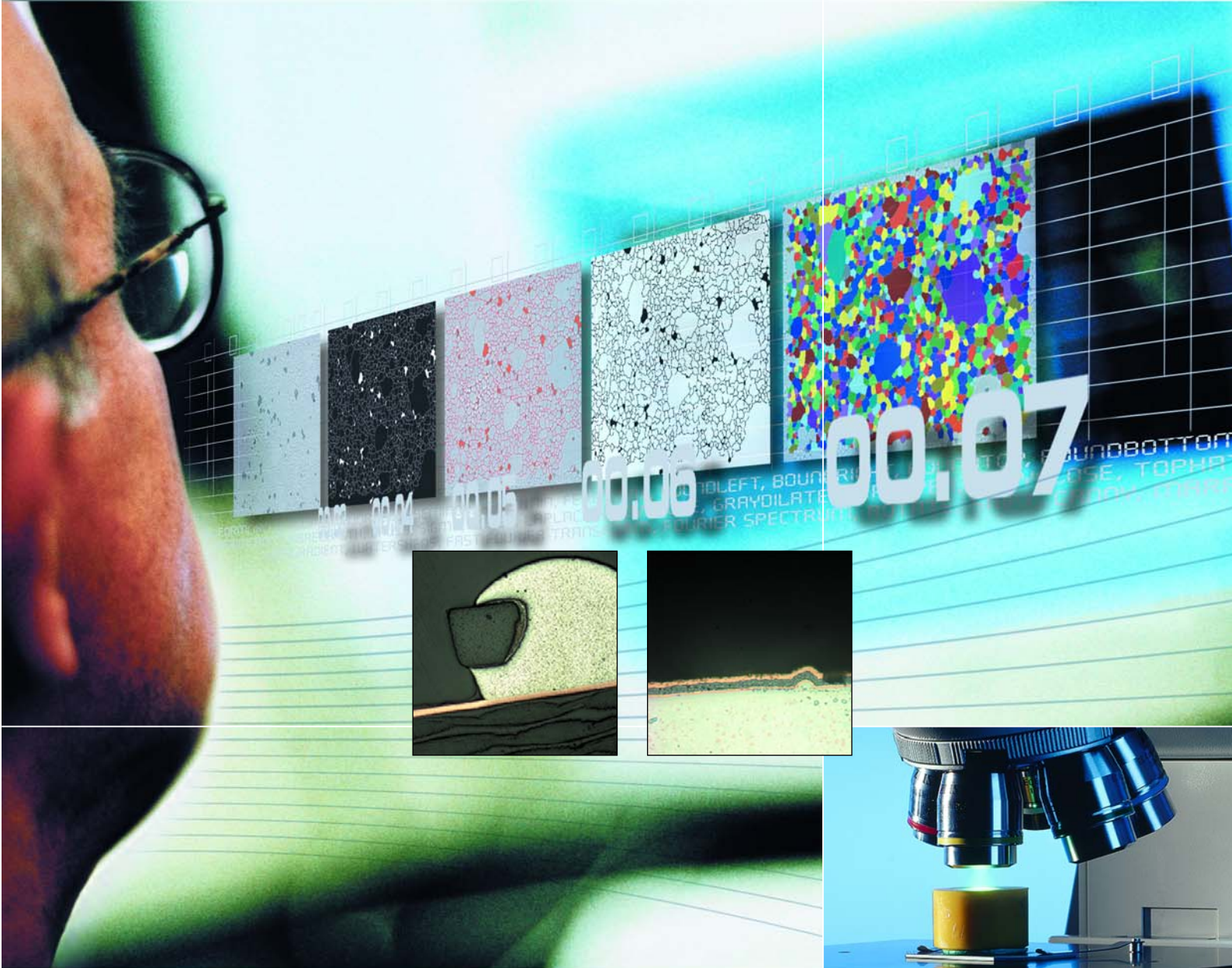


# AxioVision

## Perform to Perfection



**New dimensions in digital image processing for materials analysis**



We make it visible.

# A New Way of Thinking

From geosciences to materials research and development right up to industrial quality control and assurance, more and more materials laboratories are utilizing the advantages of digital microscopy. 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 specialists. Thanks to its unique modular architecture, this software is equally suited for both newcomers and advanced users. Software packages such as AxioVision applications offer complete solutions for routine work in science and industry. The philosophy behind AxioVision is uncompromising: the highest possible performance, easy operation, extreme flexibility, and seamless integration into Carl Zeiss microscope and camera systems. A homogeneous solution with functions that are 100% effective – right from the start.



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00.03

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## An Easy Decision

Carl Zeiss is application-driven in all of its research and development. In software, this means a superb solution for the demands of the day-to-day lab routine. All functions are tailored to the requirements of materials microscopy – from classical applications in mineralogy to the latest techniques in the plastics industry. It's easy to use the AxioVision system and to take advantage of its numerous tools. A wide range of clever features guarantees an uncomplicated and fast operation. On top of that, it is simply amazing how you can determine configurations and operating elements.

### 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 expansion

With its regular updates and numerous options, AxioVision grows along with your needs. Whatever your requirements are, the entry-level version can be expanded to meet them through additional modules for imaging, processing, analysis, and archiving.

### Easy decision

With its convenient operation, expandability, and excellent price, AxioVision is an easy choice. Above all, whether you purchase AxioVision as an entry-level version or equipped with additional modules, you are only investing in the functions you really need.



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### Panorama

Formation of overview images

### MosaiX

Automatic scanning of large surfaces

### Extended Focus

Calculation of a sharp image from several focus positions

### Autofocus

Automatic focusing

### Mark&Find

Recording and retrieving of specimens

### Imaging Plus

- Image enhancement
- Gray morphology
- Fourier transformation
- Transformation of color models

### TIC Measurement

Optical height measurement in the nanometer range

### AutoMeasure Plus

- Segmentation
- Binary image processing
- Automatic measurement

### AutoMeasure

Creation of easy measurement programs with measurement wizard

### Cumulus Workgroup

Image cataloging and archiving in network

### Cumulus Single User

Image cataloging and archiving

## Modules

### Image acquisition

Imaging with video and digital cameras, microscope control

### Image processing

- Text and graphic elements
- Annotations
- Filters for contrast and sharpness

### Image analysis

Interactive measurement with standard parameters

### Documentation

Image archiving and reporting



Image acquisition

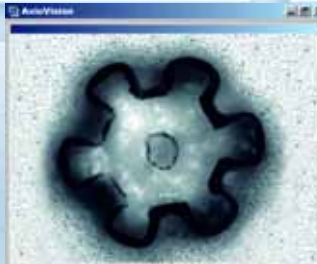


Image processing

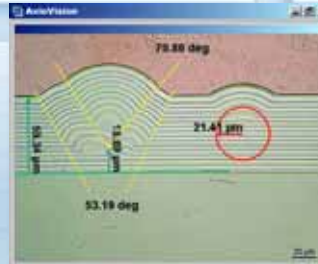


Image analysis



Documentation

## Basic program

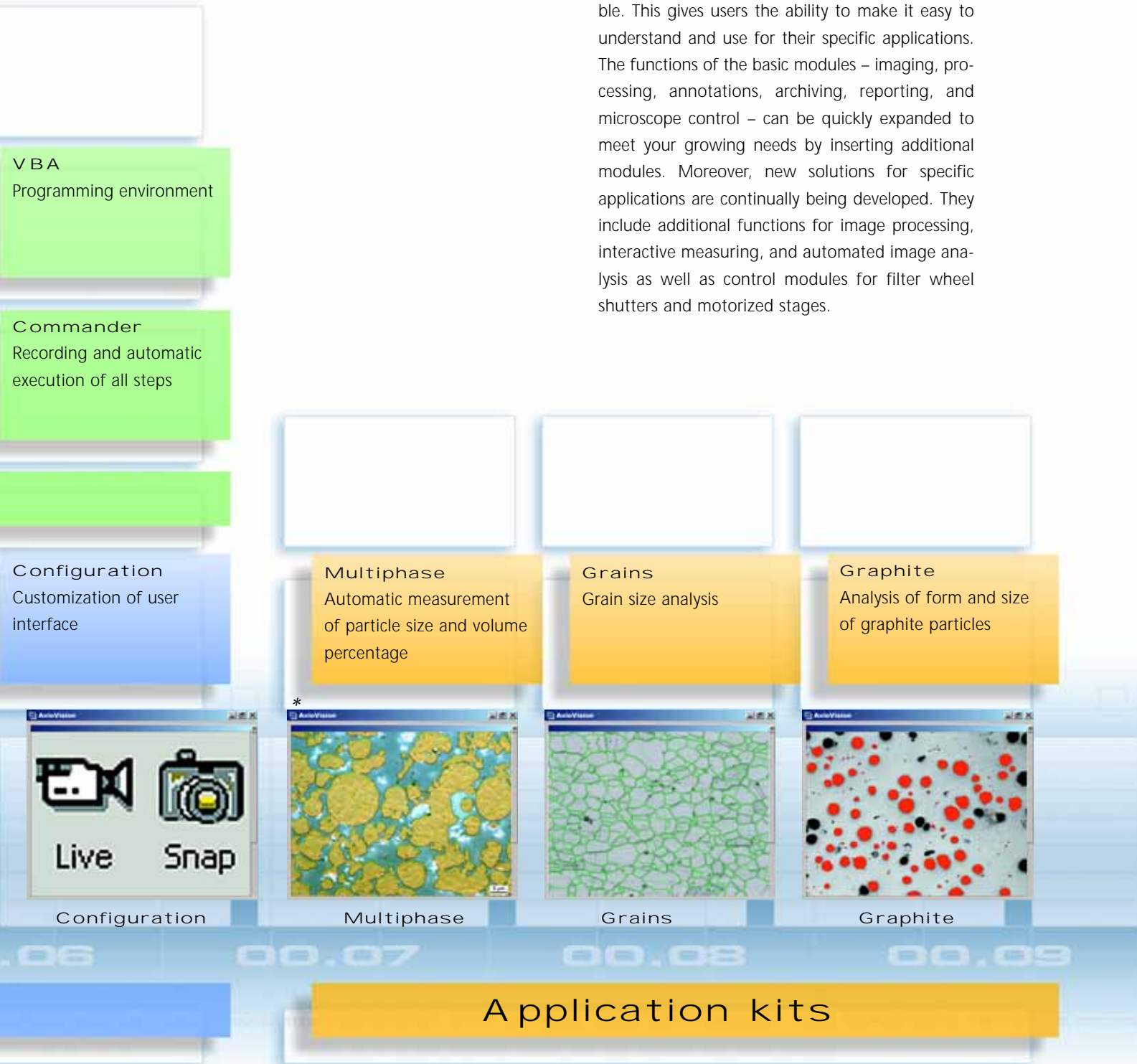
\* Pictures with the permission of ACCESS e.V., Aachen and Foundry Institute of RWTH Aachen, Germany.

## BIO MAT

The decision for the basic program from AxioVision is a decision for a sound investment in digital imaging. Further modules for biomedical applications are available and can easily be combined.

### Growing possibilities

The world of materials science is constantly changing and evolving, which means it 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 modules – imaging, processing, annotations, archiving, reporting, and microscope control – can be quickly expanded to meet your growing needs by inserting additional 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 filter wheel shutters and motorized stages.

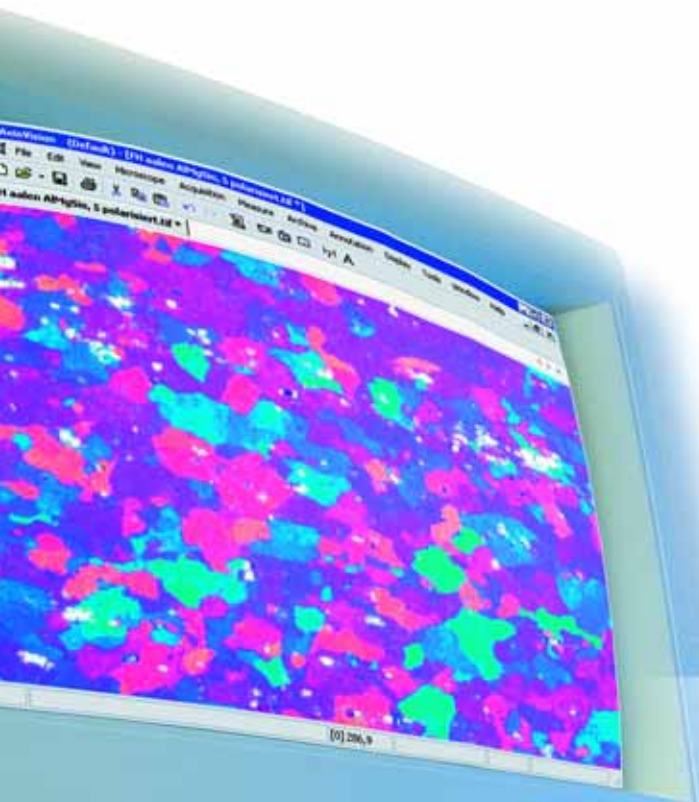


# Extensive Basics

The entry-level version of AxioVision provides a highly powerful image processing and analysis system for modern microscopy. With a wealth of functions ranging from microscope control to convenient image archiving, it is guaranteed to meet the high demands placed on state-of-the-art 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 from sample to sample. In addition, scaling factors can be recalled during analysis, greatly increasing the speed at which measurements can be performed.

**Flexible camera operation**  
Thanks to its interfaces for such standard technology as framegrabber or TWAIN, AxioVision allows you to use all types of cameras, from basic video and digital cameras right up to scientific microscope cameras. This includes the AxioCam family of cameras from Carl Zeiss. The seamless integration of cameras into AxioVision software allows the user to generate multidimensional images (with special biomedical applications) at a mouse click. The AxioCams from Carl Zeiss can provide significant



Digital camera



AxioCam



*The complete range: from digital microphotography with standard digital cameras up to image analysis with high-resolution microscope cameras.*

# Basic program

advantages in the areas of speed and resolution. All cameras in the AxioCam family are controlled by the same operational elements. If you want, you can also alter them to fit your individual applications.

*Easy and clear interfaces for camera control and image acquisition.*

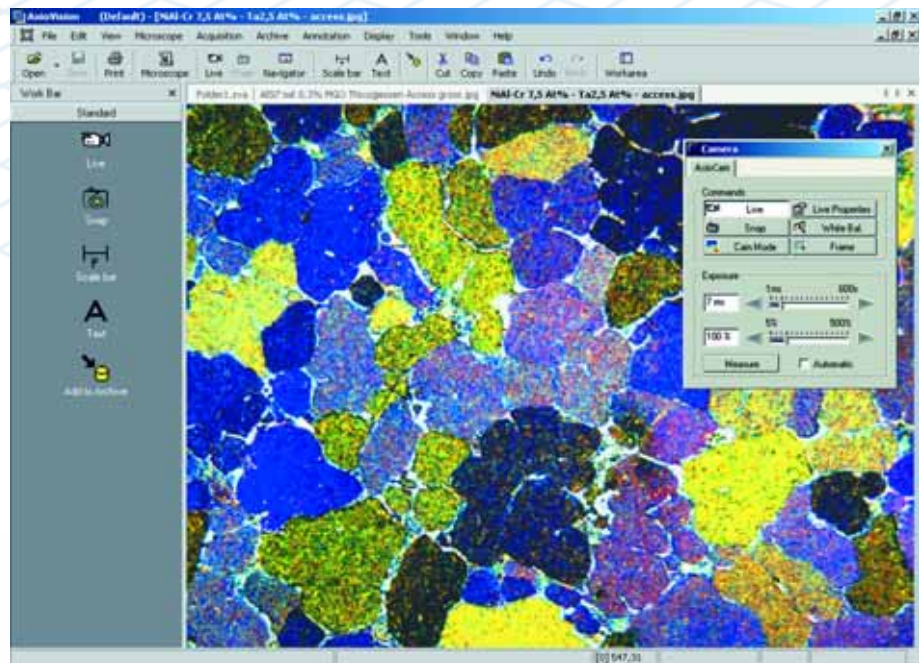
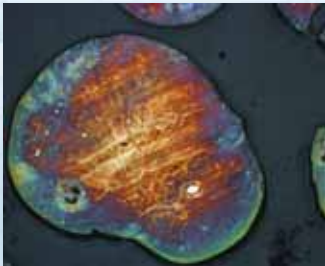


Image acquisition

Microscope control

Microscope (manual or motorized)



### Rapid image processing

AxioVision offers you all the tools for:

- contrast, brightness, and color control
- noise suppression, smoothing, and contour enhancement
- improved sharpness and detail emphasis
- correction of illumination conditions and white balance control

### Integration of text and graphic elements

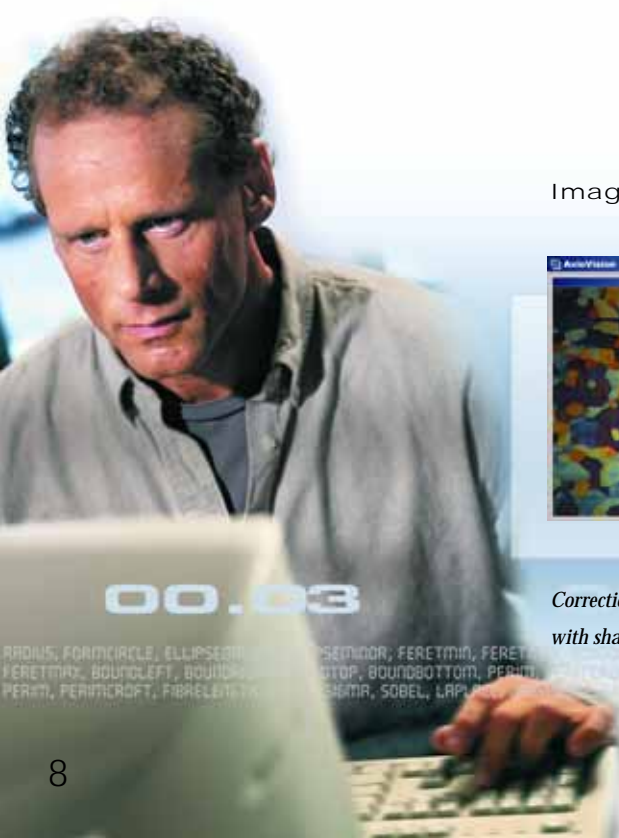
From scale bars and color markings right up to text and graphic elements – with AxioVision you can add all important annotations to your images. Since everything is in one package, you don't have to use other software for image processing. The corresponding scale is stored with each image, and scale bars can be interactively added at any time.

### Precise image measurement

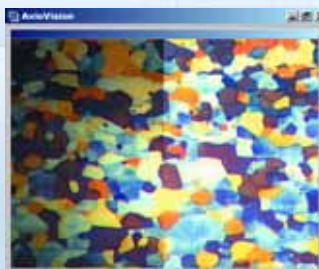
With the entry-level program, you can easily perform interactive measurements, such as length, area, and angles with the option of optimizing your workflow with the help of a measurement wizard. The measurement data are available in a list, which can be easily exported to most spreadsheet programs, such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

### ZVI images

ZVI: the image format that stores your image data together with image number, acquisition date, microscope settings, exposure data, size and scale data, contrasting technique used etc. The advantages are obvious – the image information is available at any time. In addition, annotations are not permanently burned into the image, but are stored in a file together with the image data. The image can be reproduced even years later under identical conditions.



#### Image processing



*Correction of illumination error (left: with shading; right: corrected).*

#### Text and graphic elements



*Cross-section of film with color layers indicated.*

#### Image measurement



*Clinker material in transmitted light, phase determination.*

# Basic program

## Efficient image archiving

Storing images in an electronic archive gives users an organized, space-efficient, and easy alternative to boxes of 35 mm slides. Digital data can be stored for years to come – with no loss in quality. In addition to images, you can store microscope parameters such as objective setting and filter position as well as annotations and comments directly in the image. The benefits of a digital archive are:

- fast, flexible search functions via image and specimen name, date, or other designations
- clear overview of all information recorded with the image
- use of CD, MOD etc. drives for large amount of data

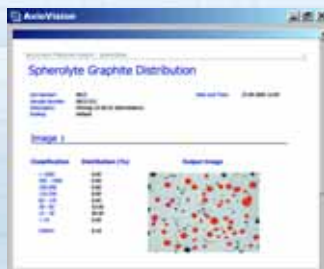
## Convincing documentation

Whether using individually formatted or predefined layouts, AxioVision gives you all the options you need to generate effective reports or presentations:

- predefined layouts for combining image and comments in various formats
- layouting functions

ZVI

Reports



# Image Acquisition Modules: Enhanced Performance

The results of your work are only as good as the quality of the information the images yield. AxioVision offers you specially designed modules to expand your image acquisition functions. These optional modules provide you with the added information that is crucial for high-quality images.

## Mark&Find

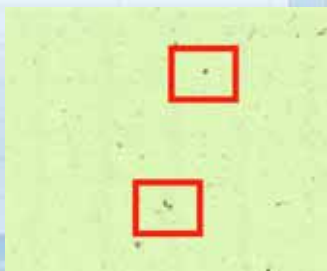
This module is used to record, store, and automatically retrieve different positions on your specimen. It requires the use of motorized x/y stages. The positions on the sample are stored together with the recorded image and can be used to reposition the sample at a later stage. Lists of positions can also be imported. Your advantage: time saving, reliable documentation of the sample, while keeping statistical accuracy. Multiple data-sets can be extracted from the same sample.

## Autofocus

The Autofocus module calculates the optimal focal position for a sample in reflected light and transmitted light. The system is calibrated for each objective so that the software focuses accurately every time. In addition, with images that are recorded at different positions, the system automatically refocuses. The Autofocus module works with all cameras that are directly controlled by AxioVision, providing that a micro-scope with motorized focus drive is used.

## MosaiX

Developed to analyze large surfaces, MosaiX permits the area of a specimen to be scanned in order to generate one single large image. This electronically created image can thus serve as a map to navigate the specimen and provides a basis for further analyses. In addition, the specimen only has to be scanned once.



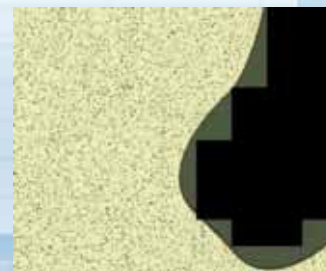
Mark&Find



Autofocus



MosaiX



1.

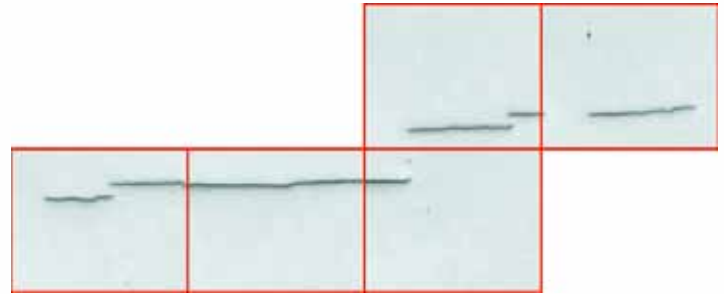
2.

*Figs. 1 and 2: Ceramic cog wheel. The overview image permits easy navigation. The details are needle-sharp.*

# Image acquisition

## Panorama

This module is ideal for specimens which do not fit into the image frame. High-resolution panorama or overview images can be formed with pixel accuracy from individual shots. Even overlapping images can be combined so precisely that all the important details of your specimen are recorded in a single image.

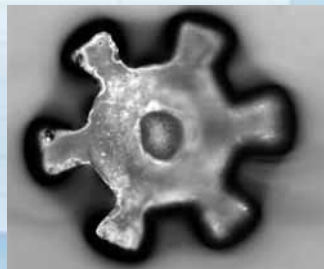
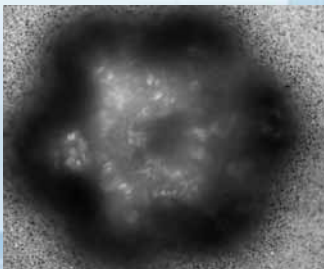
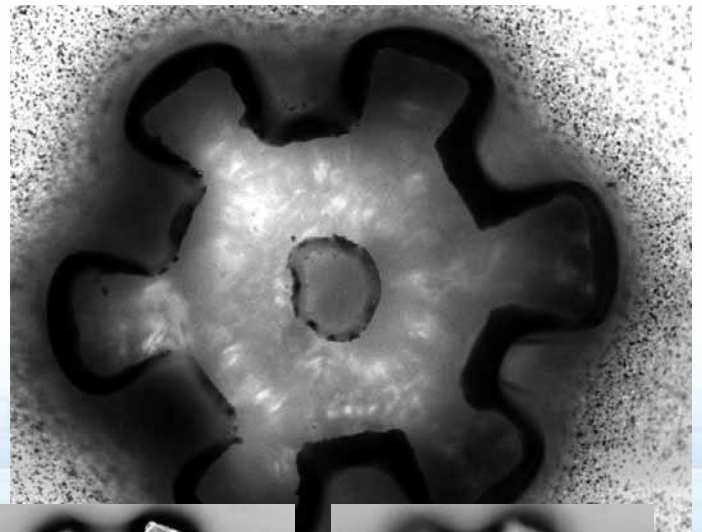


*After forming the overview image out of five individual shots, it is easy to accurately and precisely interpret the sample.*

## Extended Focus

A microscope's depth of field is often not sufficient to obtain a single image which is sharp over the whole field. The software solution to this problem is the Extended Focus module. How it works is simple and ingenious. While focussing through your sample, you record a number of images at different focus positions. Then it extracts the sharp details from each individual shot to calculate a final image that is rich and sharp in every detail.

*Single shots from different focal planes of the surface of a MEMS device (Micro-Electro-Mechanical-System). With Extended Focus, users can achieve an image that is sharp across the whole field.*

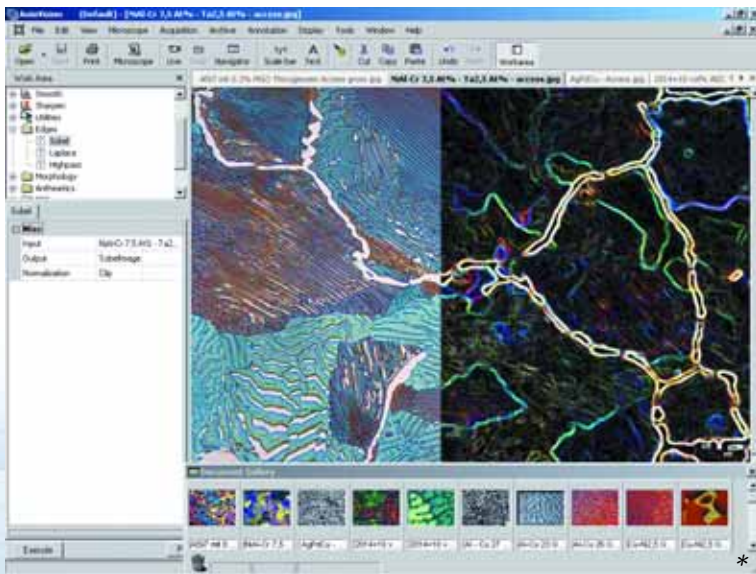


Extended Focus

# Image Processing Modules: Added Insights

Seeing what your eyes wouldn't normally see: Imaging Plus offers you all the important digital image processing and analysis techniques you need in a single module. Each image is processed so that you attain the best analytical results from each step.

## Image enhancement



*Precise edge detection with Sobel filter.*

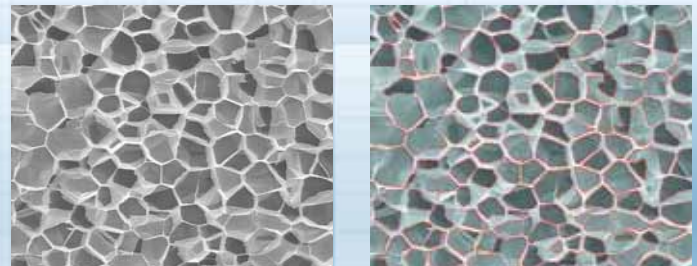
## Imaging Plus

- Image enhancement  
In addition to improving contrast, brightness, and color, this function compensates lighting deficiencies and shading. Included are filters for smoothing, sharpening, and edge detection.

- Gray morphology  
An ideal tool for grain size analysis, morphology functions permit the exact reconstruction of the borders of joined objects. With this advantage, single objects can be precisely separated from each other.

- Image arithmetics  
The process of calculating a new image from existing images pixel-by-pixel: AxioVision Imaging Plus permits quantitative combination and comparison of images.

## Gray morphology

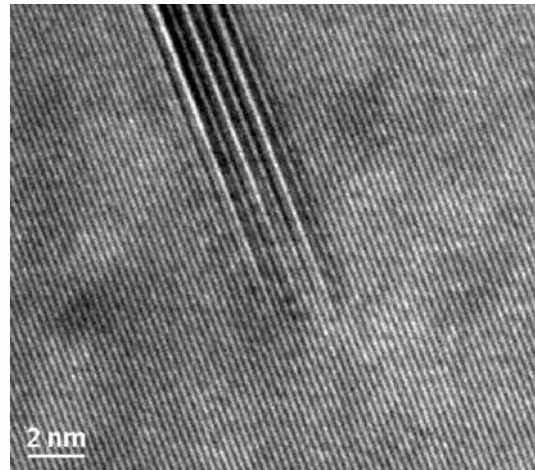


*Morphology functions permit the exact reconstruction of particle borders, thus preparing them for automatic measuring.*

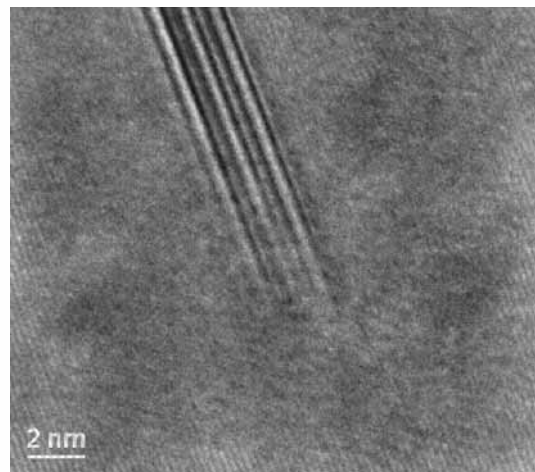
\* Pictures with the permission of ACCESS e.V., Aachen and Foundry Institute of RWTH Aachen, Germany.

# Image processing

- **Fourier transformation**  
For efficient filtering and restoration of images. The module allows the customer to freely retain or eliminate parts of the images frequency spectrum.
- **Transformation of color models**  
This functionality permits color discrimination for better separation of objects from their background as well as color independent image processing.



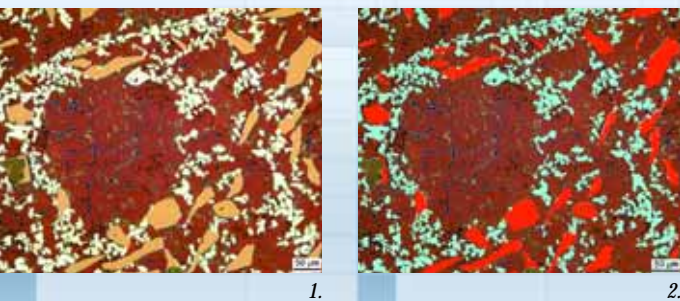
1.



2.

*Disturbances in the image such as sinusoidal artifacts (fig. 1) can be effectively eliminated through the use of Fourier transformation (fig. 2). Fig. 3 shows the parts of the spectrum, which were eliminated.*

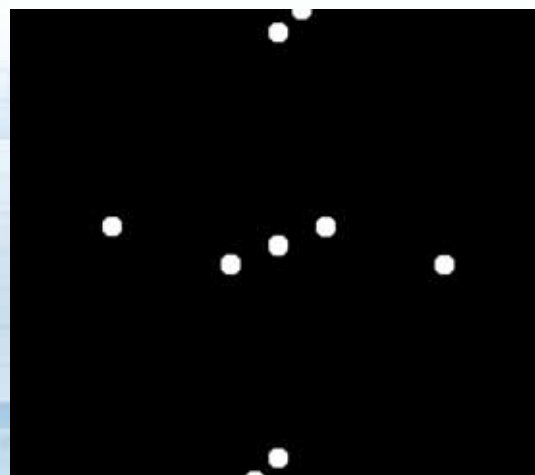
## Transformation of color models



1.

2.

- Fig. 1: Brightfield shot of composite material, contrasted with PtOx.*  
*Fig. 2: Two different phases were detected through color segmentation. The result was superimposed in color (red, turquoise) on the original.*



3.

# Image Analysis Modules: Uncompromising Precision

Utilizing all the information of an image: AxioVision offers you a powerful spectrum of additional modules for image analysis. Both interactive and automatic, they range from complex segmentation techniques to sophisticated measurement options. In addition, the measurement wizard allows you to create your individual measurement program. Fast and easy. The advantages of all AxioVision modules are standardized processes, uncompromising precision 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 shall be taken. All parameters are then executed in the specified order. As a result, geometric and densitometric parameters are presented in a straightforward measurement list, to 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 Excel).

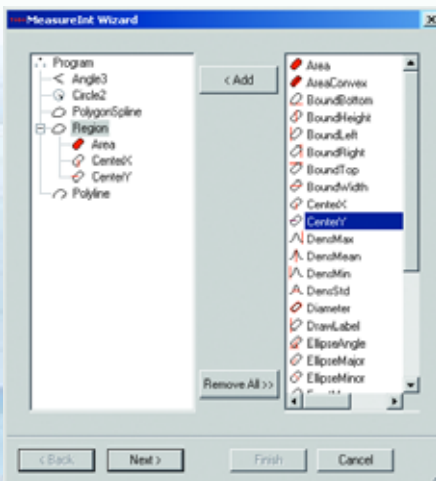
## AutoMeasure

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. Even automatic processes can be interrupted at any time and all parameters individually adjusted with the function dialog.

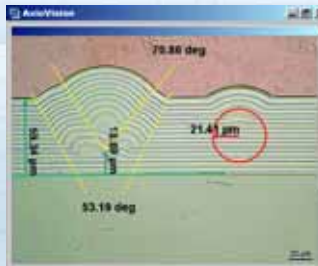
## AutoMeasure Plus

Recording the entire structure of the image completely automatically – now possible in a single measurement step with this module. The result: fast, precise and reproducible quantitative analyses. Further advantages: 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

## Measurement parameters

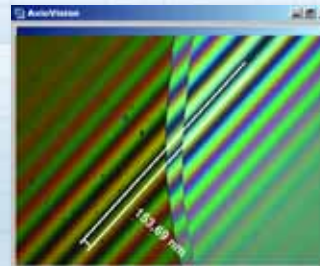


Interactive Measurement



Interactive measurement of electroplated layers in several relevant spots.

TIC Measurement



TIC measurement with 10x lens on amorphous ZrO<sub>2</sub> layer: 154 nm.

# Image analysis

work steps in a single command – ideal for the automatic processing and reproducibility of standard lab assignments. This module consists of three functionality groups:

- **Segmentation**

This function offers threshold operators for monochrome and color images necessary to identify the objects based on gray color values. The objects can also be quickly identified at a mouse click using "region growing". These methods are supplemented by complex methods for segmentation, including dynamic and automatically generated threshold as well as edge detection.

- **Binary image processing**

Numerous functions ensure that the binary image is optimally prepared for measurement. They include linking, masking, and filling voids. Artifacts can be removed easily and contours smoothed. During "skeletonizing" objects are thinned to a 1-Pixel-line or separated from each other using a background skeleton.

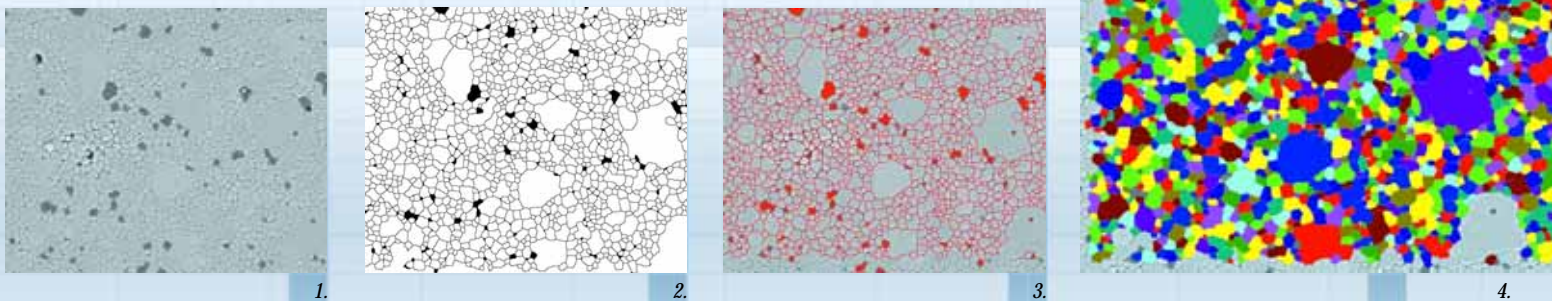
- **Automatic measurement**

Morphometric measurement parameters are generated by the contour of the specimen. The software uses the binary image as a mask to calculate geometric and densitometric parameters from the original image. Their export into Excel enables statistical information about specimen details.

### TIC Measurement

The TIC module (Total Interference Contrast – only in combination with the TIC slider from Carl Zeiss) allows 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 through to several micrometers. The advantage of the TIC 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, eliminating the need for stage rotation. It is even possible to analyze samples with large surface areas.

## AutoMeasure Plus



Automatic analysis of ceramic material. Segmentation through edge detection (white particle borders, fig. 1). Inverting of binary image (fig. 2), automatic measurement (fig. 3), and result depicted in color image (fig. 4).

# Archive Modules: Superior Data Management

**AxioVision Cumulus** – with this powerful software module you can manage your image, text and graphic data as digitally stored assets. Available in either a single user or network-compatible workgroup edition. You can catalog your data and classify them according to category or keyword. You can add annotations and comments in addition to calling up metadata from the files in order to list, export, and further process them. The basis for compatibility with other databases is ODBC, Open Data Base Connectivity.

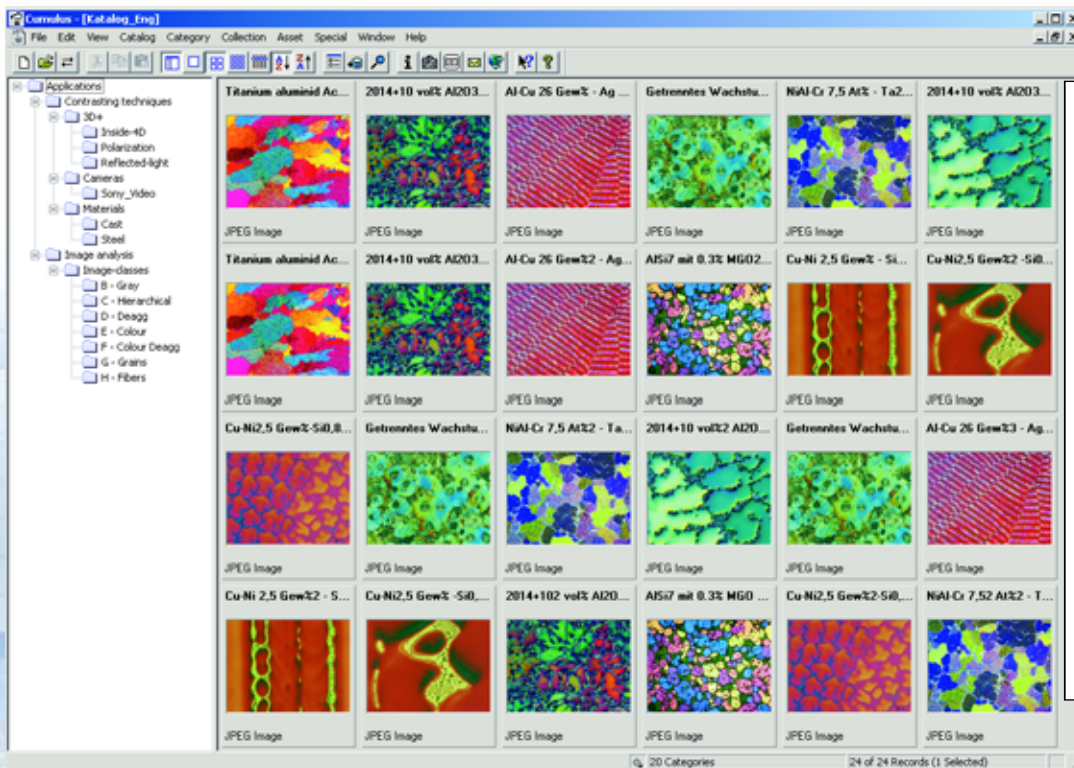
## Easy searches

A tremendous advantage for you is that assets can be classified into several categories (e.g. type of sample or contrasting technique). A double click on one or more categories provides you with all relevant records. Efficient searches with more than one search condition are easy to conduct and can be stored, if desired.

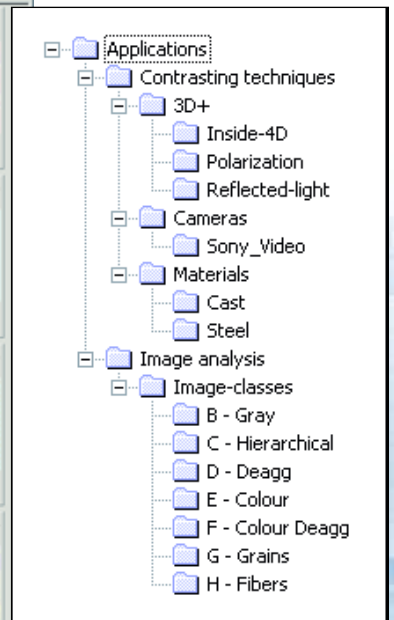
## Managing assets

A module with advanced archiving capabilities, AxioVision Cumulus displays your assets on the monitor together with text and graphic elements of your images. Moreover, you can present your assets as a slideshow, together with audio notes and teaching material. AxioVision Cumulus facilitates the publication of your results on the

## AxioVision Cumulus



## Archiving



*Creating individual database structure with categories and sub-categories is clear, interactive, and can be checked immediately.*

*Available in either a single user or network-compatible workgroup edition, AxioVision Cumulus is a powerful software module for data management and archiving.*

Internet (access via hyperlinks). Sending preview catalogs to your colleagues makes it easy for them to view your results. Additional modules permit the integration of further file formats (ppt, pdf) in catalogs or searches.

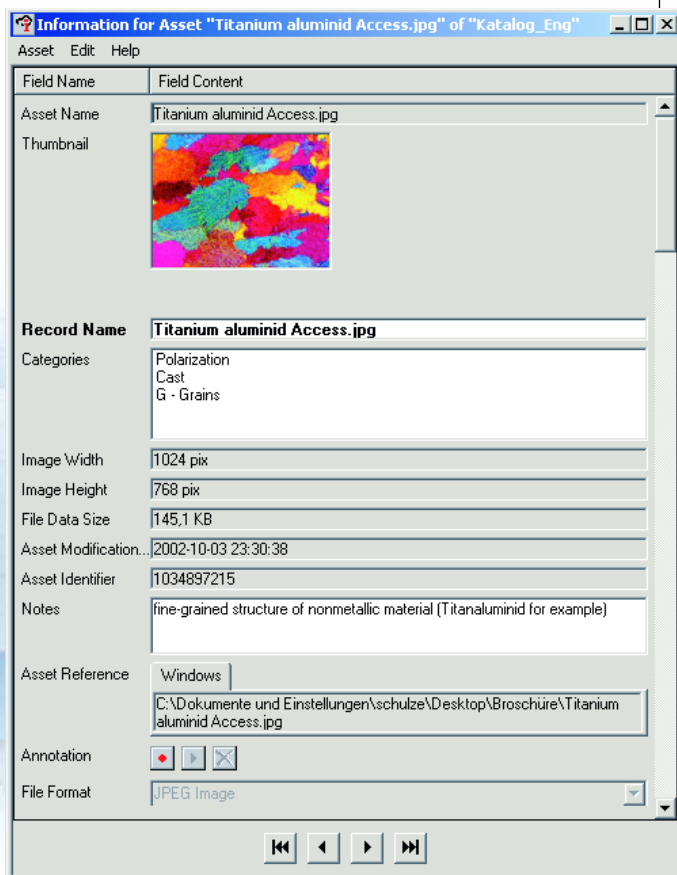
## Cumulus Workgroup

Cumulus Workgroup provides a client server solution for image management, where data are stored centrally on a file server. Workgroup members can access these systems efficiently and securely as "clients". For every catalog in the search path, access can be regulated according to user rights.

*AxioVision Cumulus facilitates the management of images and data.*

## Printout

Information window



\* Pictures with the permission of ACCESS e.V., Aachen and Foundry Institute of RWTH Aachen, Germany.

# Configuration Modules: My AxioVision

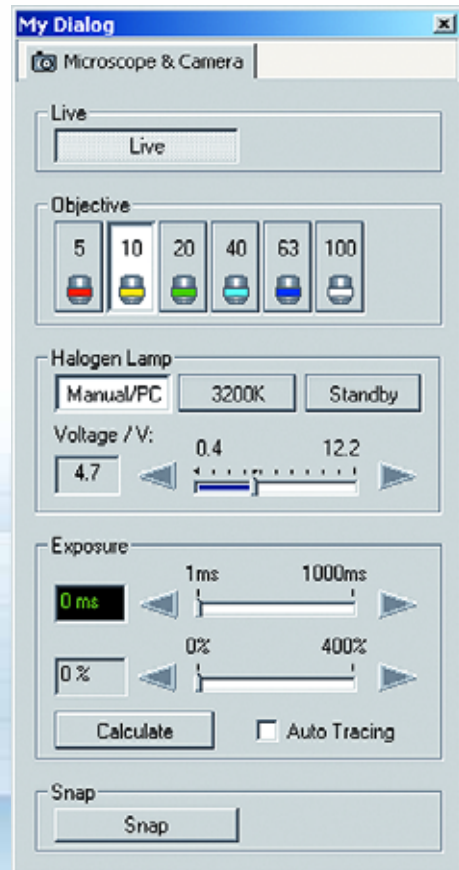
AxioVision provides a unique range of options to create individualized interfaces and functions. This is ideal to simplify and optimize digital microscopy according to transparent workflows. Already the entry-level program of AxioVision gives you the freedom you need to create your own personal working environment. You can configure individual toolbars or combine operating elements necessary for camera and microscope control in new dialog boxes. Moreover, you can add or omit elements, depending on what you need for your work. The efficiency of these configuration possibilities available in the entry-level package can be further increased with the Commander and VBA module.

My Dialog

Toolbar



User-defined toolbar for image acquisition, addition of scale bar and comments, archiving.



Individual dialog to operate microscope and camera.

# Configuration

## Commander

The Commander module allows you to record steps for image acquisition, processing, and measurement in a single command. The benefits are impressive: automatic processing of typical measurement assignments and complete reproducibility of the results in addition to fast adaptation to new lab assignments.

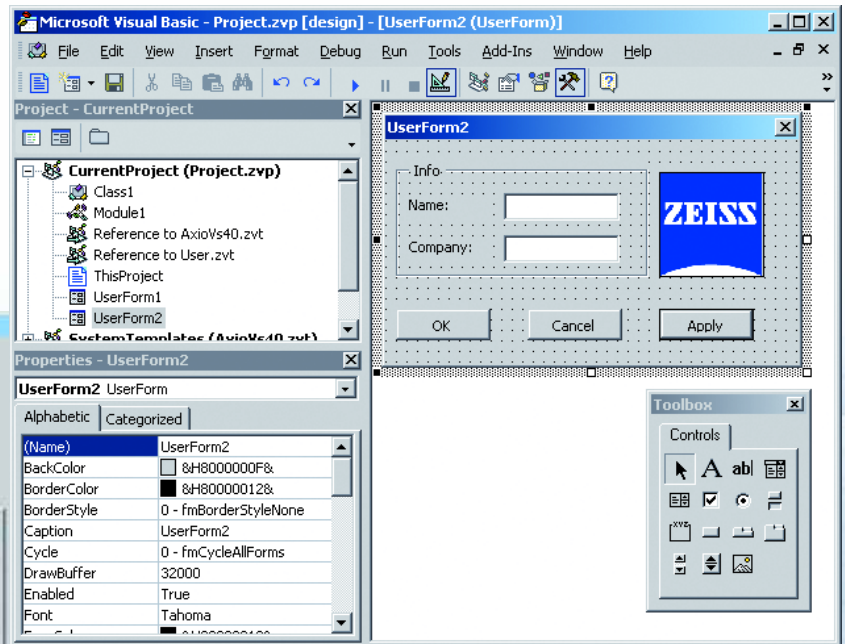
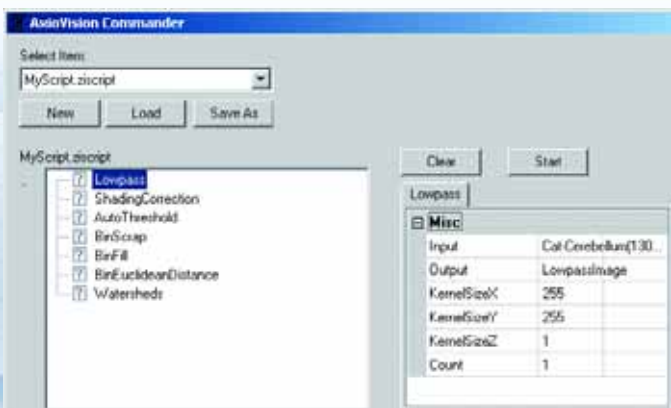
## VBA

Perhaps you need more functions than the wide range that AxioVision provides. In this case, it is possible to increase and extend the performance of Carl Zeiss software 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 big advantage: a minimum of training time for the users of individually developed software.

## VBA

## Commander



Recording work steps for automatic processing.

Programming environment to develop individual solutions in AxioVision.

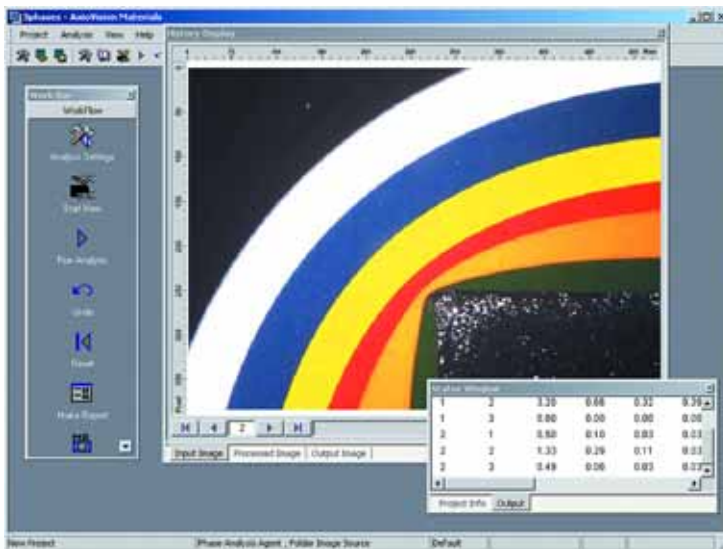
# Customized Solutions: Application Kits

**AxioVision's tailor-made solutions save you routine work and time. Its dialogs are easy to operate. All you have to do is enter the specimen data and take images!**

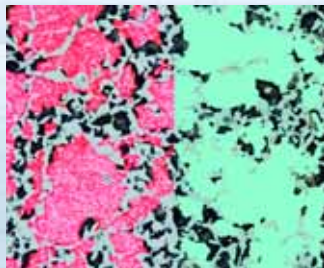
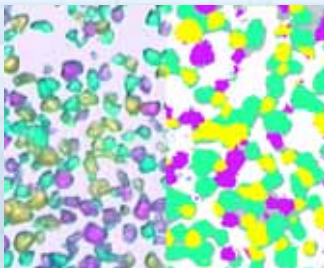
## AxioVision Multiphase - particle size analysis

This system measures particle sizes and volume percentage completely automatically, yielding high quality results. The user only needs to describe the specimen and record the images while the software does the rest – rapidly, reliably, and precisely. Every image and the entire specimen are recorded and evaluated, additionally the data and settings are stored in a database.

*Corrosion protection made of sintered lacquer layers.*



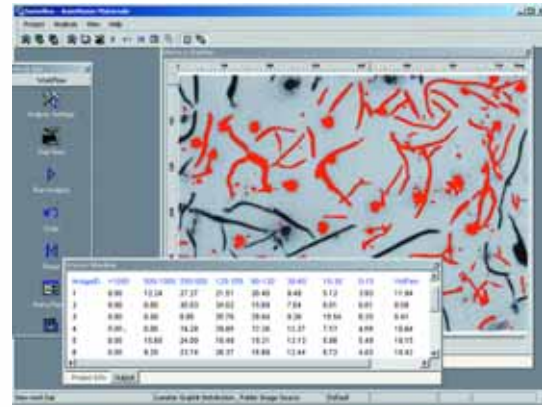
*Evaluation report.*



Particle size analysis with AxioVision Multiphase

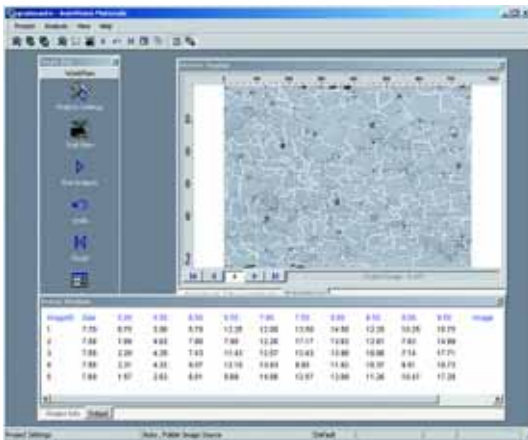
# Application kits

*Cast iron with lamellar graphite.*



## AxiVision Grains - grain size measurement

A particularly fast automatic analysis which allows you to fulfill DIN 50601, ASTM E112, and other standards completely automatically. Your advantages: fewer work steps, maximum throughput, high precision and reliable reproducibility. Complex image analytical algorithms permit extremely fast recognition, reconstruction and evaluation of the grains. The images are preprocessed and artefacts removed while grain boundaries can be clearly reconstructed, even in complex structures.



*Automatic evaluation of grain sizes in ferritic steel.*

## AxiVision Graphite - cast iron evaluation

With this solution, you can record the form and size of graphite particles - fully automatically and in consistently high quality. The data are available for documentation, export, and evaluation. The following evaluations are available:

### Nodule sizes

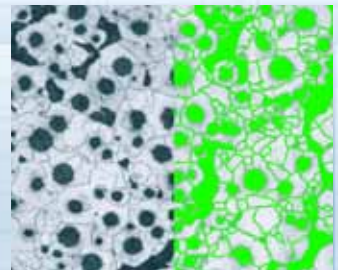
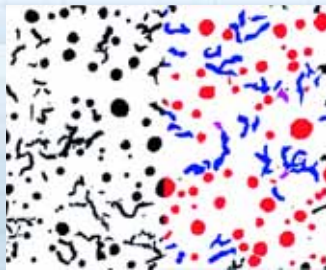
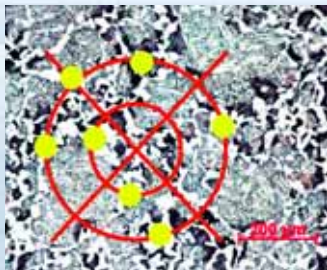
- Records size distribution and volume percentage
- Also evaluates particles which are not round

### Lamellar graphite

- Records and quantifies size distribution and volume percentage
- Detects artefacts and evaluates them separately

### Nodularity evaluation

- Determines vermicular and nodular cast iron and the intermediate forms according to SinterCast Technologies AB
- Determines the nodularity (relative proportion of cast iron) of the sample



Grain size measurement using cord length with AxiVision Grains

Cast iron evaluation with AxiVision Graphite

Image Acquisition	Functions	Contents/Description
<b>Image Formats:</b>	<ul style="list-style-type: none"> <li>Image import</li> <li>Image export</li> </ul>	bmp, tif, jpg, gif, tga, png, j2k, jp2, mac, msp, ras, pct, eps, wmf, psd, img, cmp, zvi, lsm, czi bmp, jpg, tif, tga, png, psd, cmp, avi, lsm, mov, j2k, jp2, pcx, tga, wmf, pcf
<b>Camera Control*:</b>	<ul style="list-style-type: none"> <li>Exposure time adjustment</li> <li>Gray value scaling</li> <li>Digital gain</li> <li>White balance</li> <li>3200 K</li> <li>Resolution</li> <li>Binning</li> <li>Histogram</li> <li>Color adjustment</li> <li>Frame</li> <li>Black reference</li> <li>White reference</li> <li>Image orientation</li> <li>Shutter control</li> <li>Live image frame rate</li> <li>Focus/exposure frame</li> </ul>	Manual adjustment, exposure time measurement, automatic mode Conversion to 8 bit dynamic range Adjustment of digital signal amplification Interactive or automatic adjustment of optimum neutral balance of the color channels Default value for white balance, optimized for halogen light source at 3200° K Selection of Microscanning resolution modes (AxioCam HR) Increased camera sensitivity by combining the signals of adjacent pixels Intensity distribution histogram for all three color channels Manual adjustment of the color reproduction of the white balance Interactive selection of a image sensor sub frame Image background optimization for low light level applications Correction of optical and illumination inhomogeneities in bright background Rotation and mirroring of image orientation for optimum image display Trigger of external shutter, synchronous to image acquisition Selection: slow/medium/fast Activation of measurement frame for focus and exposure information
<b>Image Processing</b>		
<b>Annotate:</b>	<ul style="list-style-type: none"> <li>Annotation</li> </ul>	Addition of text, marking of elements (arrows, scale bars, etc.)
<b>Adjust:</b>	<ul style="list-style-type: none"> <li>Brightness/contrast</li> <li>Color Balance</li> </ul>	Adjustment of brightness, contrast and gamma Manual adjustment and readjustment of color rendition
<b>Lightness:</b>	<ul style="list-style-type: none"> <li>Hue/Lightness/Saturation</li> <li>Shading correction</li> </ul>	Adjustment of hue and saturation Correction of uneven illumination
<b>Geometric Transformation:</b>	<ul style="list-style-type: none"> <li>Pixelshift</li> <li>OrthoView</li> </ul>	xyz-shift with subpixel-accuracy Display of orthogonal 3D image cub
<b>Smooth:</b>	<ul style="list-style-type: none"> <li>Gauss, Sigma</li> </ul>	Image smoothing using gauss or sigma filter
<b>Sharpen:</b>	<ul style="list-style-type: none"> <li>Enhance Contour</li> </ul>	Image sharpening using contour enhancement
<b>Resample:</b>	<ul style="list-style-type: none"> <li>Resample</li> </ul>	Image zoom-out and zoom-in
<b>Image Analysis</b>		
<b>Interactive measurement tools and parameters:</b>		
<ul style="list-style-type: none"> <li>Scaling</li> </ul>		Scaling in geometric units
<ul style="list-style-type: none"> <li>Length</li> </ul>		Distance between 2 points
<ul style="list-style-type: none"> <li>Outline</li> </ul>		Measurement of diameter, area, perimeter, length and width of the circumscribing rectangle, radius, center of gravity, mean density, standard deviation of mean density of gray value
<ul style="list-style-type: none"> <li>Angle 3, Angle 4</li> </ul>		Definition through 3 or 4 points
<ul style="list-style-type: none"> <li>Circle</li> </ul>		Measurement of diameter, area, perimeter, length and width of the circumscribing rectangle, radius, center of gravity, mean density, standard deviation of mean density of gray value
<ul style="list-style-type: none"> <li>Events</li> </ul>		Counting of events
<ul style="list-style-type: none"> <li>Interactive Measurement Wizard</li> </ul>		Directed interactive measurement
<b>Documentation</b>		
<ul style="list-style-type: none"> <li>Image gallery</li> </ul>		Clear presentation of loaded images as thumbnails
<ul style="list-style-type: none"> <li>Search functionality</li> </ul>		Full text search in all information fields
<ul style="list-style-type: none"> <li>Information window</li> </ul>		Display of all information on the image
<ul style="list-style-type: none"> <li>Printing of images/data</li> </ul>		Print of images
<ul style="list-style-type: none"> <li>Reports</li> </ul>		Creation of user definable reports
<b>Configuration</b>		
<ul style="list-style-type: none"> <li>Toolbars/Dialogs/Workflows</li> </ul>		Creating individual toolbars, dialogs and workflows
<ul style="list-style-type: none"> <li>Short-cuts</li> </ul>		Allocation of keyboard entries with AxioVision functions

\* Depending on the camera used

Module	Functions	Contents/Description
<b>Mark&amp;Find</b>	<b>Recording and retrieving of specimen</b>	
	• Database	Management of projects and samples in a database
	• Mark interactively	Color assignment of sample positions in the database
	• Visualize	Visualization of the selected points. Relocation by clicking on the colored marker
	• Focus position	Relocation with optional use of stored focus position
	• Calibrate	Calibration using a "Home slide"
<b>Autofocus</b>	<b>Automatic Focusing</b>	
	• Calibrate	Calibration by specifying the optimum focus position, usage of current microscope settings with motorized microscopes
	• Focus	Automatic calculation of the focus plane. Suited for transmitted light, reflected light as well as bright field, dark field, fluorescence
<b>Extended Focus</b>	<b>Calculation of sharp images from several focus positions</b>	
	• Execute	Capture of an extended depth of focus image by combining images of different focus positions
<b>MosaiX</b>	<b>Automatic scanning of large surfaces</b>	
	• Execute	Scanning of entire sample (motorized stage required)
<b>Panorama</b>	<b>Formation of overview images</b>	
	• Execute	Seamless composition of images
<b>Imaging Plus</b>	<b>Processing, Gray Morphology, Fourier Transformation, Color Transformation</b>	
	• 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, Shift	Rotation around an axis
	– Mirror	Mirror along horizontal or vertical axis
	– Alignment	Alignment of two images using reference points
	• Smooth	
	– Lowpass	Lowpass filter (floating average value)
	– Median	Median filter (non-linear method)
	– Rank	General rank operator
	• Sharpen	
	– Delineate	Enhancement of edges
	• Edges	
	– Sobel	Edge detection using Sobel filter
	– Laplace	Laplace filter
	– Highpass	Highpass filter
	• 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

Module	Function	Contents/Description
	– Maximum, Minimum	Maximum or minimum of two images
	– Square, SquareRoot	Square or squareroot of an image
	– Logarithm, Exponential	Logarithm or exponent of an image
	– Combine	Linear combination of two images
	• Fourier Transformation	
	– 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 Channels	Split RGB image into single color channels
	– Combine Channels	Combine single color channels to a color image
	– Convert Pixel Format	Conversion of pixel formats (e.g. "8 bit integer" to "float")
	– User Filter	Filtering an image with used defined filter matrix
<b>Interactive Measurement</b>	<b>Expanded interactive measurement techniques</b>	
	– Distance, Line, Calipers	Measurement of length
	– Multiple Calipers	Measurement of the length of multiple lines, perpendicular to a base line
	– Multiple Distance	Measurement of distance between multiple parallel lines and a base line
	– Curve, Curve (Spline)	Measurement of length of the drawn curve
	– Aligned rectangle or free orientation, outline, outline (spline), circle	Measurement of geometric and densitometric object features
	– Circle	Drawing of a circle from the contour to the center, clicking on contour points
	– Marker	x- and y- coordinates of a point
	– Interactive Measurement Program Wizard	Guided generation of a program for interactive measurement
<b>AutoMeasure</b>	<b>Creation of easy measurement programs with a measurement wizard</b>	
<b>Creation of measurement programs</b>	• 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
	– Binary image clean-up	Deletion of artefacts, filling of holes
	– Automatic object separation	Erosion and dilation, watersheds
	– Interactive 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
	– Definition of measurement conditions ("objectfilter")	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 an Excel-compatible file format (csv)
<b>Execution of measurement programs</b>	– Image acquisition	Image acquisition via camera, all images of a folder, all loaded images
	– Autom. assignment of scaling	With ZVI image format
	– Control of program execution	Activation/deactivation as well as changing of a function during the program execution
	• Program information	
	– Display	List of executed functions with parameter settings

Module	Function	Contents/Description
<b>AutoMeasure Plus</b>	<b>Segmentation, binary image processing, automatic measurement</b>	
	• Segmentation	
	– Thresholds	Adjustment of thresholds using histogram
	– RegionGrowing	Detection of associated regions (gray values within user defined tolerance level)
	– Automatic	Automatic determination of thresholds using a histogram
	– Dynamic	Threshold detection by 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 processing	
	– Bin Erode, Bin Dilate	Erosion or dilation of binary objects
	– Bin Open, Bin Close	Erosion followed by dilation or dilation followed by erosion
	– Bin Fill, Bin Scrap	Filling of holes, removal of artifacts
	– AND, OR, XOR, NOT	Bitwise logic operation on the image
	– Bin Endidean Distance	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 1 pixel wide lines (skeleton)
	– Exoskeleton	Skeletonize the image background
	• Measure	Automatic measurement of geometric and densitometric object features
<b>TIC Measurement</b>	<b>Optical height measurement in the nanometer range</b>	
	• TIC Measurement	Automatic measurement of heights
	– Parameter setup	Phase shift substrate-vacuum, phase shift thin layer material-vacuum, objective and aperture
<b>Cumulus</b>	<b>Image cataloging and archiving</b>	Single User      Workgroup
	Organizing catalogs, categories and key words	X                      X
	Storage of assets on a server	X
	Network access for workgroup members	X
	Central management of access rights	X
	Local administration of catalogs	X                      X
	Data and category fields	X                      X
	Voice annotation for assets	X                      X
	Free definable queries to all data fields	X                      X
	Short response time to complex queries	X                      X
	Asset export to HTML	X                      X
	On the fly e-mail assets	X                      X
	TCP/IP Client/Server architecture	X
	Access to the same pool of assets – even from different operating systems	X
	User rights control for asset access	X
	ODBC compatibility	X                      X
<b>Commander</b>	<b>Recording and automatic execution of steps</b>	
	Protocol, save	Record procedures and save protocol
	Start	Automatic run of recorded protocol
	Edit	Edit protocol
<b>VBA</b>	<b>Programming environment</b>	
	Visual Basic Editor	VBA environment with full access to AxioVision functionalities

Entry-level program	IM: Interactive Measurement	IM incl. measurement assistant	AutoMeasure		
<b>Region specific parameters</b>					
				• Geometric	
		X	X	AcpX, AcpY	x- and y-coordinates of the top object point
X	X	X	X	Area	Area of the region
		X	X	AreaConvex, AreaFilled	Area of the convex shell of the region and of the filled region
X	X	X	X	CenterX, CenterY	x- and y-coordinates of the geometric center of gravity of the region
		X	X	EllipseMajor, EllipseMinor	Length of the main axis and the secondary axis of the ellipse with the same geometric moment of inertia as the region
		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	BoundTop, BoundBottom, BoundLeft, BoundRight	x- and y-coordinates of the bounding box
X	X	X	X	BoundWidth, BoundHeight	Width and height of the bounding box
		X	X	AreaFrame	Area of the measurement frame
		X	X	FeretMinimum, FeretMaximum	Minimum and maximum feret of the region
		X	X	FeretMinimumAngle, FeretMaximumAngle	Angle of the minimum and the maximum feret of the region
		X	X	FeretRatio	Ratio of the ferets ( $\frac{FeretMin}{FeretMax}$ )
X	X	X	X	Diameter, radius	Diameter, radius of the circle with equivalent area
		X	X	FormCircle	Circular shape factor of the region
		X	X	FibLength	Length of a fiber-like thin region
		X	X	ID	Explicit characteristic of the region, of the squares
X	X	X		Distance measurement	Distance between 2 points
X	X	X		Angle measurement	Angle in °
				• Densitometric	
X	X	X	X	Mean	Densitometric mean value of the region (gray and color values)
X	X	X	X	Standard deviation	Standard deviation of the densitometric values of the region (gray and color values)
		X	X	Minimum, Maximum	Minimum and maximum densitometric value (gray and color values)
		X	X	Sum, Sum Square	Sum of the densitometric values of the region, sum of the squares (gray and color values)
<b>Field specific parameters</b>					
				• Geometric	
			X	FldArea	Area of all regions
			X	FldAreaPer	Percentage area of all regions in the measurement frame
			X	FldCount	Number of the measured regions
			X	FldPerim	Sum of all region perimeters
				• Densitometric	
			X	FldDensMean	Densitometric value of all regions (gray and color values)
			X	FldDensStd	Densitometric value standard deviation in all regions (gray and color values)
			X	FldDensMin, FieldDensMax	Minimum and maximum densitometric value in all regions (gray and color values)
<b>Further parameters</b>					
X	X			Counting events	
		X	X	Marker	

Application kits	Functions	Contents/Description
<b>AxioVision Grains</b>	<b>Grain size analysis</b>	
	User modes	1. Administrator mode – to set up and tune in the system 2. User mode – for routine measurements
	Evaluation agents	1. GrainsAuto – automatic Grain boundary reconstruction 2. GrainsCompare – evaluation by comparison tables 3. GrainsChord – semiautomatic measurement via chord lengths
	Display	Display of intermediate and final results
	Measurement	Measurements according to ISO, EN, ASTM, and JIS standards
	Reporting	User-definable reports, including statistics, tables, and sample images
<b>AxioVision Graphite</b>	<b>Analysis of shape and size of graphite particles</b>	
	User modes	1. Administrator mode – to set up and tune in the system 2. User mode – for routine measurements
	Evaluation agents	1. GJG – spherulite graphite evaluation – volume percent, size distribution 2. GJL – lamellar graphite evaluation – volume percent, size distribution 3. GJV – nodularity evaluation (SinterCast)
	Display	Display of intermediate and final results
	Measurement	Measurements according to ISO, EN, ASTM, and JIS standards
	Reporting	User-definable reports, including statistics, tables, and sample images
<b>AxioVision Multiphase</b>	<b>Automatic measurement of size and volume of particles</b>	
	User modes	1. Administrator mode – to set up and tune in the system 2. User mode – for routine measurements
	Interactive detection	Discrimination (black & white or color) of up to 8 phases
	Measurement of particle sizes and their distribution	– Measurement of up to 8 phases – Area, diameter of the circle with equivalent area, length maximum diameter, perimeter – Elliptical axes A and B, roundness – Volume of a sphere with a diameter equal to the diameter of the equivalent circle – Elliptical volume, color/gray level
	Definition of features	– Phase content, specific surface – Count, color/gray value
	Display	Display of intermediate and final results
	Reports	User-definable reports, including statistics, tables, and sample images

## More information:

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Subject to change