

Product Information

Particle Analyzer

Analyze Tiny Particles: Accurately and Reproducibly

INTERNET-LINK 

VIDEO/ANIMATION 

Version 1.0



We make it visible.

Secure Comprehensive Quality into the Nano Range

Particle Analyzer

Analyze Tiny Particles:
Accurately and Reproducibly

- › **In Brief**
- › The Advantages
- › The Applications
- › The System
- › Service

Particle Analyzer is a milestone for your quality controls. Particle Analyzer software supports the ISO 16232, VDA 19, and ISO 4406/07 standards. With the system solution from Carl Zeiss, you ensure that the required microscope settings are always selected correctly. You receive reliable, reproducible results independent of the user carrying out the analysis. With only a few mouse clicks, you can enter project data, create reports, and archive your results. Particle Analyzer is seamlessly integrated into the architecture of AxioVision software from Carl Zeiss. By carrying out correlative particle analyses, you expand the depth of information contained within your findings to include the results of element and materials characterization.



Particle Analyzer: Simpler. More Intelligent. More Integrated.

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Reproducible Results:

Your Needs Determine the Tool

The motorized microscope systems of your Particle Analyzer ensure that your settings are always correct – from the contrast method and selection of objectives, to the camera's exposure time and illumination settings. In conjunction with the automatic image analysis in AxioVision, you get reliably reproducible results. Itemized by quantity and size ranges, you can classify by non-metallic, metallic, and other reflective particles and fibers.

Easy Operation:

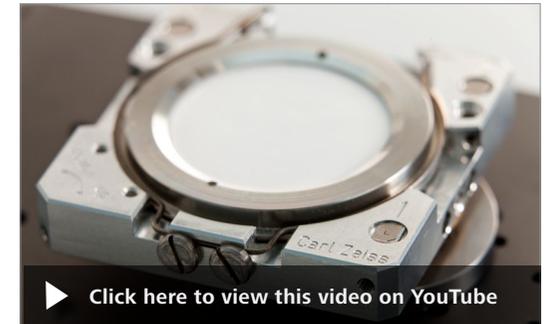
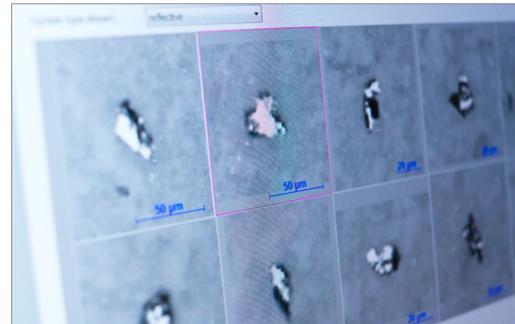
Based on Your Work Processes

The workflow of your Particle Analyzer is adaptable to your routines. You start the analysis, create a report, and archive it all with only a few clicks. You collect the results in a manner that is fit for real-world use: the system shows you all classifications and ISO codes at a glance. In the gallery and evaluation view, you gain a quick overview of all particle types: reflective, non-reflective, and fibrous. You can relocate interesting particles at the touch of a button. Use the convenient revision mode whenever you want to reclassify or edit particles.

Correlative Particle Analysis:

Shed Light on Your Material's Properties

Correlative particle analysis adds the results of your analysis with an electron microscope to the information gained from your analysis with a light microscope. At the touch of a button you can relocate particles found with the light microscope on the electron microscope. With the light microscope you can record the quantity, size distribution, morphology, and color of your particles. You can differentiate between metallic and non-metallic particles. With the electron microscope and energy dispersive spectroscopy, you also learn the elemental composition broken down by percent and the resulting material classification of your reflective particles.



Your Insight into the Technology Behind It

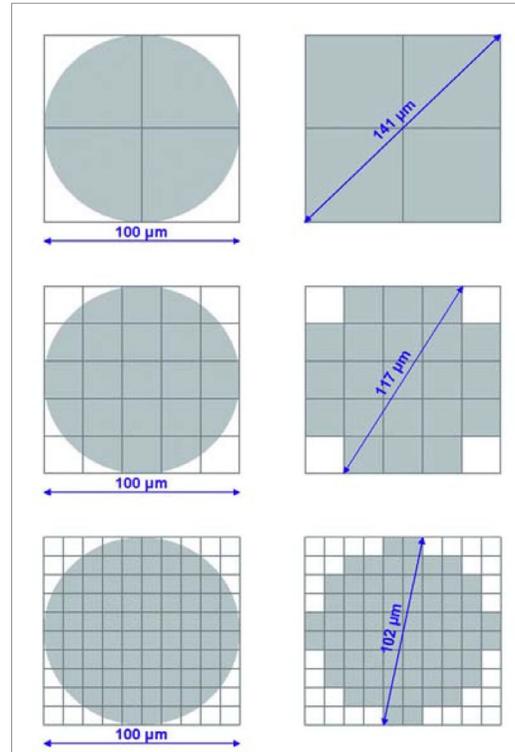
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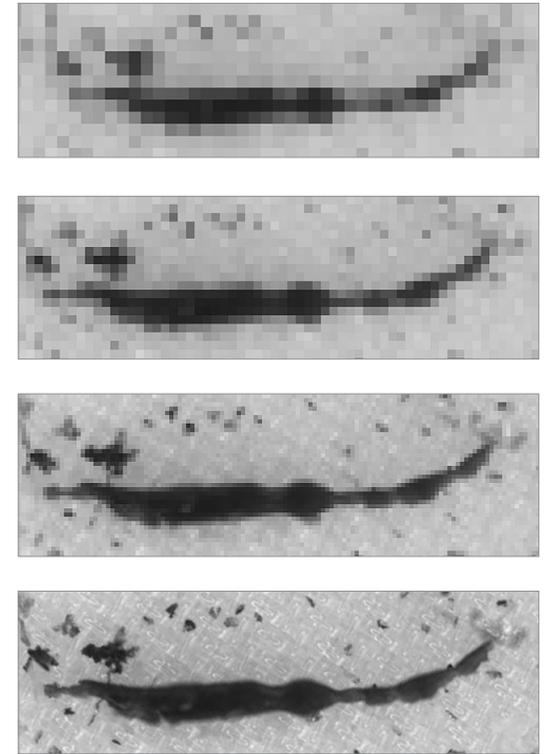
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Resolution: Theoretical Basics

The higher the resolution, the more accurate the presentation of your image. The higher the resolution, the larger the image size, and as a result, the time required to conduct the analysis. The theoretical foundation for the minimum resolution is set forth in the Nyquist–Shannon sampling theorem. The smallest detail to be resolved must be sampled with at least two pixels. When analyzing a circle, this means the circle would be sampled with four pixels. The result in the image would be a square. If the circle had a diameter of $100\ \mu\text{m}$, the analysis of the largest diameter would result in a value of $141\ \mu\text{m}$ – the analysis would be conducted with an error of over 40%. That’s why some guidelines require the sampling of the smallest particle to be carried out with 10 pixels – the result of the square analysis would be $102\ \mu\text{m}$, with an acceptable error of 2%.



Impact of the selected resolution on the accuracy of the analysis;
Left: Circle with a diameter of $100\ \mu\text{m}$ sampled with two, five, and ten pixels;
Right: Results of the analysis of the largest diameter



Improving the presentation of a particle by increasing the resolution

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Microscope and Camera Resolution

A camera only ever sees a portion of a sample. But ideally, the microscope's entire intermediate image should be reproduced directly on the camera's chip. In a light microscope, this intermediate image has a diameter of 18, 20, 23, or 25 mm. The sensors are usually much smaller, however. As a result, only a portion of the image visible through the eyepieces is recorded by the camera and displayed on the monitor. For example, a 1/2" CCD chip with an 8 mm diagonal only records 1/8 of the area of 18 mm. The resolution plays a key role when recording and analyzing microscopic images. In this context, a differentiation is made between the microscope's resolution and the camera's resolution. The microscopic or optical resolution at the object level describes the ability to differentiate between fine structures, i.e. the smallest perceptible

distance between two points. In contrast, the camera or image resolution describes the number of pixels which comprise a digital image. The higher the image resolution, the more detailed the presentation of the microscopic image, and the more accurate the results of the analysis. The ideal resolution for a lossless image depends on the resolution of the objective used and the camera adapter. In this context, two pixels are needed to display each pair of lines reproduced by the objective. If a camera adapter is used with image-narrowing optics, this must be factored into the calculation. The calculation of the required resolution at the object and sensor level is based on the following formulas:

$$\text{Resolution at the object level } (\mu\text{m/LP}) = \frac{0.33}{\text{Numeric aperture}}$$

$$\text{Resolution at the sensor level } (\mu\text{m/LP}) = \frac{\text{Resolution Object level} \times \text{Magnification Zoom factor} \times \text{Magnification factor Camera adapter}}{1}$$

To calculate the required minimum number of pixels for lossless image recording, the length and width of the camera's sensor are both divided by the resolution at the sensor level, and the result is then multiplied by two.

$$\text{Number of pixels X} = \frac{2 \times \text{sensor length } (\mu\text{m})}{\text{Resolution at the sensor level } (\mu\text{m/LP})}$$

$$\text{Number of pixels Y} = \frac{2 \times \text{sensor width } (\mu\text{m})}{\text{Resolution at the sensor level } (\mu\text{m/LP})}$$

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| Microscope | Zoom optics magnification factor | Numeric aperture | Resolution at the object level [µm/LP] | Resolution at the sensor level [µm/LP] | Number of pixels X | Number of pixels Y | Objective |
|----------------------|----------------------------------|-------------------------------|--|--|--------------------|--------------------|---------------------|
| Axio Imager 2 | 1.25 | 0.03 | 11.0 | 13.8 | 1232 | 1029 | EC Epiplan-NEOFLUAR |
| | 2.50 | 0.06 | 5.5 | 13.8 | 1232 | 1029 | |
| | 5.00 | 0.13 | 2.5 | 12.5 | 1360 | 1136 | |
| | 10.00 | 0.25 | 1.3 | 13.0 | 1308 | 1092 | |
| | 20.00 | 0.50 | 0.7 | 14.0 | 1214 | 1014 | |
| Axio Zoom.V16 | 1.00 | 0.047 | 7.0 | 7.0 | 2429 | 2029 | PlanApo Z 1.0x |
| | 2.00 | 0.083 | 4.0 | 8.0 | 2125 | 1775 | |
| | 4.00 | 0.145 | 2.3 | 9.2 | 1848 | 1543 | |
| | 5.00 | 0.175 | 1.9 | 9.5 | 1789 | 1495 | |
| | 8.00 | 0.238 | 1.4 | 11.2 | 1518 | 1268 | |
| | 10.00 | 0.247 | 1.3 | 13.0 | 1308 | 1092 | |
| SteREO Discovery.V12 | 1.00 | 0.022 | 15.0 | 15.0 | 1133 | 947 | PlanS 1.0x |
| | 2.00 | 0.039 | 8.5 | 17.0 | 1000 | 835 | |
| | 4.00 | 0.067 | 4.9 | 19.6 | 867 | 724 | |
| | 5.00 | 0.079 | 4.2 | 21.0 | 810 | 676 | |
| | 8.00 | 0.116 | 2.8 | 22.4 | 759 | 634 | |
| | 10.00 | 0.144 | 2.3 | 23.0 | 739 | 617 | |
| | Camera | Sensor size | | Camera adapter | | | |
| | AxioCam ICc 5 | 2/3"; 8.5 mm (L) × 7.1 mm (W) | | 1.0 × | | | |

The tables show microscope and image resolutions for selected figures from the Axio Imager 2 reflected light microscope, the Axio Zoom.V16 zoom microscope, and the SteREO Discovery.V12 stereo microscope. The resolution at the object level represents the smallest distance between two lines that the respective objective or zoom optics can resolve. The columns "pixel X" and "pixel Y" show the minimum number of camera pixels required for an optimal camera image at the respective level of magnification.

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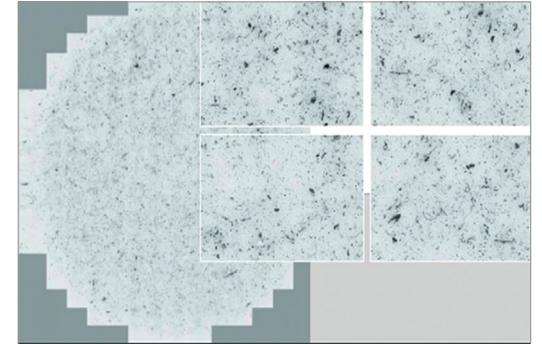
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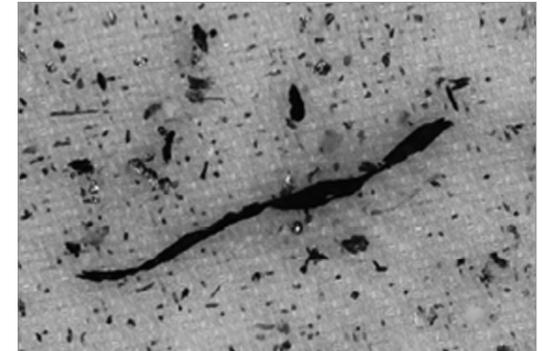
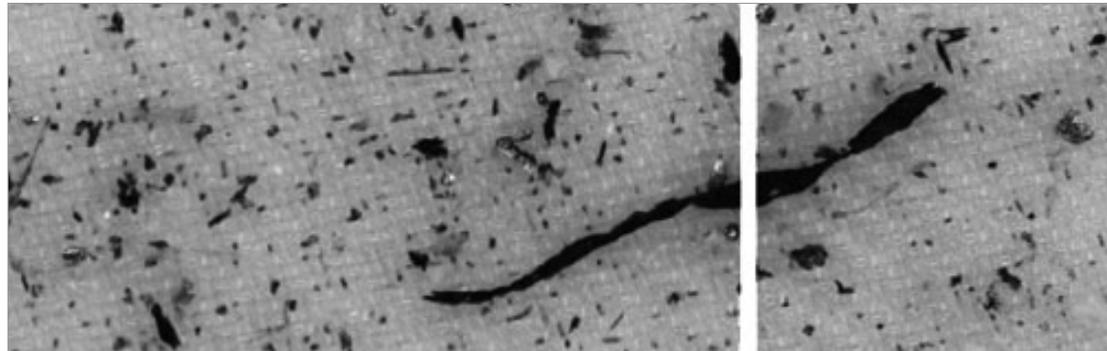
MosaiX

When analyzing component cleanliness, the quantity, size, composition, and origin of the residual particles is critical to the production process and the approval of technical and electronic parts. The resolution for recording small particles recommended in current technical guidelines automatically leads to the fact that only a very small section of a sample can be reproduced in an individual image. With the particle

analyzer system solution, you use motorized stages to analyze your samples, you record individual images, and then stitch them all together to form a large MosaiX image. Special analysis and processing algorithms ensure that particles spread across two images or small particles on the edge of an image are correctly recorded, analyzed, and measured.



Residual particles on the filter membrane; mosaic image comprised of over 200 individual images; microscope: Axio Imager 2; objective: EC Epiplan-NEOFLUAR 5x/0.13; camera: AxioCam MRC



Tailored Precisely to Your Applications

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| Typical applications; typical samples | Task | Particle Analyzer offers |
|--|--|---|
| Analyzing component cleanliness | Evaluating the cleanliness of components, i.e. determining the level of contamination after cleaning | Automatic analysis of the contamination level on the filter membrane with regard to quantity, size distribution, morphology, and type (reflective, non-reflective, fibrous), supporting ISO 16232, VDA 19, and internal standards after adjustment. |
| | Combined light microscope/electron microscope material classification | Upon adding the AxioVision correlative particle analyzer software module: automatically relocate selected particles analyzed by the light microscope. EDX analysis of preselected, reflective particles. Combined light microscope/electron microscope report of results with chemical element composition and material classification. |
| Oil analyses | Determining the level of contamination in fresh and used oils and lubricants | Automatic analysis of the contamination level on the filter membrane with regard to quantity, size distribution, and morphology supporting ISO 4406, ISO 4407 |
| Defect analyses | Finding surface defects in die-cast parts | Automatic analysis of pores, holes, and cavities. Classification by quantity, size distribution, and morphology |
| Generic particle analysis | Detection and analysis of differentiable objects and structures | Automatic analysis and classification by quantity, size distribution, morphology, and color |

Particle Analyzer at Work

Particle Analyzer

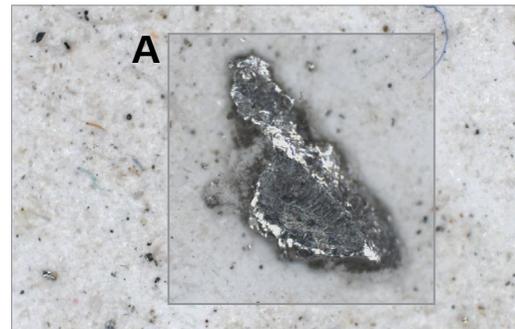
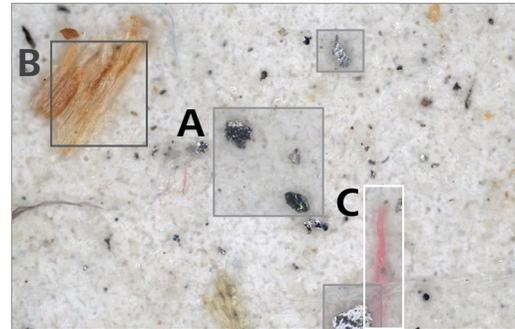
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Filter membrane with metallic particles



Residual particles on the filter membrane Microscope:
Axio Imager 2, objective: EC Epiplan-NEOFLUAR 10x/0.25

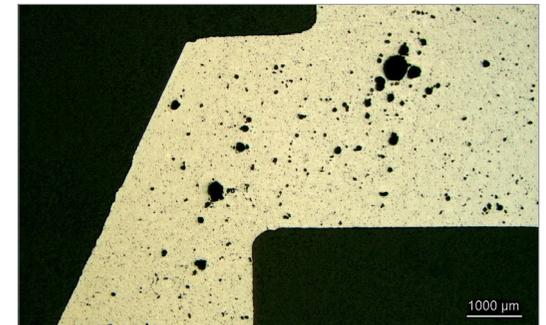


Filter membrane with different particle types

- A: Metallic particles
- B: Non-metallic particles
- C: Fibers

Die-cast parts

Structural defect in die-cast components
Mosaic image of a total area of approx. 38 mm²
Microscope: Axio Imager 2
Objective: EC Epiplan-NEOFLUAR 5x/0.13
Camera: AxioCam MRc



Defect analysis: Structural defect in die-cast components

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Correlative Particle Analysis: More Knowledge. Higher Quality.

Characterize process-critical particles. Systematically identify killer particles – Correlative Particle Analyzer combines your data from light and electron microscopy.

Completely characterize residual particles. With correlative particle analysis from Carl Zeiss, you can relocate and analyze preselected, reflective particles using electron microscopy and EDS in a fully automated process. Correlative Particle Analyzer automatically documents the results from both the light microscopic and electron microscopic analysis; you receive a combined, informative report at the touch of a button.

As an experienced user, you can inspect the results of the combined light microscopic and electron microscopic analysis on an interactive overview screen. Relocate particles at the touch of a button, automatically start new EDX analyses, and automatically generate a report. With Correlative Particle Analyzer, your results will be available up to ten times faster than first conducting an analysis with a light microscope and then subsequently with an electron microscope. You can systematically focus on potentially process-critical particles. The complementary material characterization from both microscopic worlds gives you added security.

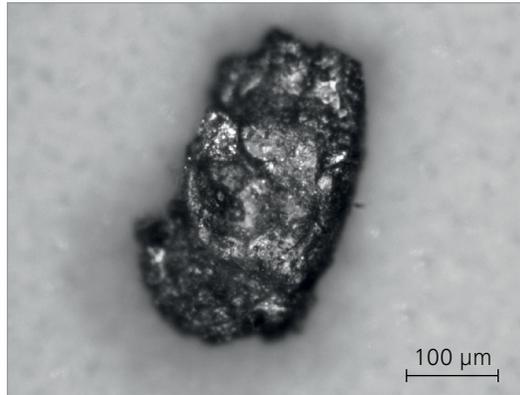


Image of a metallic particle from a light microscope

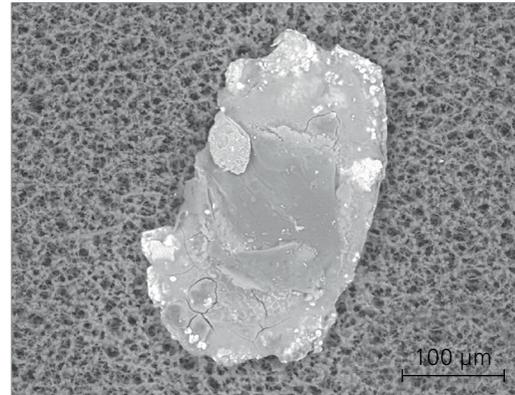
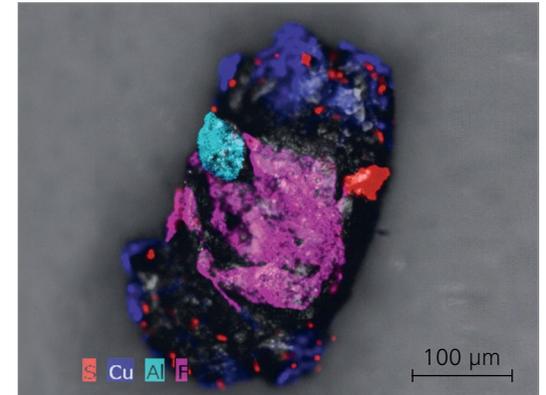


Image of the same metallic particle from an electron microscope



Overlay of the images from both systems; chemical element composition via EDX analysis; graphical EDX overlay prepared with Bruker Esprit software

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| Typical applications | Task | Solution |
|---|--|--|
| Image recording | Z-Stack and EDF | AxioVision Z-Stack module and Extended Focus |
| Image processing, image analysis, and measuring | Segmentation, binary image processing Automatic Measurement Interactive Measurement | AxioVision Interactive Measurement module: determination of object-describing parameters such as size, with the help of an analysis wizard; completion of the analysis tasks in a fixed order; presentation of the results in an easy-to-read list of results AxioVision AutoMeasure Plus plus module: easily create automatic analysis routines for an unlimited number of images yourself |
| | Analyze layer thickness | AxioVision Layer Thickness Measurement module: analyze simple and complex layers; identify layers by color value or gray scale; precise, individual, and automatic calculation of the course of measuring axis for each layer, regardless of the number of layers; presentation of results in an easy-to-read report with sample data and findings such as maximum and minimum axis length, mean value, and standard deviation |
| | Analysis of grain size supporting with ASTM E 112, ASTM E 1382, DIN EN ISO 643 | AxioVision Grains module: variable methods of standard-supporting grain size analysis: automatic reconstruction of grain boundaries and determination of individual grain sizes; semiautomatic linear intercept methods; comparison of structural and reference series images |
| | Analysis of phases and porosity | AxioVision Multiphase analysis module: analysis of samples' phase distribution; measurement of size, shape, and orientation; easy-to-read documentation in percentage of total area, as classified particle size, or as a comparison |
| | Comparative examination of materialographic samples using a microscope with reference series | AxioVision Comparative Diagrams module: convenient, interactive on-screen assessment of structural parameters; the ability to create your own reference series; easy-to-read results using a table with reference series numbers for each image as well as statistical evaluations; output of the structural image with superimposed reference series image |
| | Analysis of graphite particles in cast iron supporting EN ISO 945-1 or SAE J 1887 | AxioVision Graphite module: fully automated determination and classification of size and shape of graphite in cast iron supporting EN ISO 945-1 as well as nodularity of vermicular graphite pursuant to SAE J 1887 |
| | Determination of steel purity level supporting EN 10247, DIN 50602, ASTM E45, ISO 4967, JIS G 0555; determination of the percentage of non-metallic inclusions | AxioVision NMI module: steel purity analysis in accordance with current international standards; overview of results in image and chart form; selection of various gallery views with all analysis and classification data; storage and management of all analysis data such as charts, images, reports, testing procedures in the asset archive |

Particle Analyzer: Your Flexible Choice of Components

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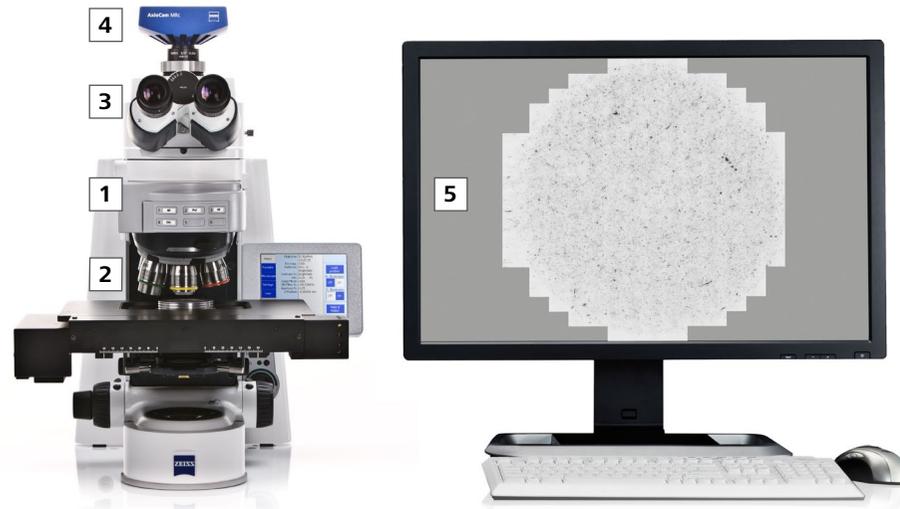
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1 Microscope

- SteREO Discovery.V8; SteREO Discovery.V12
minimum particle size 50 μm
- Axio Zoom.V16 minimum particle size 5 μm
- Axio Imager.M2m; Axio Imager.Z2m minimum
particle size 2 μm

2 Objectives

- Achromat S (SteREO Discovery.V8)
- Plan S (SteREO Discovery.V12)
- Apo, PlanApo (Axio Zoom.V16)
- EC Epiplan-NEOFLUAR (Axio Imager.M2m,
Axio Imager.Z2m)

3 Illumination

- HAL 100 (halogen)
- CL 6000 LED (cold light)
- CL 9000 LED (cold light)
- Ringlight controllable in segments
- VIS-LED (LED)

4 Cameras

Recommended cameras:

- AxioCam ICc 1 (SteREO Discovery.V8)
- AxioCam ICc 5 (SteREO Discovery.V12,
Axio Zoom.V16, Axio Imager.M2m, Axio Imager.Z2m)
- AxioCam MRc (Axio Imager.M2m,
Axio Imager.Z2m)
- AxioCam MRm (Axio Imager.M2m,
Axio Imager.Z2m)

5 Software

- AxioVision
 - AxioVision Particle Analyzer Projects
 - AxioVision MosaiX
- Optional:
AxioVision Autofocus

Correlative particle analysis

Light microscopy:

- AxioVision Particle Analyzer Projects,
AxioVision MosaiX,
AxioVision Correlative Particle Analyzer
- Electron microscopy:
- SmartPI, SmartSEM,
AxioVision Correlative Particle Analyzer,
Particle Analyzer Projects

Optional:

- AxioVision Shuttle & Find

6 Accessories

- Calibration standard for particle analysis
(with certificate, if so desired)
- Stage micrometer (with certificate, if so desired)
- Plate carrier and specimen holder for round
particle filters
- Mirror testing preparation

Correlative particle analysis

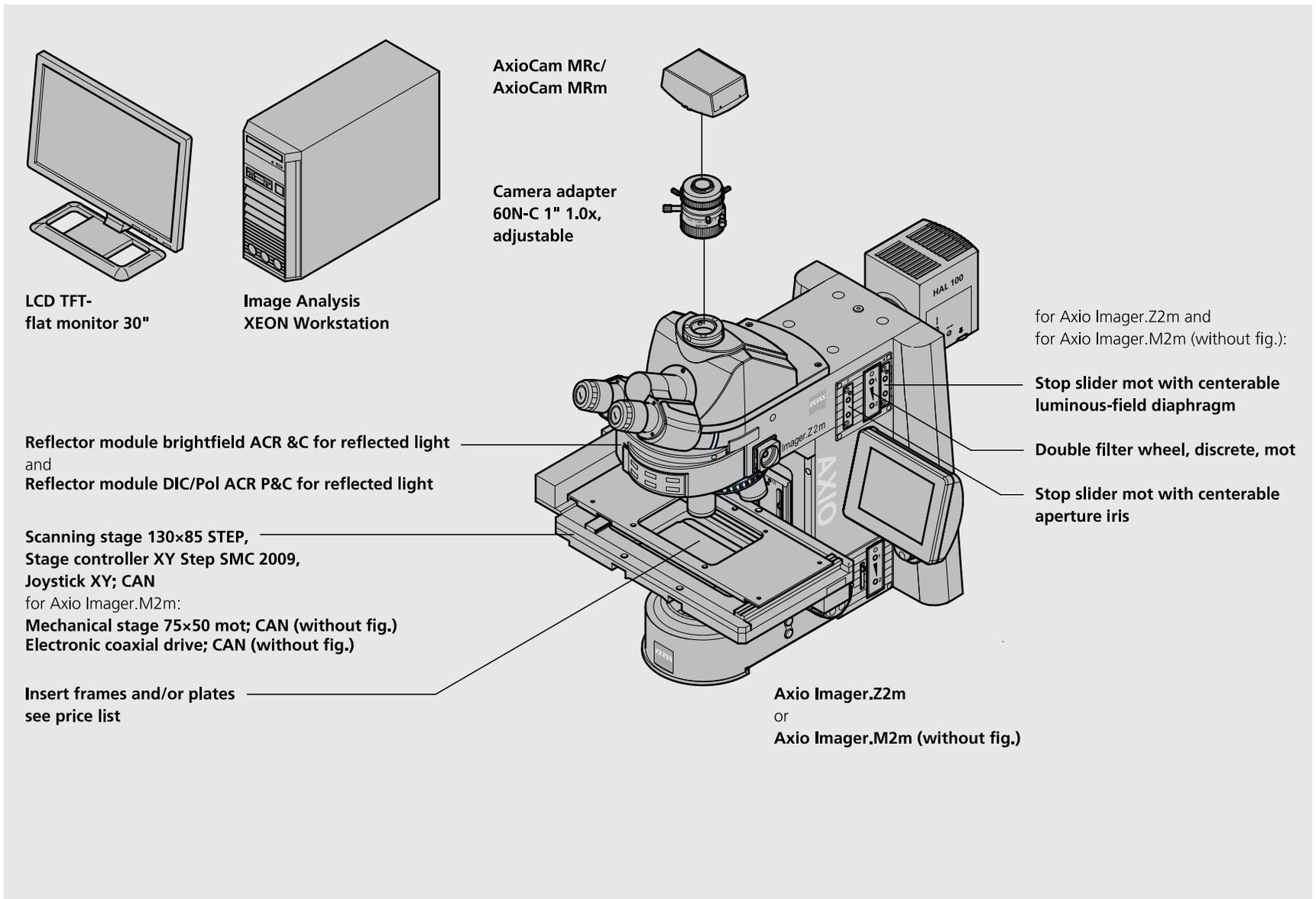
- Adapter plate with SEM recording
- Specimen holder "CorrMic MAT" particle analysis
- Calibration Marker "CorrMic", 3 pieces

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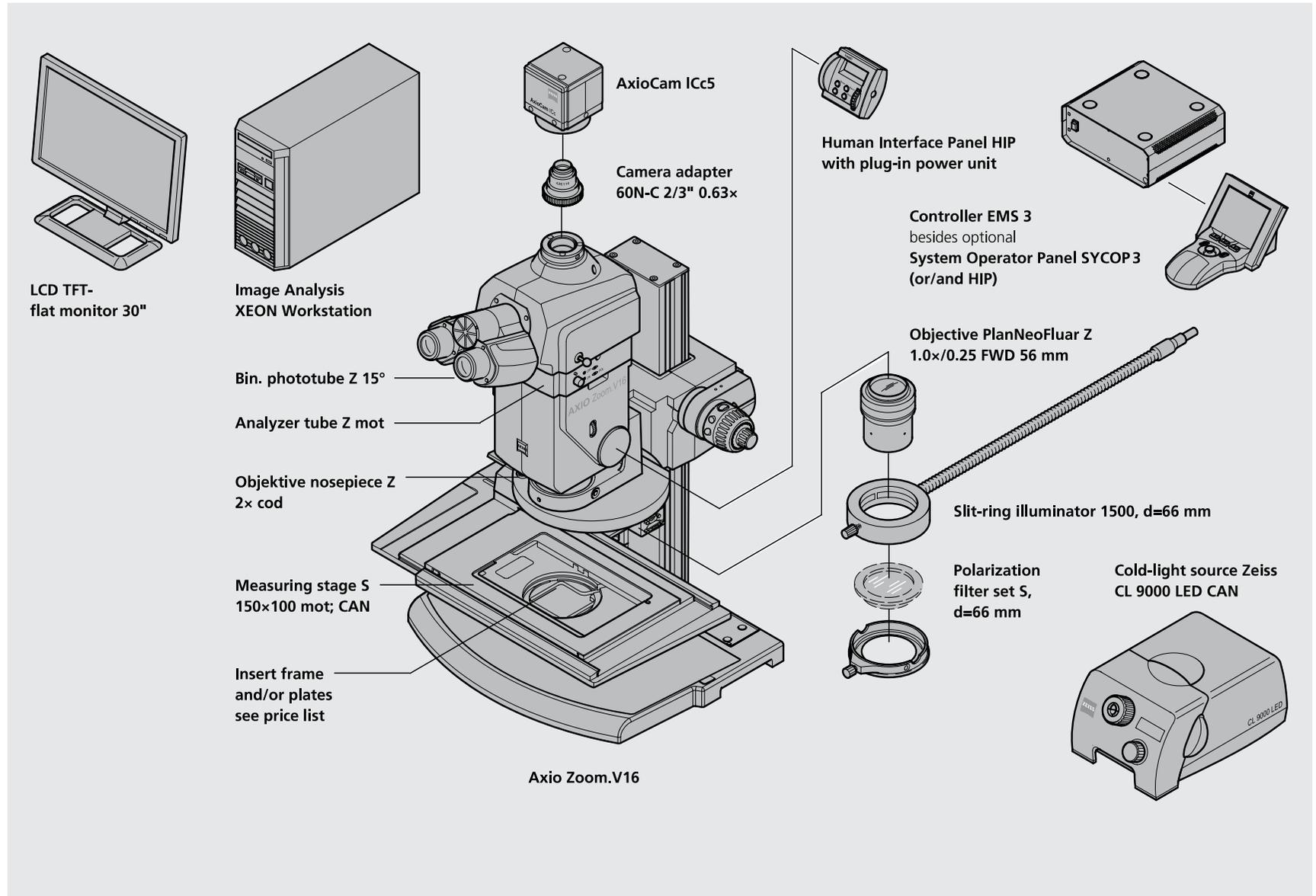


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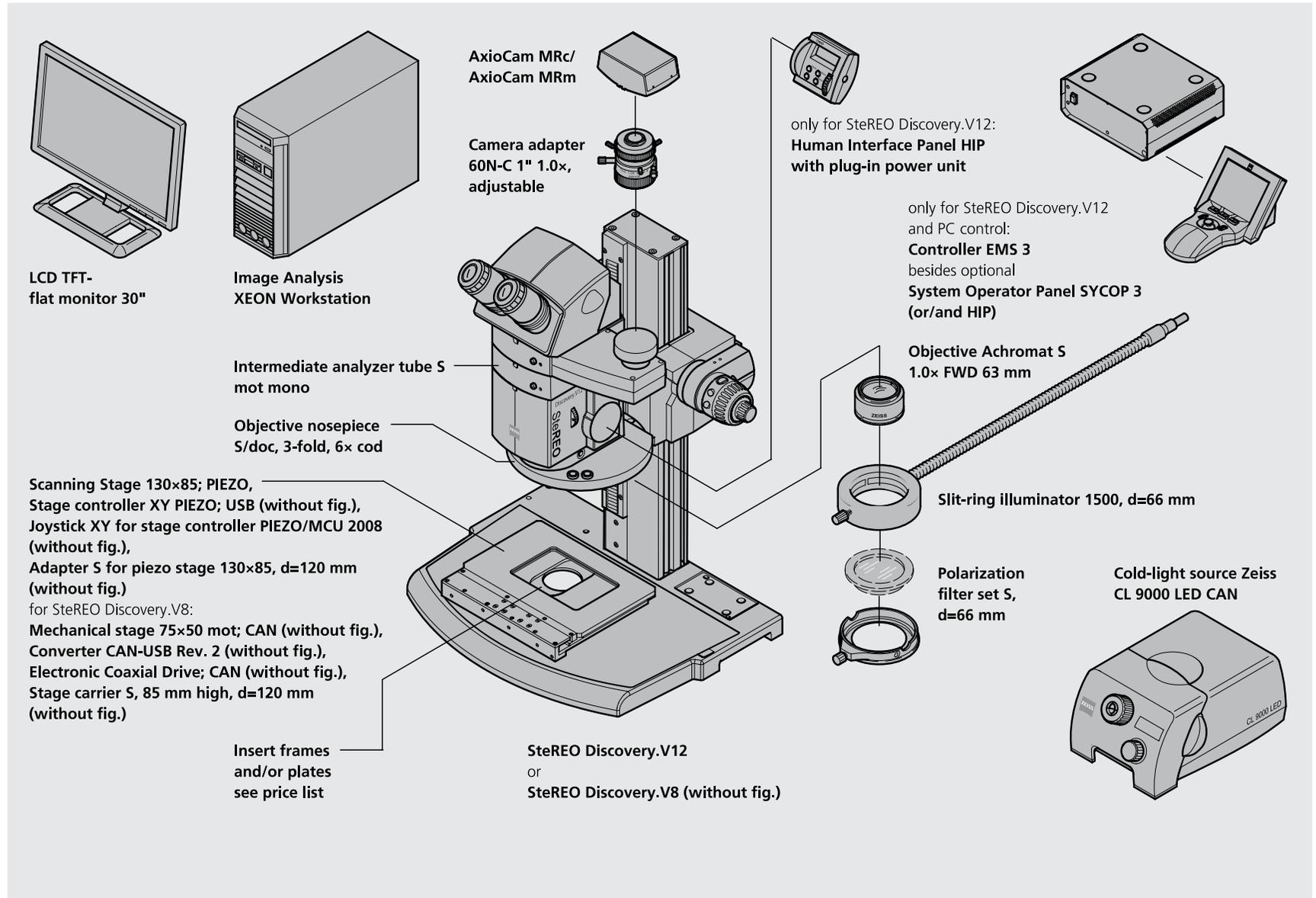


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Count on Service in the True Sense of the Word

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Because the Carl Zeiss microscope system is one of your most important tools, we make sure it is always ready to perform. What's more, we'll see to it that you are employing all the options that get the best from your microscope. You can choose from a range of service products, each delivered by highly qualified Carl Zeiss specialists who will support you long beyond the purchase of your system. Our aim is to enable you to experience those special moments that inspire your work.

Repair. Maintain. Optimize.

Attain maximum uptime with your microscope. A Carl Zeiss maintenance contract lets you budget for operating costs, all the while avoiding costly downtime and achieving the best results through the improved performance of your system. Choose from service contracts designed to give you a range of options and control levels. We'll work with you to select the service program that addresses your system needs and usage requirements, in line with your organization's standard practices.

Our standard preventative maintenance and repair on demand contracts also bring you distinct advantages. Carl Zeiss service staff will analyze any problem at hand and resolve it – whether using remote maintenance software or working on site.

Enhance Your Microscope System

Your Carl Zeiss microscope system is designed for a variety of updates: open interfaces allow you to maintain a high technological level at all times. As a result you'll work more efficiently now, while extending the productive lifetime of your microscope as new update possibilities come on stream.

Please note that our service products are always being adjusted to meet market needs and may be subject to change.



Profit from the optimized performance of your microscope system with a Carl Zeiss service contract – now and for years to come.

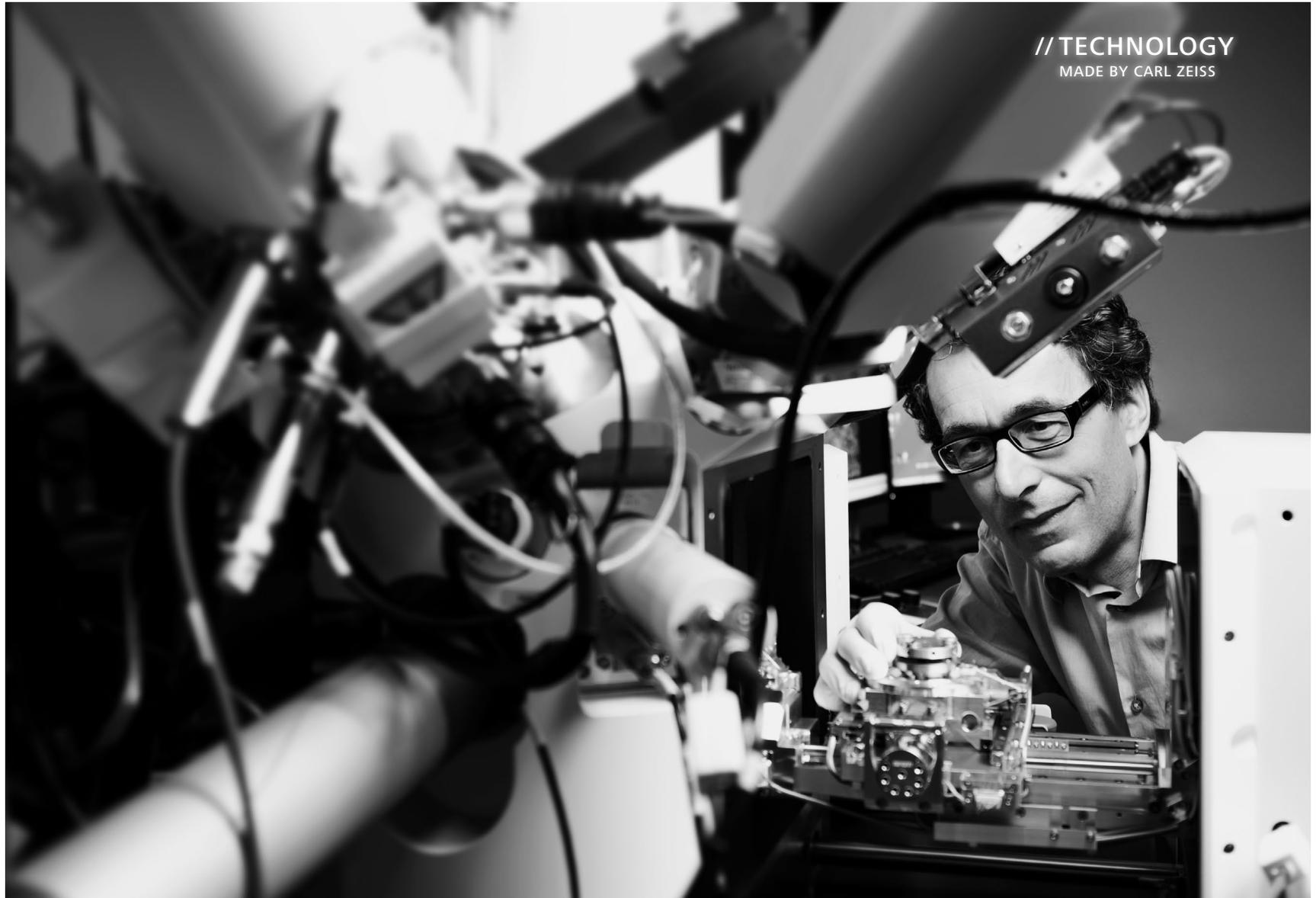
www.zeiss.com/microservice

The moment "I think" becomes "I know."
This is the moment we work for.

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Materials

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We make it visible.