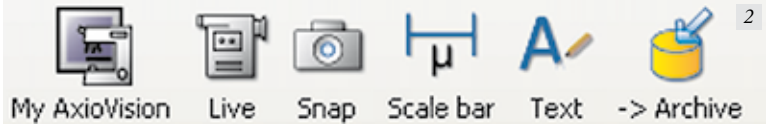
Commander

The Commander module allows you to record subsequent steps of your workflow, edit and refine these steps, set parameters, and make all this available under a single command. The benefits are impressive: automatic processing of typical lab assignments and complete reproducibility of the results in addition to fast adaptation to new requirements.

VBA

Perhaps you need more functions than the wide range AxioVision provides. In this case it is possible to increase and extend the performance of the Carl Zeiss software and adapt it to your needs with VBA (Visual Basic® for Applications), the programming language Carl Zeiss uses for AxioVision functions. VBA provides a completely integrated development environment that is familiar to programmers. Since VBA is directly integrated into the host application, it offers the advantages of fast internal cooperation as well as the opportunity to develop solutions without additional programs. The results look and act just like AxioVision. The major advantage of this module is that the users of your individually developed software require only a minimum of training time.





1) Commander window for recording work steps for automatic procedures
2) User-defined toolbar with daily workflow

Materials Packages

Highly Versatile

Compact and economical: with the materials packages, AxioVision offers you complete solutions that can be put into practice for your routine tasks in industry immediately – at an all-inclusive price. They can be used with any microscope, are easily upgraded, and are delivered fully preconfigured – from image acquisition to analysis, evaluation, and software archiving.

Three packages for three different performance requirements

The materials packages combine the strengths and performance of important AxioVision modules, starting with the functions of the basic program to modules such as AutoMeasure Plus or MosaiX. Three tailored packages are available:

- Materials Core: for routine applications
- Image Analysis upgrade: for advanced measurement tasks
- Motorization upgrade: for automatic acquisition using motorized microscopes and stages

Moreover, as you would expect from Carl Zeiss, it is possible to upgrade these packages easily and economically to gain access to the next performance class. You can therefore be confident that even with the compact solution you will be able to respond flexibly to new performance requirements at any time.

What the materials packages offer

	Image Acquisition	Extended Focus	Panorama	Autofocus	Z-Stack	MosaiX	Image Processing	Imaging Plus	Image Analysis	Interactive Measurement	Online Measurement	AutoMeasure	AutoMeasure Plus	Documentation	Asset Archive	Configuration	My AxioVision
Materials Core	x	x	x				x		x	x	x	x		x	x	x	x
Image Analysis Upgrade	x	x	x				x	x	x	x	x	x	x	x	x	x	x
Motorization Upgrade	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x

AxioVision Basic program *AxioVision module*

Application Modules

Greater Efficiency in All Routine Tasks

Whether for particle analysis or grain size analysis – the AxioVision application modules offer complete application solutions for industrial practice. They have been developed to allow reproducible results to be achieved with as little interaction as possible. The transparent system design is identical for virtually all application modules. This is realized by using fully automated processes – making your routine tasks faster, more efficient and more reliable.

Operating modes

The AxioVision application modules have been systematically developed for use in practice and are focused on two key requirements: flexibility and security. This flexibility means being able to add in-house test specifications and new standards independently at any time – without external assistance or additional programming. Another benefit is the security of knowing that there is no possibility of careless changes to settings leading to incorrect measurement results. The operating concept of all application modules is therefore based on two functional areas: all key settings for the measurement routines are defined in administrator mode. Measurements are then carried out in user mode – in a simple way via a transparent user interface. The administrator will have defined in advance whether and to what extent users can change measurement parameters here. System operation is incredibly easy and was designed to allow reproducible results to be achieved with as little interaction as possible. The performance of a measurement can be automated to such an extent that only the project data need to be entered – the entire analysis process runs automatically.

Particle Analyzer System

Particle Analysis with No Limits

Nowadays, guidelines and standards place numerous sectors under an obligation to guarantee and document the cleanliness of their products in a verifiable way. For instance, the pharmaceutical industry is subject to FDA Regulation 21 CFR Part 11 and the automotive industry to the standard VDA Volume 19. These require the analysis of complete samples and the standard-compliant acquisition of images of even the smallest particles.

Functionality

Analyzing residual dirt on filter membranes, examining lubricants, identifying defects in die cast components, inspecting distributions of active substances in crystalline form in ointments, detecting, separating and measuring plaques in microtiter plates – behind the AxioVision module Particle Analyzer Projects stands an integrated total system for a versatile range of applications. Tailored to industrial practice, this system impresses with its performance and ease of operation. It automatically sets classes and boundaries and selects the measurement parameters. The particles can be classified on the basis of various types (reflective, non-reflective, fibers, etc.). Measurement results are presented clearly in an image gallery and can be edited. It is also possible to relocate, further process, delete or reclassify particles – an important function that enables you to control and correct your measurement results at any time. The key to the system's convenience and operational reliability is the fact that, on the basis of the motorized microscope platform, the entire measurement procedure is performed fully automatically – from image acquisition and particle detection to analysis and report generation. For microscopy you can reliably reproduce.

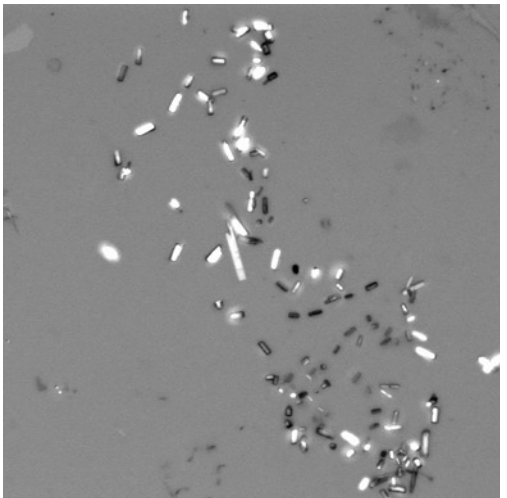
Integrated guidelines

The Particle Analyzer system supports all national and international key standards: e.g. ISO 4406, ISO 16232 and VDA Volume 19. The corresponding classes and class boundaries are set automatically and the relevant measurement parameters are selected. Within the context of GxP projects as an option Carl Zeiss can also supply – with AxioVision GxP* – the necessary software and documentation. A certifiable calibration standard is also available as an option for system inspection. The analysis system is configurable and you can easily add new standards to the existing system yourself without having to wait for new software.

* Module not available in all countries

The system variants of the Particle Analyzer based on SteREO Discovery.V12 and Axio Imager.Z2m

Active substances in crystalline form in ointments



NMI System

Determining Non-metallic Inclusions in Steel

Current and new industry standards define a wide range of requirements for determining the content of non-metallic inclusions in steel. NMI is integrated into a total system with a practical orientation and enables you to determine the content of non-metallic inclusions – reliably and with absolute precision in accordance with established steel standards.

Functionality

Developed in collaboration with experienced users involved in the production and application of steel, NMI offers a powerful analysis method that allows you to respond reliably to and comply with the requirements of even the latest industry standards. With NMI you control all system components fully automatically via the software. Workflows are automated with the help of test specifications, which can be adapted individually. Once it has been set up, the system scans the surfaces of your steel samples independently and analyzes them. Inclusions will be captured in full even if they are larger than the field of view of your camera.

Supported standards

NMI supports the following standards in a measurement:

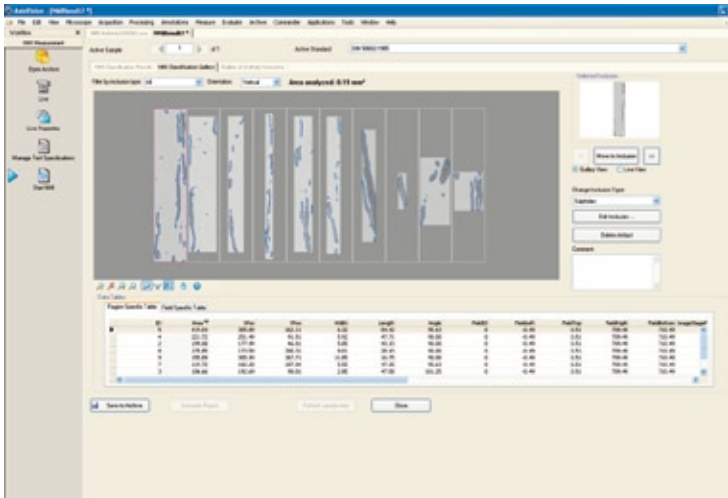
- EN 10247
- DIN 50602
- ASTM E45
- ISO 4967
- JIS G 0555

Results display and data management

The results display in NMI sets the standard with regard to transparency and depth of information. A wide range of options is available for displaying the measurement values from the results view in image and tabular form to the selection of various gallery views offering all measurement and classification data, elimination of artifacts, etc. Reports are generated automatically according to the requirements of the selected standard and can be modified individually. All measurement data, such as tables, images, and reports, but also the test specifications are saved and managed in an Asset Archive. The archive features search and filter functions ensuring that the data can be easily found and called up again at any time.

The system variants of NMI based on Axio Imager.Z2m and Axio Observer.Z1m

Results view with gallery of largest inclusions



Grains

On the Trail of Structures

A standard-compliant and flexible solution for analyzing grain sizes in materialographic samples – Grains offers you an easy-to-use analysis tool for determining grain sizes in accordance with the requirements of international standards. Fully automatically or interactively and with high precision and reproducibility.

Functionality

Three measurement modes are available for analyzing grain sizes: Comparison, a purely interactive method for comparing micrographs with comparative diagrams; the semi-automatic intercept method; and the automatic method, which automatically reconstructs grain boundaries for you and determines the individual grain size. You decide which method is appropriate with a click of your mouse depending on the characteristics of the sample.

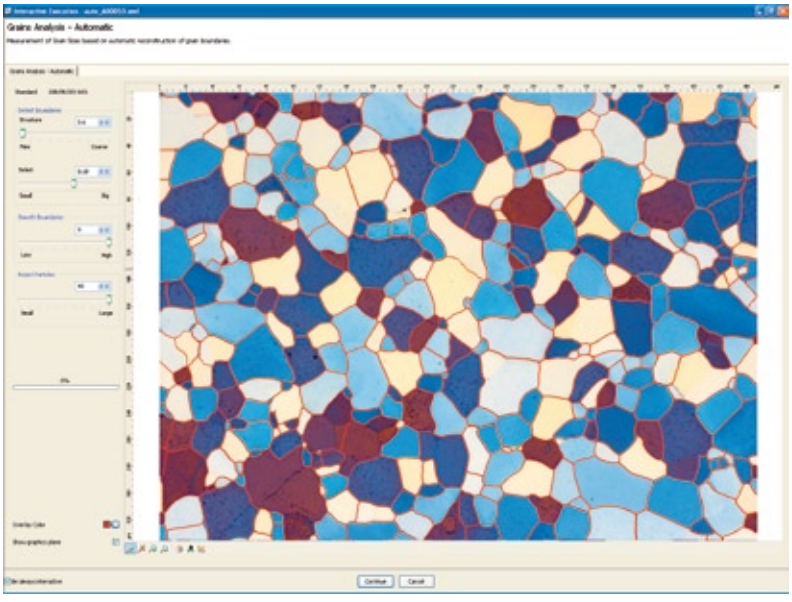
Supported standards

Grains supports the following standards:

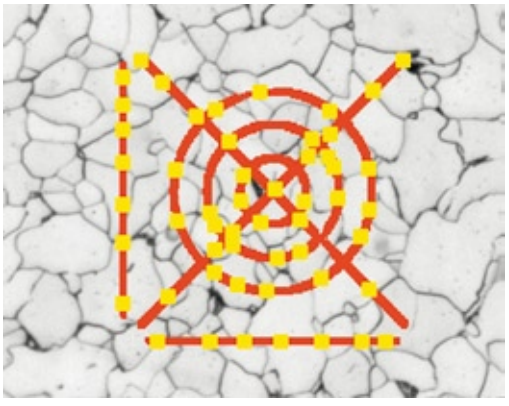
- ASTM E 112
- ASTM E 1382
- DIN EN ISO 643

Additional standards for the Comparison method:

- ASTM – Plate I, Plate II, Plate III, Plate IV
- SEP 151061
- BS 4990



Automatic grain size analysis



Resulting image for intercept method

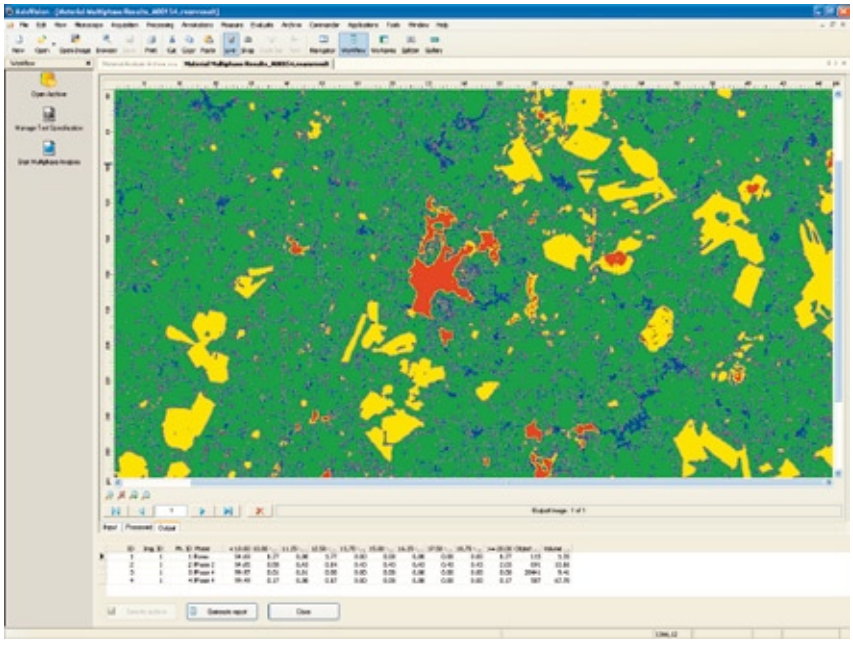
Multiphase

Greater Flexibility for Phase Analyses

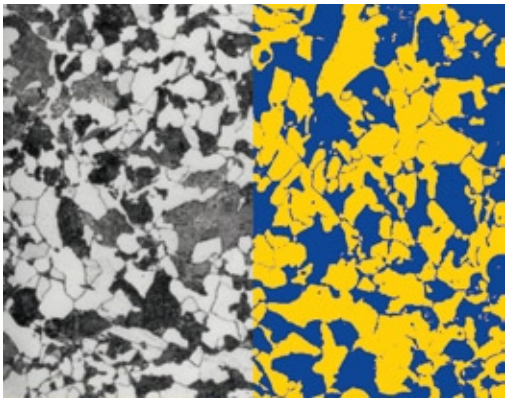
Multiphase analyzes the phase distribution in your samples for you. Phases are precisely measured on the basis of parameters such as size, shape or orientation and documented clearly in terms of the percentage of the area they represent, like classified particle sizes or in the form of a comparison – quickly, precisely, and reliably.

Functionality

With Multiphase you decide whether you want to determine the percentage of the area that the selected phases represent or the size of the individual particles of a phase. The measurement values are then classified to provide you with a better overview. Complete flexibility is offered thanks to the free definition of parameters: individual class boundaries, linear or logarithmic classification, weighting on the basis of area or number. The parameters for the measurement can be drawn freely from the complete range of AxioVision measurement functions and even user-defined parameters are possible. If the standard steps prove insufficient experienced users will have the option of tailoring the image processing steps to meet their individual requirements. The results are then displayed in a clearly structured report – the standard reports supplied can be modified individually.



Multiphase analysis: results view



Ferrite and perlite

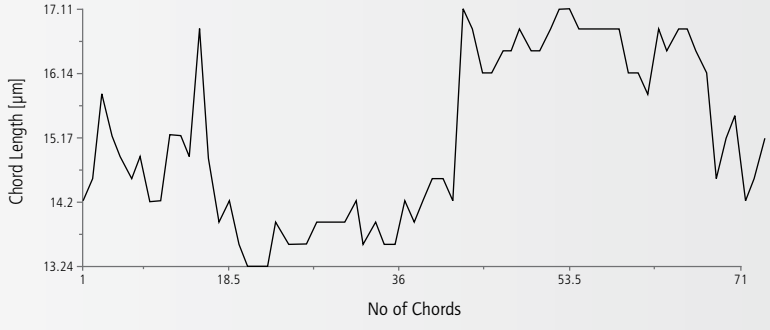
Layer Thickness Measurement

Precision in All Layers

Convenient and economical: Layer Thickness Measurement is a powerful tool for determining layer thicknesses in your samples – from simple to complex layers and from individual layers to several layers.

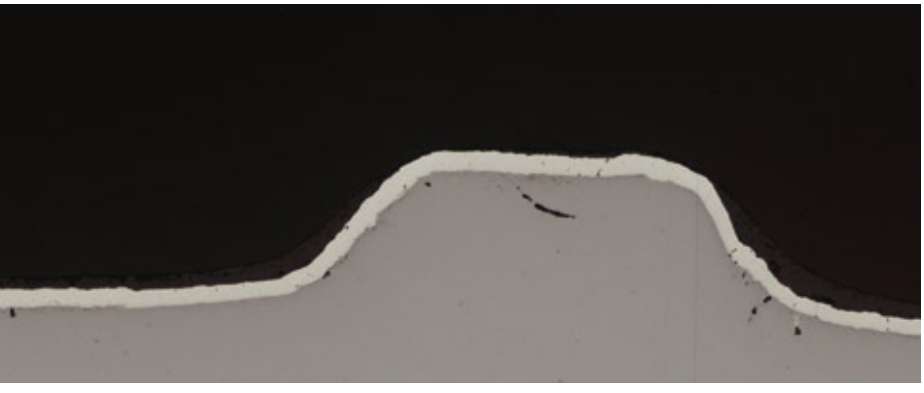
Functionality

Layer Thickness, which can be used universally to meet your specific requirements, offers you a choice of different methods for detecting the individual layers of your samples. In the first step, the layers are identified on the basis of the color or gray value or drawn in interactively. The module then automatically calculates the course of the measurement chords, depending on the layer gradient present. It does this precisely and individually for each layer and independently of the number of layers. How the measurement will be performed is always your decision. You choose the number of measurement chords or the distance between the measurement chords and therefore determine the accuracy of the result. This forms a clearly structured report containing sample data and measurement values, such as the maximum and minimum chord lengths, mean, and standard deviation. In addition, a distribution of the chord lengths can also be displayed graphically. If you wish so, you can also use all the other statistical analyses available in AxioVision, which is another important advantage.

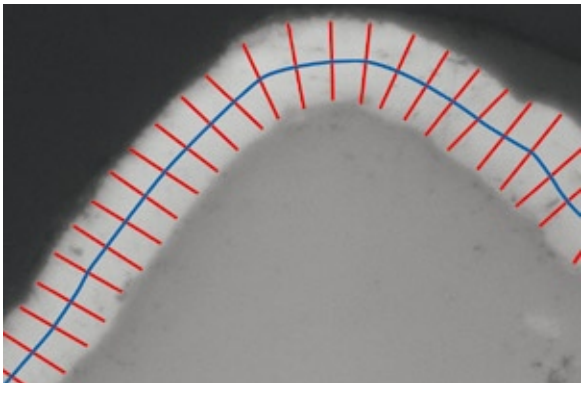


Description	Distance [µm]
Minimum	13.24
Maximum	17.11
Mean	15.14
Std.Dev.	1.26
Range	3.87

Cross-section polish of a coated screw



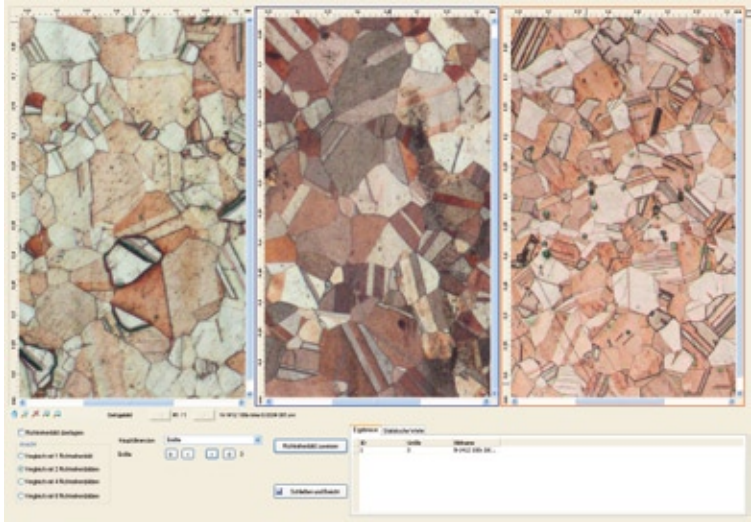
Coating with measuring chords



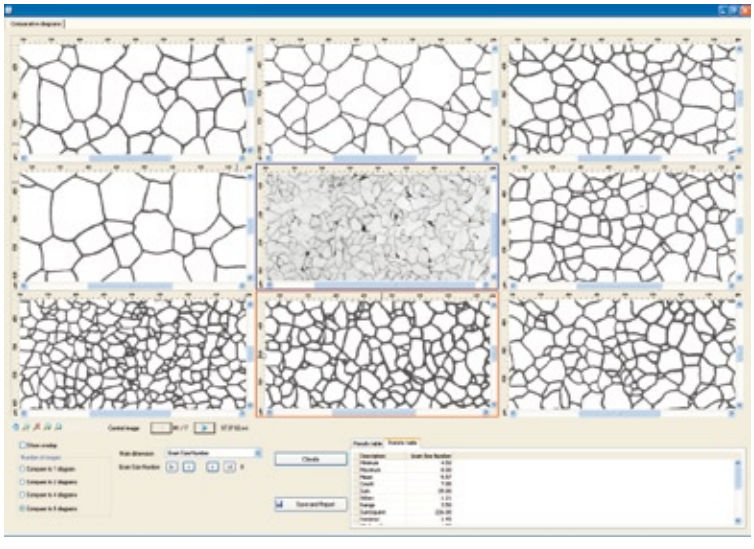
Comparative Diagrams

Assessing Structural Parameters

Assessing structural parameters conveniently on screen, generating comparative diagrams yourself – Comparative Diagrams introduces a new level of quality to the interactive comparison of defined parameters and replaces the previous method involving the use of comparative diagram charts. It is a powerful tool for metallographers, materials scientists, and quality assurance professionals.



User-generated: the image of the sample is flanked by two comparative diagrams



Comparative view with eight comparative diagrams

Functionality

Comparative Diagrams, which serve as an aid for the comparison of samples under the microscope, are collections of images that have been assigned certain characteristics to – e.g. structural characteristics or good/bad preparation. Comparative Diagrams displays the micrographs of the samples you wish to examine together with the comparative diagrams on screen and thus makes interactive comparison possible. The result is a table containing the comparative diagram numbers relating to each image and a table containing statistical analyses. You can also have a micrograph displayed with an overlaid comparative diagram.

Integrated standards

It is possible to generate your own comparative diagrams with no additional costs and no waiting time: using the wizard function you can adapt the comparative diagrams simply to your own requirements. The comparative diagrams of the following standards are included in the software package:

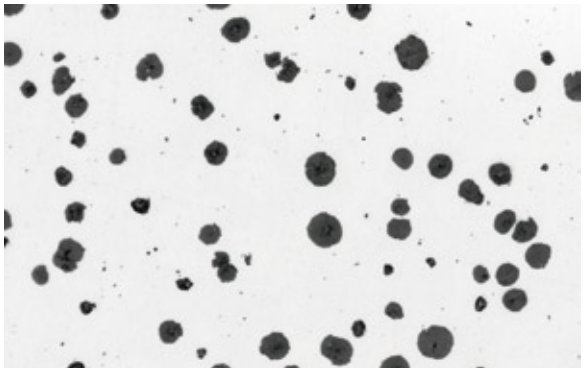
- EN ISO 643
- ASTM E 112
- ASTM E 1382
- BS 4990
- SEP 151061
- EN 10247
- DIN 50602

Graphite

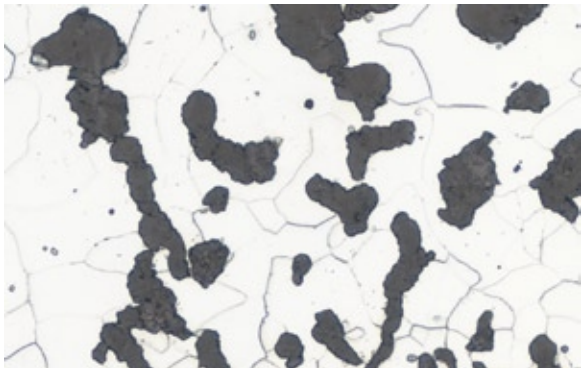
Classifying Graphite Particles

Whether you need to determine the size and shape of graphite particles in cast iron in accordance with EN ISO 945 or the nodularity of vermicular graphite according to SAE J 1887, with this application module you can measure graphite particles fully automatically and with consistent analysis quality.

Cast iron with lamellar graphite



Spheroidal graphite



Vermicular graphite

Functionality

Developed for the efficient measurement of graphite with practice in mind, the Graphite module analyzes your samples in accordance with the applicable standards. The graphite particles are classified automatically by shape and size. With both methods the results are analyzed according to the specifications of the standards, archived, and documented in appropriate test reports. The Graphite module offers the following methods:

- Determination of shape and size according to EN ISO 945
- Nodularity of vermicular graphite according to SAE J 1887

Overview

Functions

Basic program		
Image Acquisition	**Function**	**Contents/Description**
Image Formats:	• Image Import	zvi, bmp, tif, jpg, j2k, jp2, gif, tga, png, psd, cmp, pct, ras, eps, wmf, mac, msp, img, czi, lsm, vgi, rek, raw, avi, zvhi
	• Image Export	avi, bmp, j2k, jp2, jpg, lsm, mov, pct, pcx, png, psd, tga, tif, wmf
Camera Control:	• Exposure Time Adjustment	Manual adjustment, exposure time measurement, automatic mode
	• Automatic Exposure Time	Adjustment of exposure time in live image
	• Target Value for Exposure Time	Definition of the sensitivity level of the sensor during an exposure measurement
	• Focus/Exposure Frame	Optional measurement frame as a focus aid and for spot measurement of the exposure time
	• Live Image Frame Rate	Selection: fast/medium/slow for best possible display of the live image
	• Resolution	Selection of Microscanning resolution modes (AxioCam HR)
	• Binning	Increased camera sensitivity by combining the signals of adjacent pixels
	• Color Adjustment	Manual adjustment of the color balance
	• Color Saturation	Adjustment of the level of color saturation
	• Frame	Interactive selection of an image sensor sub frame
	• White Balance	Interactive or automatic adjustment of optimum neutral balance of the color channels
	• 3200K	Default value for white balance, optimized for halogen light source at 3200K
	• Gray Value Scaling	Adjustment of dynamic range (retain original, convert to 8 bit, convert to 16 bit)
	• Histogram	Intensity distribution histogram for all three color channels
	• Black Reference	Generation of correction image for long exposure times (dark current compensation)
	• Shading Correction	Generation of correction image to compensate for optical inhomogeneities
	• Image Orientation	Rotation and mirroring of image orientation for optimum image display
	• B/W or Color Mode	Conversion of color images into monochrome images during acquisition
	• Digital Gain	Adjustment of digital signal amplification
	• Analog Gain	Analog signal amplification prior to digitization
	• NIR Mode for B/W Cameras	Mode for further increased sensitivity in near IR for monochrome AxioCam cameras
	• EMCCD Gain	Adjustment of signal amplification for cameras with EMCCD sensor
	• CCD Port	Selection of amplifier port for cameras with several read-out amplifiers
	• Offset	Adjustment of basic brightness value
	• Mode	Selection of different, manufacturer-dependent special modes
	• Unsharp Masking	Sharpening of images immediately during acquisition
	• Trigger Input	Triggering of acquisition by means of TTL signal
	• Trigger Output	Triggering of a trigger signal, e.g. to control an external shutter

Image Processing		
Annotate:	• Annotation	Addition of text, marking elements (arrows, scale bars, etc.)
Adjust:	• Brightness/Contrast/Gamma	Adjustment of brightness, contrast and gamma
	• Color Balance	Manual adjustment and readjustment of color rendition
	• Hue/Lightness/Saturation	Adjustment of hue and saturation
	• Shading Correction	Correction of uneven illumination
	• Z-Stack Correction	Correction of bleaching effects in z-stack fluorescence images
	• Transfer display attributes	Transfer of display settings (brightness, contrast, gamma) to other images
	• Adjust display attributes	Adjustment of display settings (brightness, contrast, gamma) to pre-defined values
	• White Balance	Change of white balance in a color image

Overview

Functions

Geometric Transformation:	• Shift	xyz shift of images
	• Rotate 90	Rotation of an image to 90°
	• Z-Stack Alignment	Alignment of the individual planes of a z-stack image which for instance has been acquired using a stereomicroscope
	• OrthoView	Generation of projections along orthogonal axes in 3D images
Image Smoothing:	• Gauss, Sigma	Image smoothing using Gauss or Sigma filter
Image Sharpening:	• Enhance Contour	Enhancement of image sharpness by the intensification of contours
	• Unsharp Masking	Intensification of image sharpness by the enhancement of contrast for small structures and edges
Utilities:	• Resample	Reduce/enlarge the size of an image
	• Copy Image	Copy an image and image information that can be selected
	• Load Look-up table	Load a pseudo-color table
	• Export Image	Export image into other formats
	• Convert Pixel Format	Change the pixel format of an image
	• Create Image Subset	Generate a subset from a multi dimensional image
	• Add Channels	Combine images with the same dimensions (z-stack, time lapse) into multichannel images
	• Reset Indices	Re-indexing of image dimensions in ascending order

Image Analysis		
Interactive Measurement Tools and Parameters:	• Magnetic Cursor	The cursor detects edges, which facilitates the process of finding them, e.g. when measuring lengths
	• Scalings	Scaling in geometric units
	• Automatic Scaling	Automatic detection of pixel size
	• Create/Append Table	Generation/attachment of a data table based on the measurement tools drawn in
	• Length, Line	Definition using 2 points
	• Outline/Outline (Spline)	Measurement of diameter, area, perimeter, length and width of the circumscribing rectangle, radius, center of gravity, mean density of gray value, standard deviation of mean density of gray value
	• Angle 3, Angle 4	Definition using 3 or 4 points
	• Circle	Measurement of diameter, area, perimeter, length and width of the circumscribing rectangle, radius, center of gravity, mean density of gray value, standard deviation of mean density of gray value
	• Events	Counting of events
	• Profile	Gray value profile along a line
	• Evaluate	Functions for the processing and statistical analysis of data tables

Documentation		
	• Gallery	Clear presentation of loaded images as thumbnails
	• Info View	Display of all information of the image
	• Cut View	Display of z-stack images in 3 orthogonal section views (x,y - x,z - y,z)
	• Gallery View	Clear presentation of multidimensional images
	• Splitter Display	Comparison of up to 12 images, also multidimensional; generation of comparison as new image document for presentation purposes
	• Printing of Images/Data	Print of images
	• Reports	Creation of user-definable reports

My AxioVision		
	• Toolbars/Dialogs/Workflows	Creation of individual toolbars, dialogs, and workflows
	• Shortcut	Allocation of AxioVision functions to keyboard combinations
	• Icons	Allocation of symbols to AxioVision functions
	• Microscope	Allocation of AxioVision functions to up to 10 microscope softkeys

Image Acquisition modules		
Z-Stack	**Acquisition of image series from different focus positions**	
	• Focus Control	Automatic adjustment of the minimum possible step size according to microscope type
	• Z-Stack Configuration	Definition of start and stop position (or center position) and interval between individual z-planes
	• Nyquist Criterion	Automatic calculation of the optimal z-interval
	• Navigation	Precise stepwise navigation through defined z-stack or to the start, stop or center position
	• Experiment	Saving of z-stack definitions as experiment for exact reproduction of an experimental set-up
	• ReUse	Extraction of z-stack definitions from previously acquired images for the exact reproduction of an experimental set-up
Time Lapse	**Flexible acquisition of image series over time**	
	• Time Configuration	Definition of interval as well as number of cycles or total time
	• Exposure Time	Automatic measurement of the correct exposure time for the first time point
	• Image Information	Acquisition time point as annotation in image
	• Autosave	High data security during long time lapse acquisitions thanks to Autosave function
	• Image Size	Acquisition of images as large as required depending on experimental conditions (> 2 GB)
	• Time Lapse Processing	
	- Gliding Average	Calculation of average values from time lapse images
	- Time Differential	Calculation of first and second derivative from time lapse images
	- Time Concatenate	Combination of two time lapse images to form a new time lapse image
	- Image Ratio	Division of two time lapse images
	- Time Lapse Alignment	Alignment of the individual time points of a time lapse image
	- Time Stitching	Stitching of heterogeneous ZVI time lapse images to generate one contiguous sequence to enable movie creation from Smart Experiment results
	• Experiment	Saving of time lapse configurations as experiment for exact reproduction of an experimental set-up
	• ReUse	Extraction of time lapse settings from previously acquired images for the exact reproduction of an experimental set-up
	• Smart Experiments	Free combination of different types of experiments to create a Smart Experiment which can be used to acquire heterogeneous multidimensional images
Mark&Find	**Recording and relocating positions**	
	• Database	Management of projects involving different types of slides in a database (slides, multiple specimen holders, Petri dishes, multiwell plates)
	• Mark Interactively	Color assignment of sample positions in the database
	• Classify	Assignment of colors and allocation of names for object positions
	• Select	Activation/deactivation of individual positions
	• Visualize	Visualization of the selected points on a graphic slide, relocation by clicking on the colored marker
	• Focus Position	Repositioning with optional use of stored focus position
	• Import/Export	Import and export of position lists in a file format compatible with Microsoft® Excel
	• Calibrate	Calibration using a HOME Calibration slide
MosaiX	**Automatic scanning of large surfaces**	
	• Execute	Scanning of the entire surface of a sample (motorized stage required)
	• Focus Correction	Correction of the focus position in the case of uneven sample
	• Stitching	Correct alignment of tiles to each other
	• Convert	Conversion of tile images into a composite image
	• Combinability	MosaiX can be freely combined with all multidimensional image acquisition modules

Overview

Functions

Extended Focus	**Calculation of sharp images from several focus positions**	
	• Acquisition/Computation from z-stack	Generation of an image with extended depth of focus from single images acquired from different focus positions directly from the camera or from an acquired z-stack
	• Alignment	Correction of the alignment of single images during acquisition with a stereomicroscope
Autofocus	**Automatic focusing**	
	• Methods	Choice between autofocus with calibration and parameter options and autofocus that is always calibrated and does not require parameterization
	• Calibrate	Calibration by specifying the optimum focus position using the current microscope setting with motorized microscopes
	• Focus	Automatic calculation of the optimum focus plane at the touch of a button. Suitable for transmitted-light, reflected-light as well as brightfield, darkfield, and fluorescence
Panorama	**Formation of overview images**	
	• Acquisition	Generation from individually acquired camera images
	• Import from Files	Generation from images that have been saved previously
	• Stitching	Correct alignment of tiles to each other
	• Convert	Conversion of tile images into a composite image
HDR Imaging (High Dynamic Range)	**Acquisition method for extending the available dynamic range of digital cameras**	
	• HDR Snap	Generation and processing of an HDR image using pre-set parameters
	• HDR Series	Generation of an HDR raw data image using different exposure times
	• HDR Merge	Processing of an HDR raw data image to create an HDR image with offset correction
	• HDR Setup	Basic setting for activating HDR acquisition for all imaging techniques
Image Processing modules		
Inside4D	**Visualization in 3D**	
	• Volume Display	Volume display of z-stack images with up to 8 channels with selective switching between different channels or view in merged pseudo-color mode
	• Shadow Projection	Creation of animations with strong sense for spatial conditions
	• Transparency Rendering	Presentation of transparent structures
	• Surface Rendering	Enhancement of individual structures
	• Maximum Projection	Ideal for prints and publication
	• Mixed Mode	Simultaneous display of surface and transparency-rendered data, simplifies display of small objects within the context of larger structures
	• Spatial Interaction	Free positioning of the 3D volume in space (with free choice of angles for x, y and z; lateral position and zoom factor)
	• 3D Inside View	Orientation within a volume
	• Annotations	Optional display of volume edges, color coding, and scaling of axes
	• Animations	Generation of animations as rendered image series with export options in popular video formats (AVI, QuickTime)
	• Maximum Rendering Speed	Acceleration of rendering methods by modern graphic boards (support of OpenGL standard)
	• Clipping Planes	Exposure of interesting structures by means of up to three freely movable and configurable clipping planes

Imaging Plus	Image Improvement, Gray Morphology, Fourier Transformation, Color Transformation	
	• Adjust	
	- Contrast	Contrast enhancement using interactive/automatic histogram adaptation
	- Negative	Calculation of inverted image (negative)
	- Gray Transformation	Adjustment of gray values using transformation tables
	• Geometric Transformations	
	- Rotate	Rotation around an axis
	- Mirror	Mirror along horizontal or vertical axis
	- Alignment	Affine transformation
	- Elastic Registration / Warping	Alignment using a reference image
	• Smoothing	
	- Denoising	Denoising using wavelet transformation
	- Lowpass	Lowpass filter (gliding average)
	- Median	Median filter (non-linear method)
	- Rank	General rank operator
	- Gauss Anisotropic	Anisotropic Gauss filter with selectable Sigma values
	• Sharpening	
	- Edge Enhancement	Enhancement of edges
	• Edges	
	- Sobel	Edge detection using Sobel filter
	- Laplace	Laplace filter
	- Highpass	Highpass filter
	- Local Variance	Edge detection filter calculating the local variance of each pixel in relation to its neighborhood
	• Morphology	
	- Gray Erode, Gray Dilate	Erosion or dilation of objects
	- Gray Open, Gray Close	Erosion followed by dilation or dilation followed by erosion
	- Tophat White	Removal of bright regions
	- Tophat Black	Accentuation of dark regions
	- Gray Gradient	Morphological gradient to detect contours
	- Watersheds	Watersheds – algorithm for separation/reconstruction
	• Arithmetics	
	- Add, Subtract	Addition or subtraction of two images
	- Add Constant	Addition of a constant value
	- Multiply, Divide	Multiplication or division of two images
	- Multiply Constant	Multiplication with a constant value
	- Average	Average of two images
	- Maximum, Minimum	Maximum or minimum of two images
	- Square, SquareRoot	Square or square root of an image
	- Logarithm, Exponential	Logarithm or exponent of an image
	- Combine	Linear combination of two images
	• FFT	
	- Transform	Fourier transformation on an image
	- Spectrum	Calculation of power or phase spectrum
	- Filter	Filtering in the frequency domain using a defined filter
	- Inverse	Inverse Fourier transformation

	• Utilities	
	- Copy Region	Copying of image regions
	- Color Model	Transformation of RGB color space into HLS color space and vice versa
	- Split RGB Extractions	Splitting of a RGB image into single color channels
	- Combine RGB Extractions	Combination of single color channels to form a color image
	- User Filter	Filtering of an image with user-defined filter matrix
	- Generate Noise	Superimposing an image with predefined noise
	• Time Lapse Processing	
	- Gliding Average	Calculation of average values from time lapse images
	- Time Differential	Calculation of first and second derivative from time lapse images
	- Time Concatenate	Combination of two time lapse images to create a new time lapse image
	- Image Ratio	Division of two time lapse images
	- Time Lapse Alignment	Alignment of the individual time points of a time lapse image
	- Time Stitching	Stitching of heterogeneous ZVI time lapse images to generate one contiguous sequence to enable movie creation from Smart Experiment results

Image Analysis modules		
Interactive Measurement	**Expanded interactive measurement techniques**	
	• Distance, Calipers	Measurement of length
	• Multiple Calipers/Distance	Measurement of the length of multiple lines perpendicular to a base line
	• Curve, Curve (Spline)	Measurement of the drawn curve's length
	• Aligned rectangle or free orientation	Measurement of geometric and densitometric object features
	• Circle (Radius), Circle (Points)	Drawing of a radius to the center, clicking on contour points
	• Marker	x- and y-coordinates of a point
	• Points, Relative Points	x- and y-coordinates of one or more points with free definition of the coordinate system
	• Interactive Measurement Program Wizard	Guided generation of a program for interactive measurement
	• Interactive Measurement Programs	Loading and execution of interactive measurement programs

Online Measurement	**Interactive measurements in online images**	
	• Activate Online Measurement	Execution of interactive measurements in an online image
	• Layer	Predefined and individual grids can be displayed in the online image

AutoMeasure	**Creation of easy measurement programs with a measurement wizard**	
Creation of Measurement Programs	• Automatic Measurement Program Wizard	Guided generation of a program for automatic measurement
	• Image Enhancement	Contrast, brightness, gamma, noise reduction (Sigma), shading correction, improvement of edges
	• Segmentation	Global or local definition by clicking or circumscribing objects, specification of thresholds using the image histogram, definition of multiple phases
	• Binary Image Clean-up	Deletion of artifacts, filling of holes
	• Automatic Object Separation	Erosion and dilation, watersheds
	• Editing of the Measurement Mask	Drawing of separation lines, deletion of objects, addition of objects
	• Selection of Measurement Parameters	Region-specific, field-specific, geometric, and annotation parameters, user-defined parameters
	• Definition of Measurement Conditions ("object filter")	Logical concatenation (and/or) of region-specific parameters, definition by simple clicking on reference objects
	• Definition of a Measurement Frame	Rectangle, circle, freehand
	• Measurement	Measurement of geometric and densitometric features for single objects or the entire image
	• Documentation	Marking of measured objects and display of freely selectable measurement parameters in the graphics plane
	• Data Storage	Saving of measurement data in a Microsoft® Excel compatible file format (CSV, XML)

Execution of Measurement Programs	• Image Acquisition	Image acquisition via camera, all images of a folder, all loaded images
	• Control of Program	Activation/deactivation as well as the changing of functional parameters during execution of the program
	• Program Information	List of executed functions with parameter settings

AutoMeasure Plus	**Segmentation, binary image processing, automatic measurement**	
	• Segmentation	
	- Thresholds	Interactive adjustment of thresholds with histogram support and specification of fixed values
	- Region Growing	Detection of associated regions (gray values within user-defined tolerance range)
	- Multiphase	Adjustment of thresholds for several phases of an image with histogram support
	- Automatic	Automatic determination of thresholds using a histogram
	- Dynamic	Technique for threshold detection using size information
	- Valleys	Detection of dark lines (valleys) in images with bright background
	- Canny	Edge detection considering "steepness" of edges
	- Marr	Detection of edges and associated regions
	• Binary Functions	
	- Erode, Dilate	Erosion or dilation of binary objects
	- Ultimate Erode	Erosion of binary objects while keeping the smallest structures
	- Open, Close	Erosion followed by dilation or dilation followed by erosion
	- Clean Up Binary Image	Filling of holes, removal of artifacts
	- Mark Regions	Marking of regions using a mask image
	- Object Separation	Automatic separation of touching regions
	- Binary Image Editor	Interactive subsequent editing (separating, combining) of binary images
	- AND, OR, XOR, NOT	Bit-by-bit "logic" operations
	- Distance Transformation	Generation of a "distance map", indicating the distance of each pixel to the object border
	• Skeletonizing of Binary Images	
	- Thinning	Thinning of binary objects to lines 1 pixel wide ("skeleton")
	- Skeleton	Skeletonization of the image background
	• Selection of Measurement Parameters	Region-specific, field-specific, geometric, and annotation parameters, user-defined parameters
	- Definition of Measurement Conditions ("object filter")	Logical concatenation (and, or) of region-specific parameters, definition by simple clicking on reference objects
	- Definition of a Measurement Frame	Rectangle, circle, freehand
	- Measurement	Automatic measurement of geometric and densitometric object features, drawing of measurement values into the graphics plane of the image

3D Measurement	**Measurement of three-dimensional structures and parameters**	
	• Interactive Measurement in 3D Space	Drawing of lines, angles, markers, and curves in rendered 3D views
	• Segmentation	Interactive adjustment of thresholds in rendered 3D view and with specification of fixed values
	• Binary Image Editor	Interactive subsequent editing (separating, combining) of 3D binary images
	• Measurement	Automatic measurement of geometric and densitometric object features, drawing of measurement values in the graphics plane of the image

Overview

Functions

Particle Analyzer Projects	**Measurement of particles**	
	• System solution	Coordinated components: microscope, camera, PC, software
	• Automatic classification	Supported standards, e.g. VDA 19, ISO 16232, user-defined adjustment of standards
	- Particle classification	Reflective particles, non-reflective particles, fibers
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement
	• Data management	Based on Asset Archive, selection of the data to be saved
	• Results display	
	- Results view	Display of the classification results for each standard and method
	- Gallery of the largest inclusions	View the largest inclusions, relocate the inclusions under the microscope, remove artifacts, various galleries
	• Report	Issue of standard-compliant reports, modification possible

NMI	**Determination of the content of non-metallic inclusions in rolled steel**	
	• System solution	Coordinated components: microscope, camera, PC, software
	• Multiple samples	Acquisition and analysis of several samples during a single measurement
	• Simultaneous analysis of all supported standards	EN 10247, DIN 50602, ASTM E 45, JIS G 0555, ISO 4967
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement
	• Data management	Based on Asset Archive, selection of the data to be saved
	• Results display	
	- Results view	Display of the classification results for each standard and method
	- Gallery of the largest inclusions	View the largest inclusions, relocate the inclusions under the microscope, remove artifacts, various galleries
	• Report	Issue of standard-compliant reports, modification possible

Grains	**Determination of grain size**	
	• Measurement modes	
	- Comparison	Comparison using comparative diagrams ASTM – Plate I, Plate II, Plate III, Plate IV, SEP 151061, BS 4990
	- Intercept	Intercept method supporting DIN EN 623, ASTM E 112, ASTM E 1382, various line patterns
	- Automatic	Automatic reconstruction of grain boundaries supporting DIN EN 623, ASTM E 112, ASTM E 1382, additional measurement parameters possible
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement
	• Data management	Based on Asset Archive
	• Report	Issue of standard-compliant reports, modification possible

Multiphase	**Analysis of multiphase samples**	
	• Measurement	Phase components as a percentage, classification of particle sizes, free choice of measurement parameters
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement

	• Data management	Based on Asset Archive
	• Report	Issue of reports, modification possible
Graphite	**Analysis of graphite particles in cast iron**	
	• Measurement modes	
	- Shape and size	Determination of shape and size in accordance with EN ISO 945
	- SinterCast	Determination of nodularity in accordance with SAE J 1887
	- Lamellar	Determination of the size of lamellar graphite in accordance with EN ISO 945
	- Spherolyte	Determination of the size of spheroidal graphite in accordance with EN ISO 945
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement
	• Data management	Based on Asset Archive
	• Report	Issue of standard-compliant reports, modification possible
Comparative Diagrams	**Interactive comparison of comparative diagrams with micrographs**	
	• Display	Comparison with one, two, four or eight comparative diagrams
	• Wizard	Creation of user-defined comparative diagrams
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement
	• Data management	Based on Asset Archive
	• Report	Display of images, data tables, and statistical analysis, modification possible
Layer Thickness	**Measurement of layer thickness**	
	Layer detection	Gray or color value segmentation or interactive detection
	Measurement	Individual or several layers, straight or curved layers
	• User modes	
	- Administrator	Definition of the measurement procedure using test specifications
	- User	Execution of the measurement
	• Data management	Based on Asset Archive
	• Report	Issue of results, modification possible
Calotte Grinding	**Measurement of layers in accordance with DIN V ENV 1071 (calotte grinding method)**	
	• Drawing in of measurement circles	Drawing in of measurement circles for single or multilayer
	• Analysis	Automatic calculation of layer thickness, display of measurement results in image, generation of report
TIC	**Optical height measurement with Total Interference Contrast**	
	• TIC settings	Correction of phase shift and objective aperture
	• Automatic TIC measurement	Measurement of fringe displacement in the interference image

Topography	**Height and roughness measurement in 3D topographies**	
	• Generation of topographies	
	- Calculation from stereo image pairs	Calculation of the topographic image from a stereoscopic image pair
	- Calculation from z-stack images	Generation of the topographic image from a z-stack by means of surface recognition
	- Composition from texture image and height map	Generation of the topographic image from a texture image and a specified height map
	• Topographic views	
	- Texture	Display of the structure of the detected surface
	- Height image	Display of the height map in gray value or pseudo-color coding
	- 3D projections	3D display of the topography in gray value or pseudo-color coding, texture projection, grid or surface projection
	- Anaglyph	Display of the topography as a stereogram that can be viewed using anaglyph glasses
	• Measurements	
	- Profile measurement	Measurement and display of height profiles of lines, polygons, and curves
	- Roughness measurement in accordance with EN ISO 4287	Calculation of roughness statistics from primary, roughness, and waviness profiles
	- Cut-off wavelength	Setting of the cut-off wavelength for measuring roughness and waviness
	- Flood height	Setting of a flood height for displaying regions of equal height
	• Generation of views	Each topographic view can be saved as an image
	• Generation of measurement value lists	
	- Height profiles	Height profiles can be saved as a graph or a data list
	- Roughness statistics	The roughness statistics of the drawn-in profile lines can be saved as a data list

Documentation and Configuration modules		
Asset Archive	**Archiving of images, measurement data, and reports**	
	• Structured Archiving of Assets	Allocation of assets to projects, contacts, and categories
	• Search	Keyword search and freely definable search queries on the basis of field content
	• Value Lists	Data entry using adaptable value lists
	• Local Management of Archives	Single-user system, storage location for the database may be selected

Commander	**Recording/execution of steps**	
	• Record, Save	Recording of work steps and saving of scripts
	• Start	Automatic execution of recorded scripts
	• Edit	Subsequent editing of scripts

VBA	**Integrated development environment**	
	• Visual Basic Editor	VBA environment with full access to AxioVision functionalities

Overview

Region-specific Measurement Parameters

Region-specific parameters						
• Geometric parameters						
Entry-level	Materials Packages	Interactive Measurement	AutoMeasure	3D Measure		
		X	X	X	AcpX, AcpY	x- and y-coordinates of the first object point of a region
				X	AcpZ	z-coordinate of the first object point of a 3D region
X	X	X	X		Area	Area of the region in scaled and unscaled units
		X	X		Area convex, Area filled	Area of the convex shell of the region and of the filled region
			X		Area to area sum	Area of the region in relation to the total area of all regions
			X		Area to Frame area	Area of the region in relation to the area of the measurement frame
				X	Surface, SurfaceFilled	Surface content of the 3D region and of the filled 3D region
				X	Volume	Volume of the 3D region in scaled and unscaled units
				X	Volume filled	Volume of the filled 3D region
				X	Volume to volume sum	Volume of the 3D region in relation to the total volume of all 3D regions
				X	Volume to Frame Volume	Volume of the 3D region in relation to the volume of the measurement frame
			X	X	Count of inner parts	Number of holes and regions within holes
X	X	X	X	X	CenterX, CenterY	x- and y-coordinates of the geometric center of gravity of the region
				X	CenterZ	z-coordinate of the geometric center of gravity of the 3D region
		X	X	X	Ellipse major, Ellipse minor	Length of the main axis and the secondary axis of the ellipse with the same geometric moment of inertia as the region/3D region
				X	Ellipse Semi-Medial Axis	Length of the middle axis of the ellipse with the same geometric moment of inertia as the 3D region
		X	X	X	Ellipse angle	Angle of the main axis of the ellipse with the same moment of inertia
X	X	X	X		Perimeter	Perimeter of the region
		X	X		Perimeter convex	Perimeter of the convex shell of the region
		X	X		Perimeter filled	Perimeter of the filled region
		X	X		Perimeter Crofton, Perimeter Crofton filled	Perimeter of the region and perimeter of the filled region according to Crofton
		X	X		Perimeter X, Perimeter Y	x- and y-projection of the perimeter
		X	X		Perimeter XF, Perimeter YF	x- and y-projection of the perimeter of the filled region
		X	X		Perimeter XY, Perimeter XYF	Diagonal projection of the perimeter and the perimeter of the filled region
	X	X	X	X	Bound left, Bound top, Bound right, Bound bottom	x- and y-coordinates of the bounding box/the bounding cuboid of a 3D region
				X	Bound front, Bound back	z-coordinates of the bounding cuboid of a 3D region
X	X	X	X	X	Bound width, Bound height	Width and height of the bounding box/the bounding cuboid of a 3D region
				X	Bound depth	Depth of the bounding cuboid of a 3D region
	X		X		Area Frame	Area of the measurement frame in scaled and unscaled units
				X	Volume Frame	Volume of the measurement frame in scaled and unscaled units
	X	X	X	X	Feret minimum, Feret maximum	Minimum and maximum feret of the region

Region-specific and Field-specific Measurement Parameters

Entry-level	Materials Packages	Interactive Measurement	AutoMeasure	3D Measure		
Region-specific parameters						
• Geometric parameters						
		X	X		Feret Min. Angle, Feret Max. Angle	Angle of the minimum and the maximum feret of the region
				X	Feret Min. Azimut, Feret Max. Azimut	Horizontal orientation of the minimum and the maximum feret of the 3D region
				X	Feret Min. Elevation, Feret Max. Elevation	Vertical orientation of the minimum and the maximum feret of the 3D region
	X	X	X	X	Feret Ratio	Ratio of the ferets (Feret Min/Feret Max)
X	X	X	X	X	Diameter, Radius	Diameter, radius of the circle with equivalent area/sphere with equivalent volume
	X	X	X	X	Form circle, Form sphere	Circular shape factor of the region/spherical shape factor of the 3D region
		X	X		Fibre length	Length of a fiber-like thin region
	X	X	X		Index/ID	Explicit characteristic of the region, of the squares
X	X	X		X	Distance, Length	Distance between 2 points, length of a line
	X	X			Distances Mean	Mean distance of multiple distances
X	X	X		X	Angle Measurement	Angle in degrees
• Densitometric parameters						
X	X	X		X	Mean	Densitometric mean value of the region (gray and color values)
X	X	X	X	X	Standard Deviation	Standard deviation of the densitometric values of the region (gray and color values)
		X	X	X	Minimum, Maximum	Minimum and maximum densitometric value (gray and color values)
		X	X	X	Sum	Sum of the densitometric values of the region
		X		X	Sum Square	Sum of the squares (gray and color values)
Field-specific parameters						
• Geometric parameters						
			X		Area sum	Area of all regions in scaled and unscaled units
			X		Area sum filled	Area of all filled regions
			X		Area percent	Percentage area of all regions in the measurement frame
			X	X	Number of regions	Number of the measured regions
			X		Perimeter sum	Sum of all region perimeters
				X	Surface sum	Surface content of all 3D regions
				X	Volume sum	Volume of all 3D regions in scaled and unscaled units
				X	Volume sum filled	Volume of all filled 3D regions
				X	Volume percent	Percentage volume of all 3D regions in the measurement cuboid

Overview

Field-specific and Image-specific Measurement Parameters

Entry-level	Materials Packages	Interactive Measurement	AutoMeasure	3D Measure		
Field-specific parameters						
• Densitometric parameters						
			X	X	Mean	Densitometric mean value of all regions (gray and color values)
			X	X	Standard Deviation	Densitometric value standard deviation in all regions (gray and color values)
			X	X	Minimum, Maximum	Minimum and maximum densitometric value in all regions (gray and color values)
Further parameters						
X	X	X		X	Count	Number of objects clicked on
		X		X	Marker	x- and y-coordinates of an object
X	X	X			Gray/Color Value Profiles	Gray value/color value along a profile line
			X	X	User Parameter	Parameter that can be defined by the user
Image-specific parameters						
X	X	X	X	X	Name	Name of the image
X	X	X	X	X	Acquisition Time	Time point at which the image was acquired
X	X	X	X	X	Exposure Time	Exposure time of the image
X	X	X	X	X	Focus Position	Focus position of the image
X	X	X	X	X	Microscope Magnification	Microscope magnification set during image acquisition
X	X	X	X	X	Date Saved	Date on which the acquired image was saved
X	X	X	X	X	Stage Position X, Y	x- and y-stage position at which the image was acquired
X		X	X	X	Channel Name	Name of the channel for multichannel images
X		X	X	X	Phase Name/Index	Phase name/index for multiphase images
X		X	X	X	Index/ID Channel	Index/ID of the channel of the multichannel image
X		X	X	X	Index/ID z-plane	Z-index/ID for z-stack images
X		X	X	X	Index/ID Time	Time index/ID for time lapse images

Statistical parameters

Minimum, Maximum, Mean, Count, Sum, Standard Deviation, Range, Sum of squares, Variance, 25-Quartile, 50-Quartile (Median), 75-Quartile, 10-Percentile, 90-Percentile, 1-Percentile, 99-Percentile, Kurtosis, Skewness

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