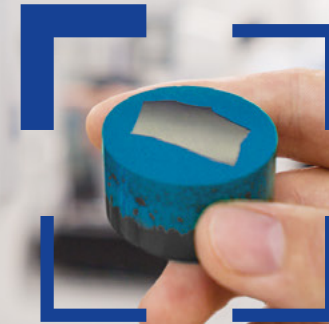# Connected Productivity in the Materials Lab

ZEISS ZEN core

Your Software Suite for Connected Microscopy—from the Materials Lab to Production

zeiss.com/zen-core

ZEISS

Seeing beyond

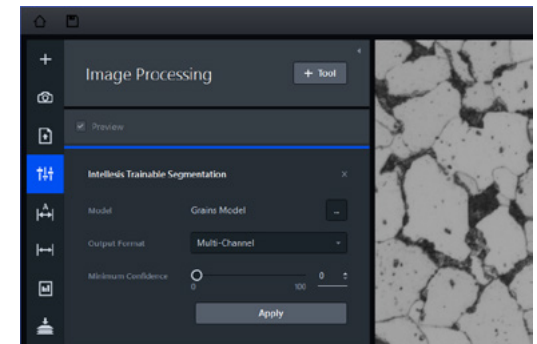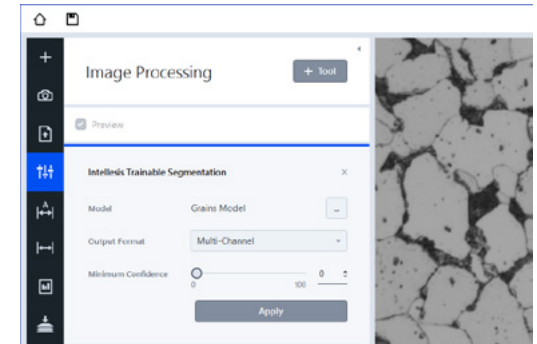# Your Software Suite for Connected Microscopy—from the Materials Lab to Production

ZEISS ZEN core is a powerful software suite for microscopy imaging, automated control of motorized ZEISS microscopes, and multi-modal workflows in material laboratory environments.

Use ZEN core to handle routine tasks on a wide range of ZEISS microscope and camera systems. While extracting the highest technical performance from your microscopes, ZEN core provides access to every parameter and function you might wish to optimize through an intuitive and configurable graphical interface.

Create task-specific workbenches that show only the required microscope controls on the screen. Combine these workbenches to create dedicated jobs that assist your operators through a defined flow of consecutive tasks, to ensure data repeatability in a multi-user environment.

ZEN core helps you to make your lab even more productive. With workflow and infrastructure solutions that connect data from different microscopes, ZEN core delivers more meaningful information in the form of correlated multi-scale and multi-modal characterization data. And thanks to its database connectivity features, you keep your valuable data together across instruments, laboratories, and locations.

The user interface of ZEN core provides both a bright and a dark mode to meet the needs of different users and their preferred working environment.

Image. Analyze. Connect.

Easy to Configure. Easy to Use.

ZEN core gives you the benefit of an adaptive user interface tailored to the needs of industrial and research environments. The easy-to-follow GUI configuration accommodates tasks of all kinds and any complexity. ZEN core also offers you configurable user management, so you can specify users and user roles. Whatever their level of experience, operators will learn the software quickly. Using the ZEISS Word Add-In lets you easily create user configured report templates in MS Word®. The reporting functionality exports reports to various file formats including PDF or DOCX.

Advanced Imaging and Automated Analysis

ZEN core is the command center for automated imaging and analysis functions on compound light microscopes. By using built-in automated image acquisition routines, such as HDR or Best Image, you benefit from the consistency of an advanced and repeatable workflow. ZEN core provides automated image segmentation based on machine learning algorithms, as well as analysis functionality such as phase analysis or particle counting. Application-specific packages enhance your microscope to answer typical questions about the material structure in research and quality control.

Infrastructure Solution for the Connected Laboratory

ZEN core provides the infrastructure for connected laboratory environments, linking all your ZEISS imaging and microscope solutions to a single, familiar GUI. ZEN core is also the interface to the ZEISS Axiocam camera portfolio, safeguarding an open connected laboratory architecture for 3rd party solutions. ZEN core bridges different forms of light and electron microscopy, improving productivity and multi-modal data integrity. Data management and database connectivity features help you to keep your valuable analysis data together across instruments, laboratories, and locations.
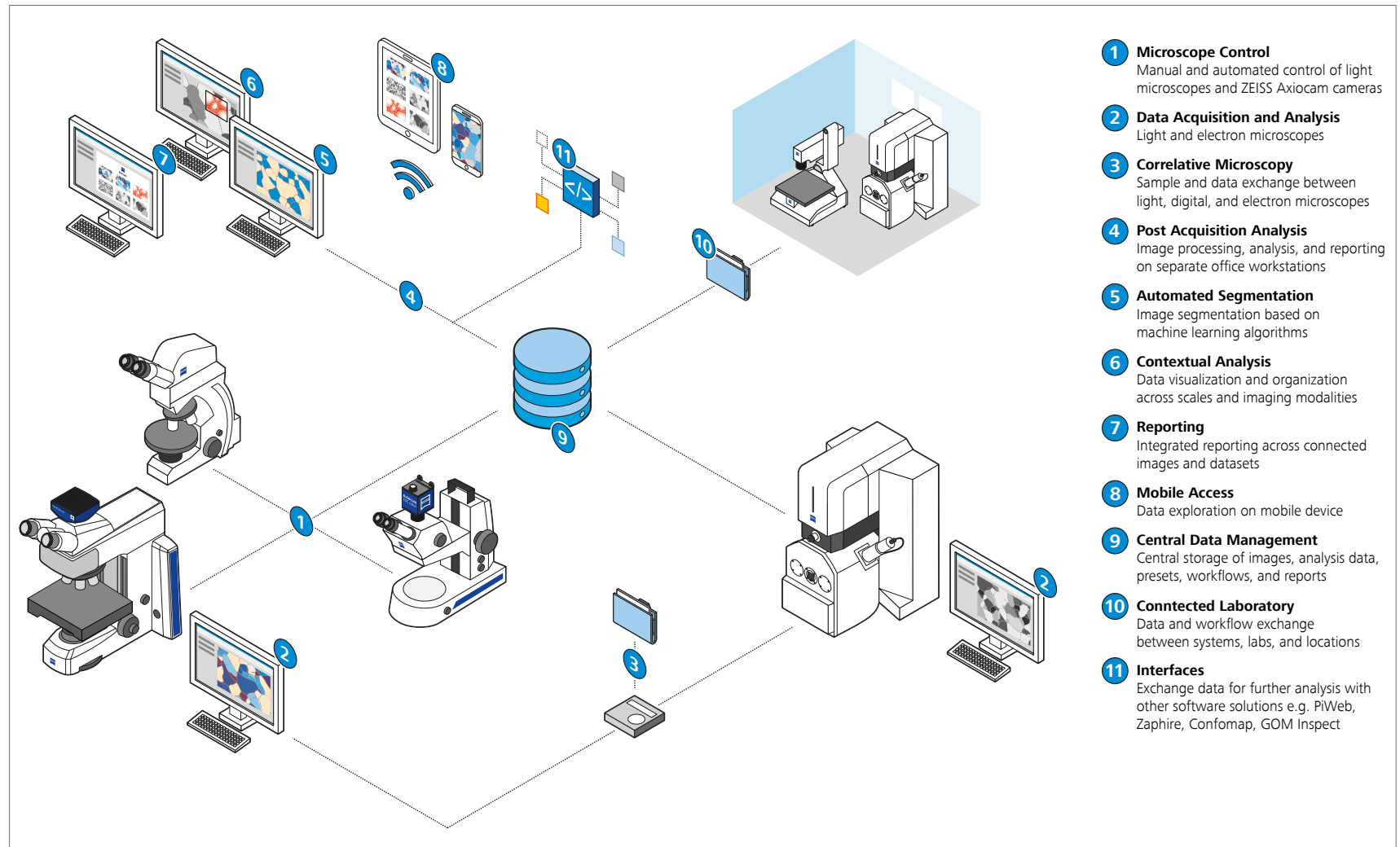
Expand Your Possibilities

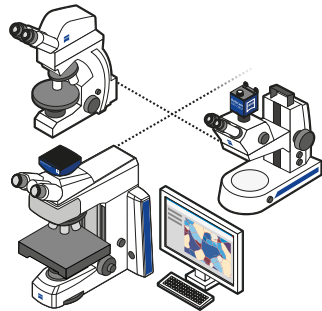**One Interface for all Microscopes in a Multi-User Environment**

From entry-level stereo microscopes to fully automated imaging systems, ZEN core provides a unified user interface for ZEISS microscopes and cameras. ZEN core enables the correlation of light and electron microscopy in multi-modal workflows and provides connectivity between systems, laboratories and locations.

1 Microscope Control
Manual and automated control of light microscopes and ZEISS Axiocam cameras

2 Data Acquisition and Analysis
Light and electron microscopes

3 Correlative Microscopy
Sample and data exchange between light, digital, and electron microscopes

4 Post Acquisition Analysis
Image processing, analysis, and reporting on separate office workstations

5 Automated Segmentation
Image segmentation based on machine learning algorithms

6 Contextual Analysis
Data visualization and organization across scales and imaging modalities

7 Reporting
Integrated reporting across connected images and datasets

8 Mobile Access
Data exploration on mobile device

9 Central Data Management
Central storage of images, analysis data, presets, workflows, and reports

10 Conntected Laboratory
Data and workflow exchange between systems, labs, and locations

11 Interfaces
Exchange data for further analysis with other software solutions e.g. PiWeb, Zaphire, Confomap, GOM Inspect

Expand Your Possibilities

Image, Analyze and Connect your Data Using the Complete Software Suite
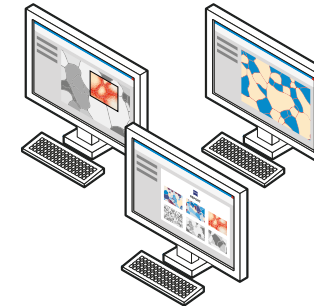
ZEN core

ZEN core, with its configurable user interface, gives you seamless control of your ZEISS microscopes and cameras as you perform data acquisition, analysis and reporting.
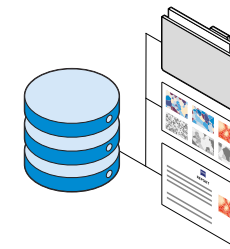
ZEN analyzer

ZEN analyzer is the desktop version of ZEN core, designed for all those activities that can be done independently of the microscope. This is the ideal solution for analysis, reporting and creating job templates, providing remote access to ZEN Data storage. Your instrument is not blocked for post-processing tasks, but instead can be used to run other experiments—anywhere, anytime, and with genuine efficiency. Additionally, access to all workbenches available in ZEN core gives you full control of all data and templates, accessible from your desk.

ZEN Data Explorer

Combine ZEN Data Explorer with ZEN Data Storage for mobile access to your data. This lets you use your tablet or smartphone to examine your results when you're on the go.
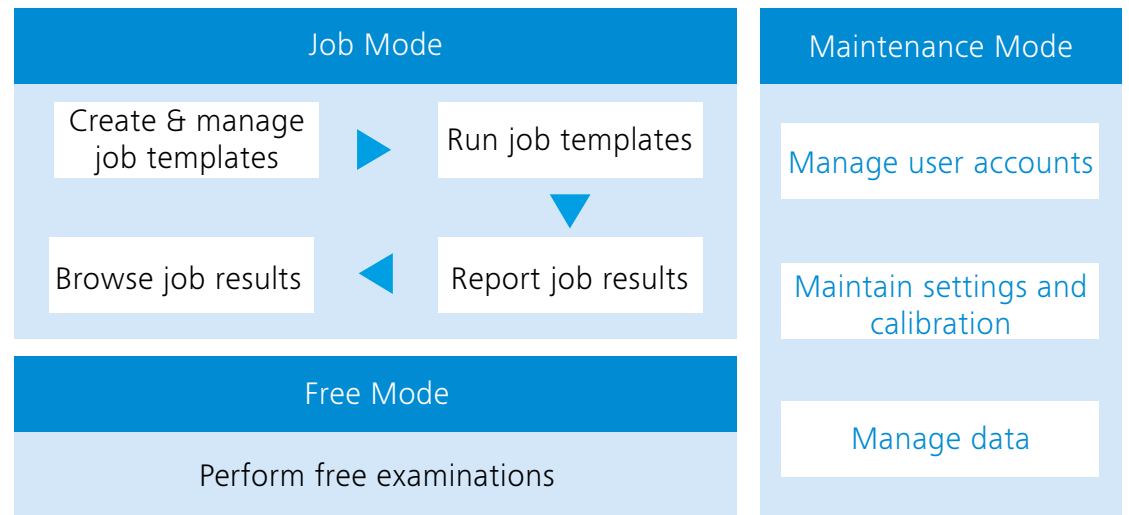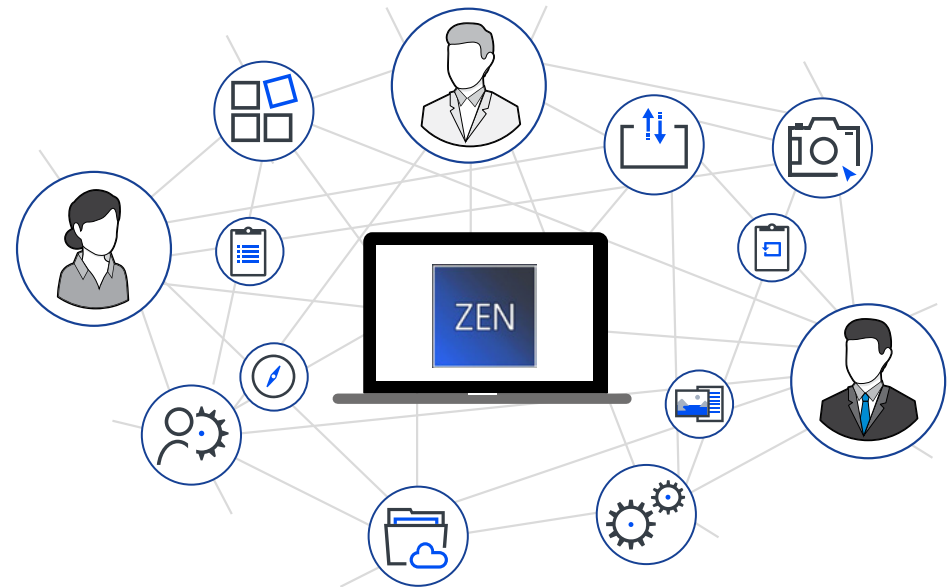
ZEN Data Storage

ZEN Data Storage enables data and workflow exchange between systems, labs and locations. It allows server-based user management and secures central data handling for your lab and quality assurance. All your images, templates, forms and reports are accessible in one hub.

Expand Your Possibilities

User Management Designed to Assure Data Repeatability and Integrity

ZEN core comes with powerful built-in features for user management. Create accounts with defined privileges and roles such as administrator, supervisor and operator. If necessary, you can define precisely what each user is allowed to do, right down to the level of individual features. Create and manage users directly in ZEN core—or connect to ActiveDirectory and reuse those user accounts. Protect access with passwords and leverage extensive capabilities to put password rules and expiration times in place. Auto-logoff helps you prevent further unwanted access.

Job Mode		Maintenance Mode
Create & manage job templates ▶ Run job templates		Manage user accounts
Browse job results ◀ Report job results		Maintain settings and calibration
Free Mode		Manage data
Perform free examinations		

Sample configuration of multi-user management
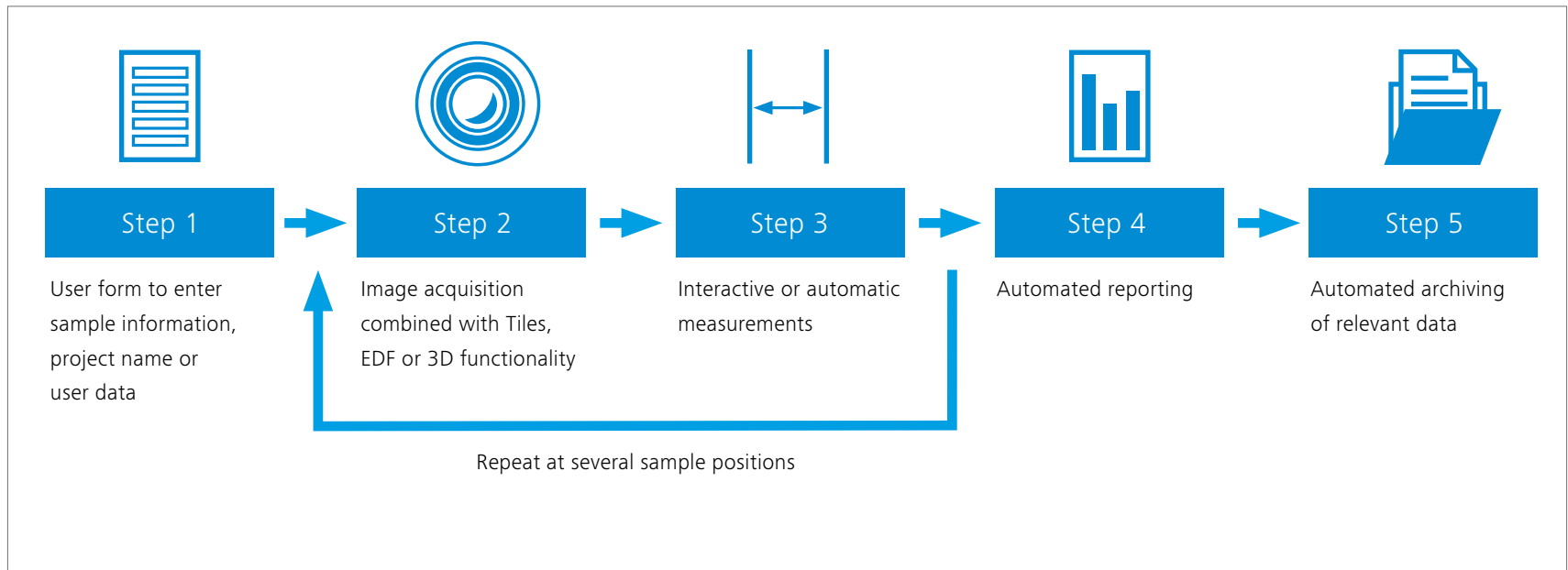
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Expand Your Possibilities

Job Mode

Job Mode makes it easy to set up workflows for repetitive tasks. You can predetermine microscope parameters and specify them as individual workbenches to guarantee reproducible results. Then combine workbenches in a job template to set up individual workflows. Any parameter in the workbenches of a job template (e.g. camera exposure time) can be locked or even preset and hidden from the operator to ensure consistency in sample examination. Combine Job Mode with user management functions to assign inspection tasks to certain users or user groups. Create loops for when you want an operator to execute the same workflow multiple times and store a summarized report at the end. You can even set workbenches to "run silent" (that is, in the background and invisible to the operator) with preset options for implementing batch processing and, for example, analyzing multiple images in exactly the same way.

Workflow Example

Step 1	Step 2	Step 3	Step 4	Step 5
User form to enter sample information, project name or user data	Image acquisition combined with Tiles, EDF or 3D functionality	Interactive or automatic measurements	Automated reporting	Automated archiving of relevant data

Repeat at several sample positions

Workflow example for a job in Job Mode of ZEN core.

Expand Your Possibilities

Reporting

ZEN core´s powerful reporting functionality lets you create reports in MS Word or PDF format. Combined with ZEN core's Job Mode, the reporting process is fully automated without any customer interaction.
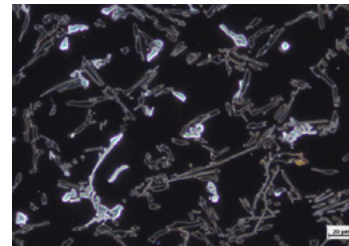
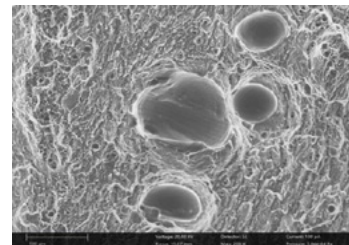Report templates are created in MS Word using the plug-in ZEISS Word Add-In.
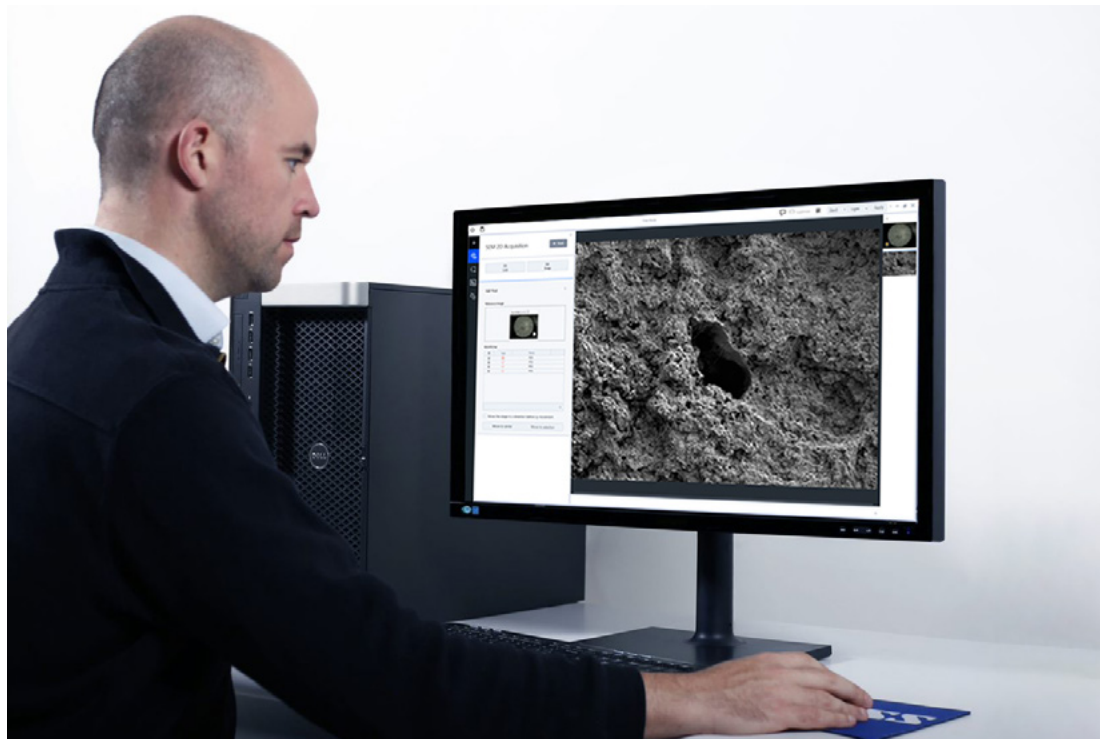
Expand Your Possibilities

ZEISS Solutions Lab For Rapid Application Development

So, you have just purchased a new microscopy system from ZEISS—or perhaps you now have access to several systems to deliver correlated data across length scales. The possibilities are endless and you are anxious to get to work. So where to begin?

If you are looking for a specific solution to your challenge, skim the website to see what is already available. The hub for the Solutions Lab offers apps for industrial R&D, Materials Science, investigation of metals and natural resources. Even if you do not find a suitable solution, something close to it may have been created for a similar application in another field and we can get you the rest of the way. Simply contact ZEISS via the contact form on the ZEISS Solutions Lab webpage or ask your ZEISS salesperson, explaining what you are looking for. You can always count on our support in developing your best solution.

You Will Benefit From:

- automation of your imaging process or workflow
- advanced image analysis and corrections
- automation of your ROI (region of interest) search
- tailoring of flexible and adaptable workflows for your configuration and of course, some handy small applications that turn 20 clicks into one.

Visit us at:
www.zeiss.com/solutions-lab

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Expand Your Possibilities

Software Maintenance Agreements

Sign up for an SMA (Software Maintenance Agreement) and get notified immediately via the ZEISS Portal when a new version for your system is ready to be downloaded. As a result, you will always keep all your systems up to date. Enjoy the latest features, newest possibilities and most recent security mechanisms.

The ZEISS Portal delivers everything you need in one platform:

- Keep an overview of your systems.
- Get the latest software every six months and thus take advantage of optimal instrument performance.
- Create tickets and benefit from fast and competent support.

- Sign up immediately with no costs. The first year using SMA is free.
- Learn and enhance your skills from deeply technical how-to videos.
- Never miss any ZEISS news.

Visit us at:
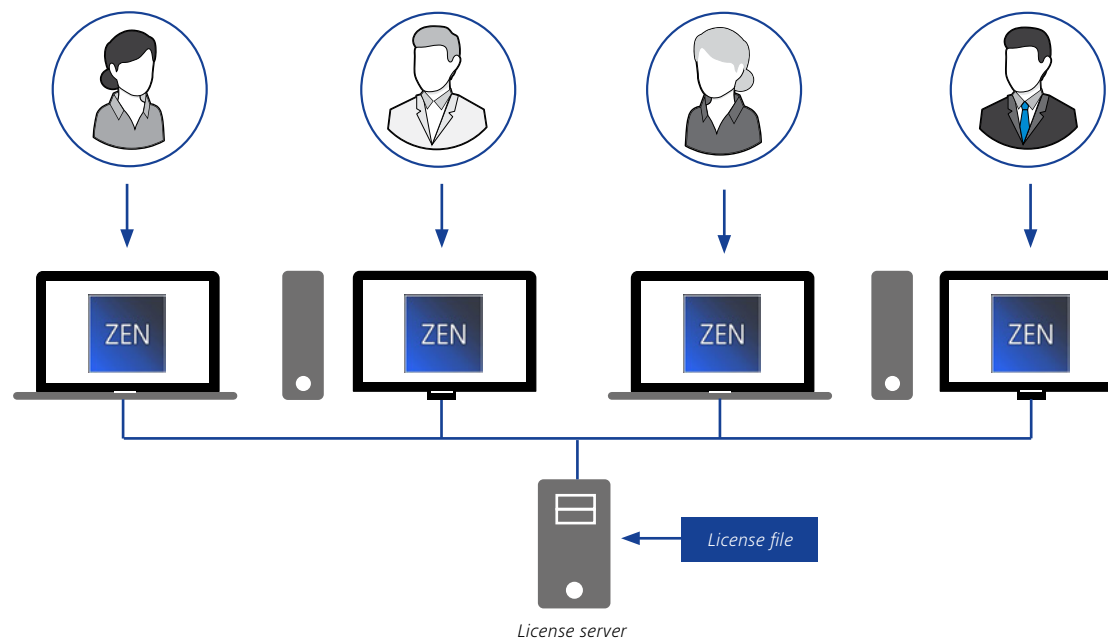**portal.zeiss.com**

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Expand Your Possibilities

Floating Licensing – Designed to Assure The Optimal Use of Licenses

With Floating Licensing you have a flexible model at hand any time an individual user needs to work on the microscope. In a multi-user laboratory, that's much more cost effective and it saves you administrative hassle, too. The licenses are stored on a central license server that distributes accesses to any user of ZEN core who might be working on the office PC or from home.
Floating Licenses are available for Toolkits of ZEN core and ZEN analyzer.
The more users working in your lab, the greater the benefits you will get from sharing licenses. In this way you will minimize idle and time save money as you will require fewer licenses.

License file

License server

Every user of a multi-user lab will benefit from the optimal use of the licenses.

What's New: ZEN core Highlights

Enjoy Working with the New Features

The ZEN software provides a comprehensive end-to-end solution for any microscopy user, continuously evolving to address emerging materials research applications with added features.

Benefit from updates in the functionalities of the AI Toolkit now including Instance Segmentation and the ZEN Data Explorer with the new multi-channel Pol Viewer.
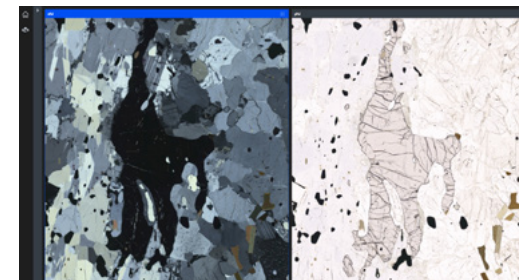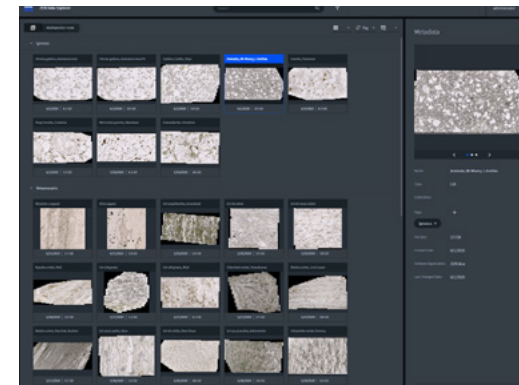

Battery cathode material, scanning electron microscope image segmented with a deep learning instance segmentation model.

Reliable and Precise Results. Realized with Integrated AI

In materials research, multiphase analysis, layer thickness measurements, or technical cleanliness analysis are applications that often require the use of AI powered solutions. Machine learning-based algorithms aim at workflow automation, gaining speed and guaranteeing reliability. Here, imaging is often only the first step. The real value is in the data that the images provide. Additionally, image segmentation and object classification are still a challenge in microscopy but simultaneously they are the foundation for all subsequent image analysis steps. AI is the means of choice to help you automate workflows and to ensure that the results are reproducible, precise, and operator independent.

With the AI solutions comprised in ZEN core all relevant materials applications are AI-ready. The latest AI/ML technologies allow the examination of samples that have previously been impossible to analyze. Pre-trained machine learning models for pixel segmentation or object classification are included and can be executed directly out-of-the-box.

If you need to train your own models you can either do this with the AI Toolkit directly in ZEN core or on the platform ZEISS arivis Cloud and import them into ZEN core later.

Geological thin sections visualized in ZEN Data Explorer; graphical user interface (top), polarized image (bottom left), bright field transmitted light (bottom right).

Your Simple and Affordable ZEN Packages

Instruments	Manual Light Microscope	Motorized Light Microscope	SEM/FIB-SEM	Desktop Computer
Base Software	ZEN starter	ZEN core		ZEN analyzer
Acquisition Toolkit	Base Acquisition	Motorized Focus Acquisition	Motorized Acquisition	Smart Acquisition
General Toolkits	2D Toolkit	3D Toolkit	arivis Pro*	AI Toolkit
		Connect Toolkit	Developer Toolkit	GxP Toolkit
Application Toolkit	Materials Apps / TCA	NMI	Automated Imaging	TEM Prep / Auto Liftout
System / Driver / Special	Coded Mic / Linkam		ToF-SIMS	

* Sold as a stand-alone software

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ZEISS ZEN core at Work

Standard Features

Free Mode · Job Mode · Manage Templates · Browse Results · Maintenance

ZEN core home screen: Access to image acquisition and job functions

Measurement functions

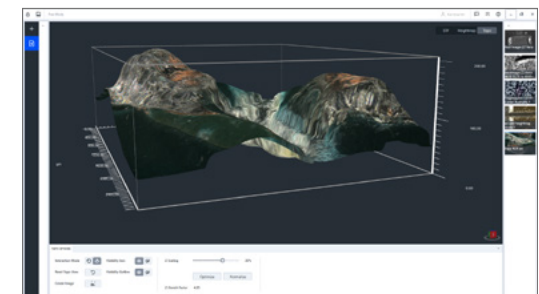### ZEN core's standard features make your lab even more productive:

- Full operational control of ZEISS microscopes, cameras and components
- Workbenches for repetitive application tasks
- Single and automated panorama image acquisition
- High dynamic range (HDR) image acquisition
- Creation and management of input forms
- Live image video recording
- Image and data information displayed in datazone below the image
- Sample-centric correlative display and organization of data and images
- Processing and analysis of any kind of image e.g. both light and electron microscopy
- User management functionality
- Best Image functionality

- Multi-image viewer
- Enhanced depth of field via manual focus
- Measurement functions
- Topography visualization including profile line measurement
- Microsoft Word® and Adobe Acrobat® PDF reports and report templates
- Data archive for images, documents and templates with searching and tagging
- Image exporting to all standard image formats such as JPG, BMP, TIFF
- Connection to Confomap
- Connection to GOM Inspect
- Extended workflow capabilities, loop functionality.

Reporting template

Topography visualization

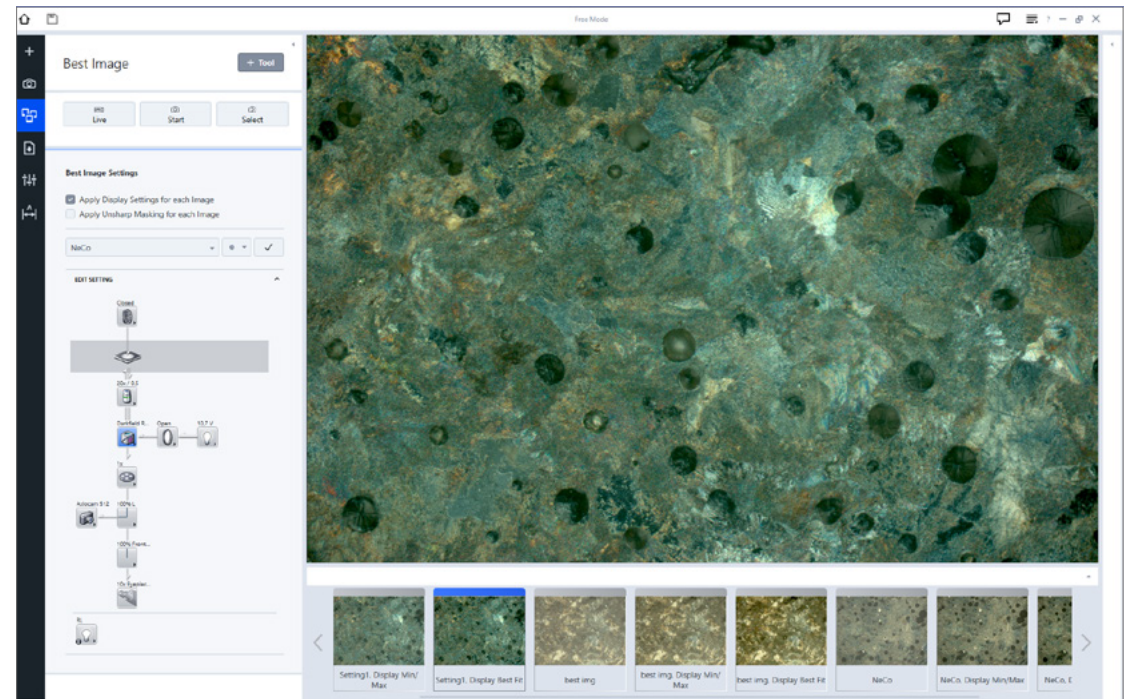# ZEISS ZEN core at Work

Automation for Compound Light Microscopes

Obtain results – rapidly and repeatably. ZEN core provides you with a wide range of choices for automated image acquisition:

- Best Image: assists you with the optimum microscope settings for image acquisition.
- HDR: ensures best image quality even with challenging light conditions.
- Panorama and Tiles: create stitched images in just a few clicks.
- Autofocus: automatically determine the perfect focus position for your sample.
- EDF: Automatically acquire multiple images at different focus positions and combine them to an image with enhanced depth of field.
- Time Series: acquires images at defined time intervals.
- Coded Microscope: ensures repeatable results, even with ZEN starter.
- Flexible Acquisition: combine different modes in only one acquisition.

Best Image workbench generates several images by applying different microscope presets. The user can choose the best image.
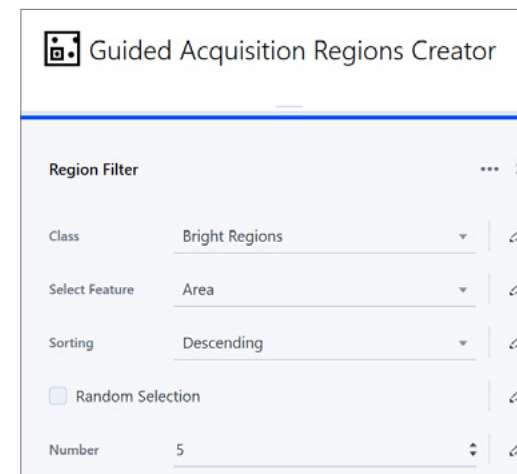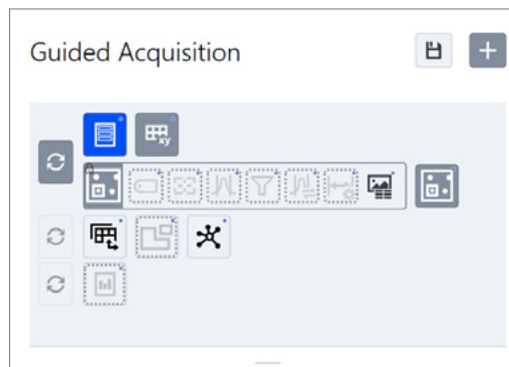
ZEISS ZEN core at Work

Guided Acquisition

Now you can automate your workflow every step of the way to advanced imaging tasks. Guided Acquisition lets you achieve operator-independent results in no time at all.

Traditionally, as a user of the microscope you would start an advanced image acquisition workflow with an overview image, followed by searching and acquiring regions of interest (ROI). Then, eventually, you would connect any data that have been acquired during the workflow.

Guided Acquisition comes with a ready-to-use job for an easy start. After you have taken the overview scan, the software automatically detects ROIs using image analysis. Subsequently you can filter these ROIs by selecting relevant classes or features like "area" and sort through the results to define regions for more detailed scans which are then automatically acquired. There is no need for you to manually connect your data as ZEN Connect does this for you immediately. At that point, automation makes sure you will gain the best results in image quality.

Guided Acquisition - Automatically define regions for the detail scan from an overview image

ZEISS ZEN core at Work
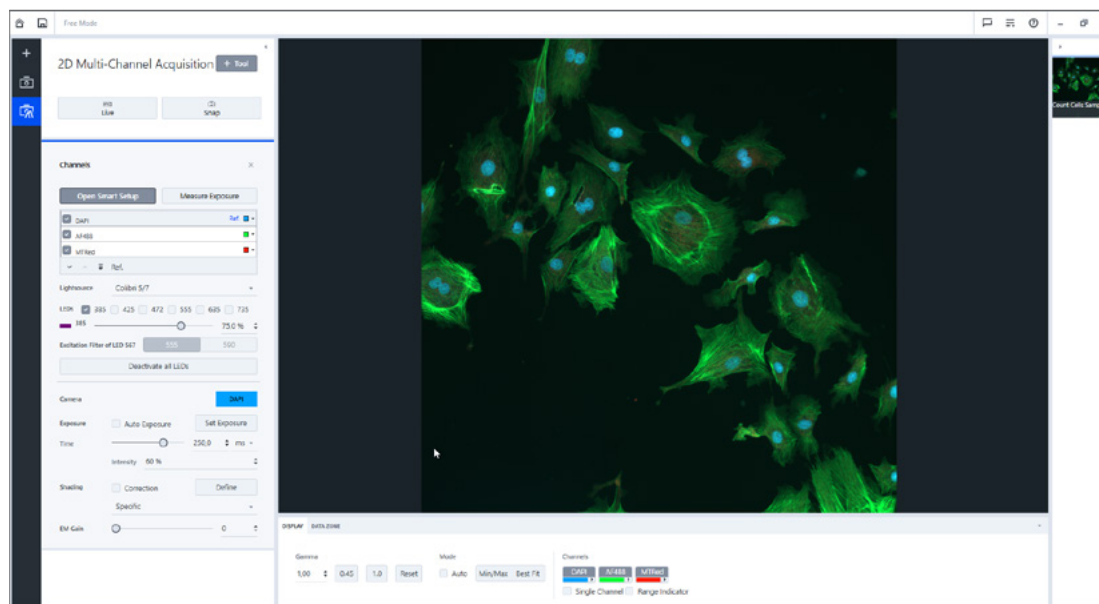
ZEN Multi-Channel Acquisition

Whether you work in materials or life sciences, ZEN core lets you acquire and overlay signals automatically in various individual channels. This is key for optimal visualization and data analysis. Prominent examples include polymer analysis in materials research—say, for investigating micro- and nanoplastics—and fluorescence imaging in biomedical disciplines. The latter supports the understanding of structure and dynamics of biological samples, the characterization of spatial distribution of proteins, cell-cell interactions and colocalization experiments.
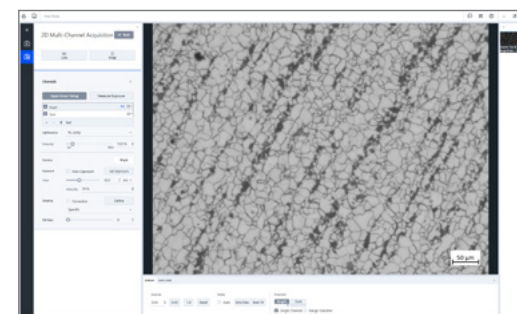
ZEN Multi-Channel Acquisition allows for:

- Easy and intuitive definition of your experiment using smart setup
- High reproducibility and ease-of-use for repetitive work using job mode
- Complete workflows including image acquisition, analysis and reports
- Combining with the GxP module to work in regulated environments such as pharmaceutical companies
- The combination of fluorescence, transmitted light and reflected light channels
- Channel-specific camera and light source settings

Smart Setup allows to easily define the channels of the acquisition.

2D Multi-Channel Acquisition workbench allows to acquire images with multiple (fluorescent) channels in one go with automated switching of illumination and camera mode settings per channel.

2D Multi-Channel Acquisition can also be used to setup a multi-channel experiment without any fluorescence imaging, just using e.g. bright- and darkfield.
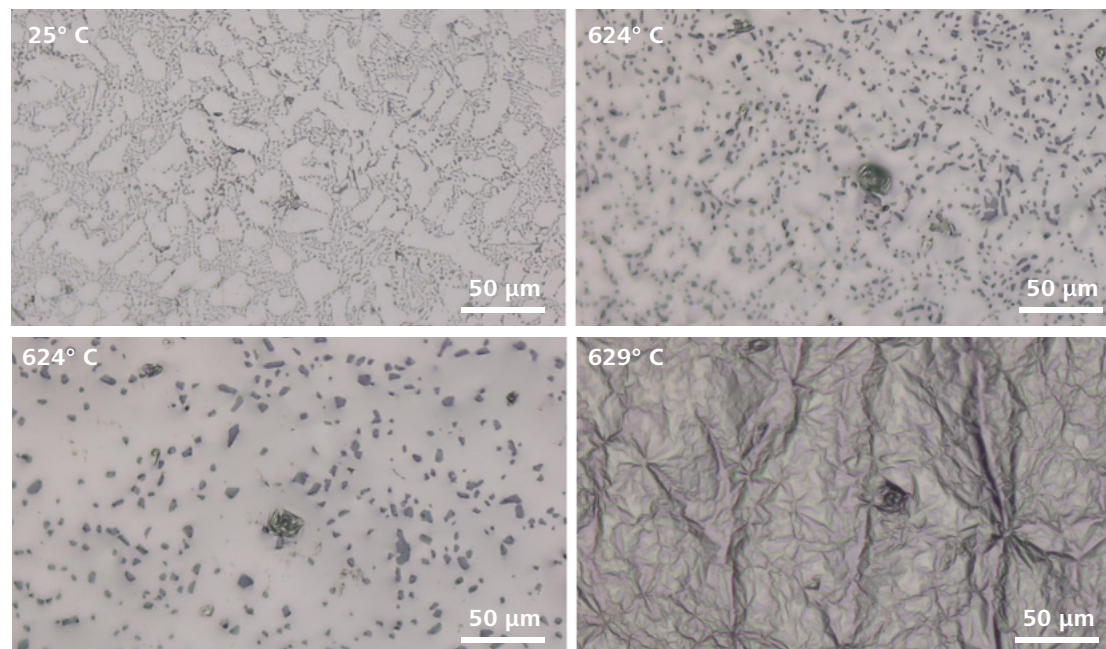
ZEISS ZEN core at Work

Linkam Stage Control

Observing materials in a static state can reveal useful insights into their microstructure, but there's much more to be learned from observing them *in situ* under real service conditions. With Linkam heating/cooling stages you can perform experiments that reveal information about how a material behaves under temperature changes. Use ZEN core to set up and control the experiment directly—that guarantees a perfect interplay between image acquisition and heating stage control.
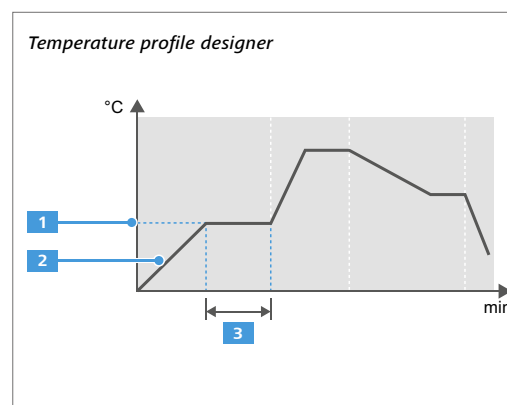
- Setup heating/cooling ramps
- Setup holding time
- Setup temperature
- Image acquisition triggered by time or temperature
- Export of data and temperature curves
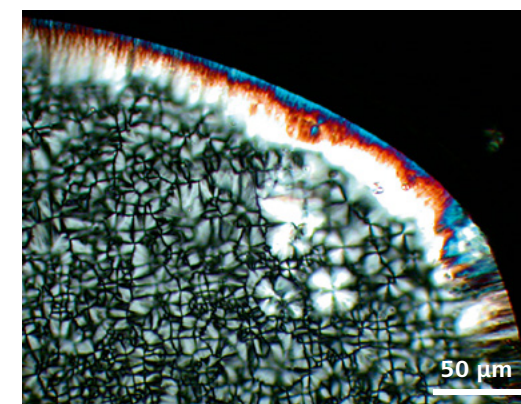
Typical Applications:

- Observation of melting and crystallization behavior
- Determination of the melting and solidification interval
- Investigation of the shape, structure, number and size of different phases
- Investigation of the influence of additives or fillers on crystallization behavior

Microstructure of AlSi alloy under different temperatures to observe the melting behavior.

Easily design your heating experiment with different temperature profiles (1. Limit, 2. Rate, 3. Hold time).

Liquid-crystalline phase of [C$_{14}$mim]Br Polarization contrast EC EPIPLAN 10×/0.20 at 100 °C.
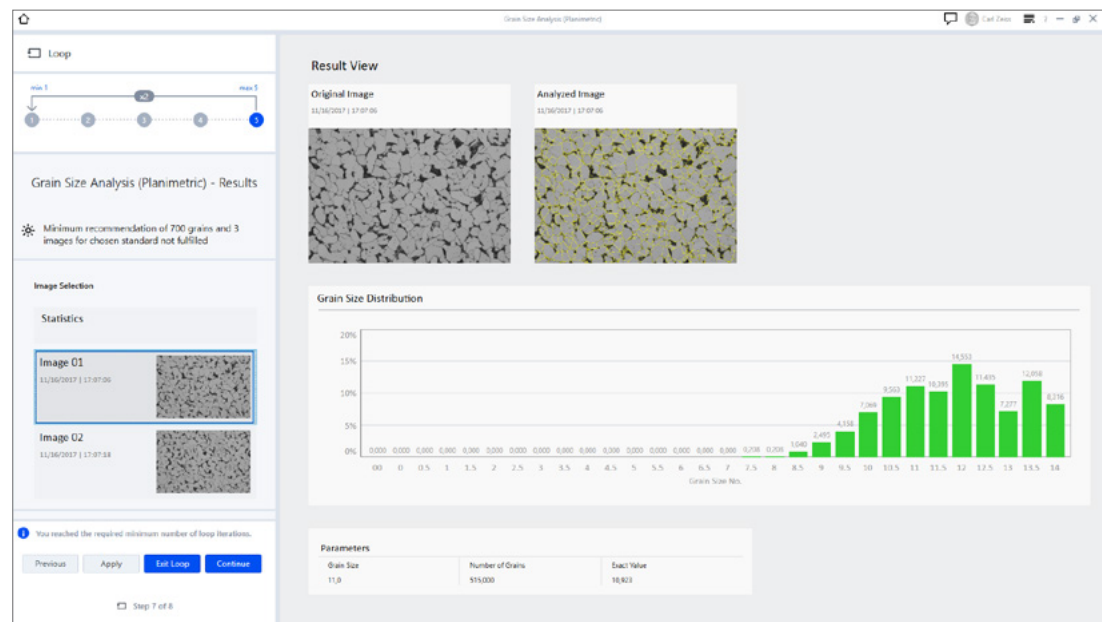
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ZEISS ZEN core at Work

Grain Size Analysis

The size and distribution of grains are directly linked to the material properties. Quantify the crystallographic structure of your materialographic samples in accordance with international standards. Three evaluation methods allow you to characterize your material:

- **Planimetric method** for automatic grain boundary reconstruction
- **Intercept method** with a variety of different chord patterns to interactively recognize and count the intersections with grain boundaries
- **Comparison method** for manual image evaluation with comparative diagrams

Perform image segmentation using the latest AI algorithms. Conveniently train your models with classical machine learning models in the ZEN AI Toolkit. When you need to process large amounts of data with instance segmentation, you can benefit from sophisticated cloudbased deep learning models: Train your models with arivis Cloud. This allows you to analyze even the most challenging samples.

Planimetric Grain Size Analysis – result view

Supported Standards:
- DIN EN ISO 643:2020
- ASTM E 112-13
- ASTM E 1382-97
- GB/T 6394 2017 Plate I-V
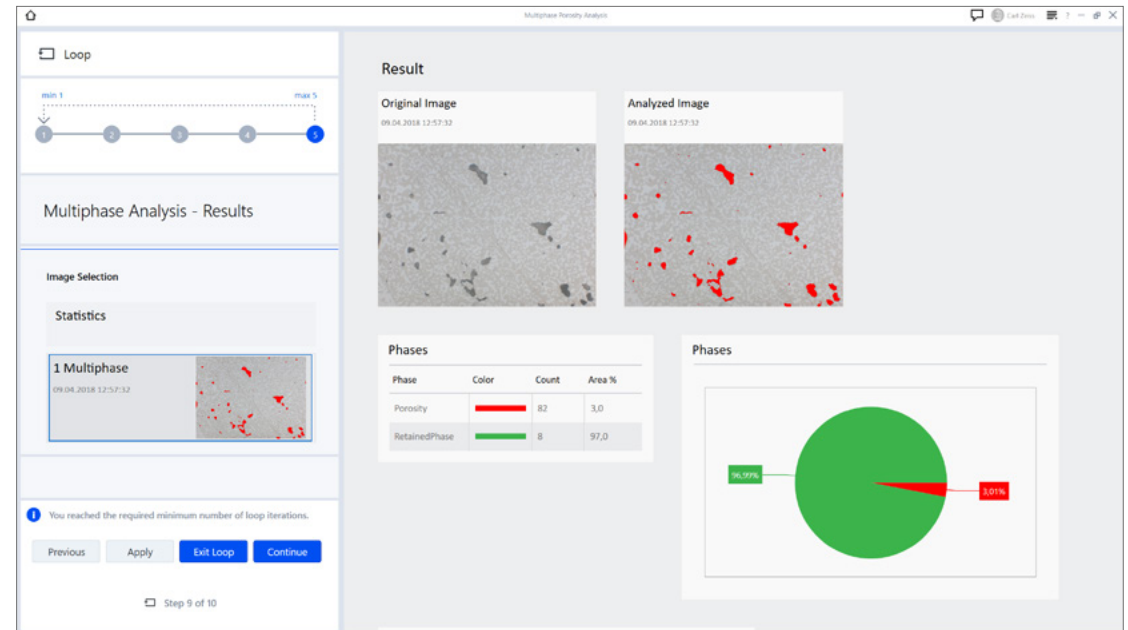
ZEISS ZEN core at Work

Multiphase Analysis

Any part of a material with a distinct composition can be taken as a "phase". Different phases are separated from one another by distinct boundaries. Distribution and orientation of phases affects the material properties such as hardness, strength or elongation.

Analyze the phase distribution in your samples. Determine size, shape or orientation precisely and fully automatically. Use this distribution analysis to gain information about porosity of additively manufactured material.

Beyond classical thresholding, AI-based tools offer machine learning models that you can conveniently train in ZEN core with the ZEN Toolkit AI. Or, use sophisticated deep learning models for semantic or instance segmentation and train your models in the cloud with arivis Cloud.

Multiphase Analysis – result view with distribution of different phases

ZEISS ZEN core at Work

Cast Iron Analysis

Depending on process parameters and chemical composition of the material, graphite particles in cast iron can occur in different shape and distribution. This influences the mechanical properties of the material.

Analyze the shape and size of graphite particles fully automatically. Obtain the spheroid number according to DIN EN ISO 945 (2019). Determine the nodularity of vermicular graphite and examine the content of graphite particles in area percentage.

Supported Standards:

DIN EN ISO 945:2019

Cast Iron Analysis – image segmentation step

ZEISS ZEN core at Work

Layer Thickness Measurement

Measure thickness of coatings and platings, or the depth of hardened surfaces in the cross section of a sample.

Evaluate complex layers systems either automatically or interactively. The module calculates the course of the measurement chords depending on the gradient present.
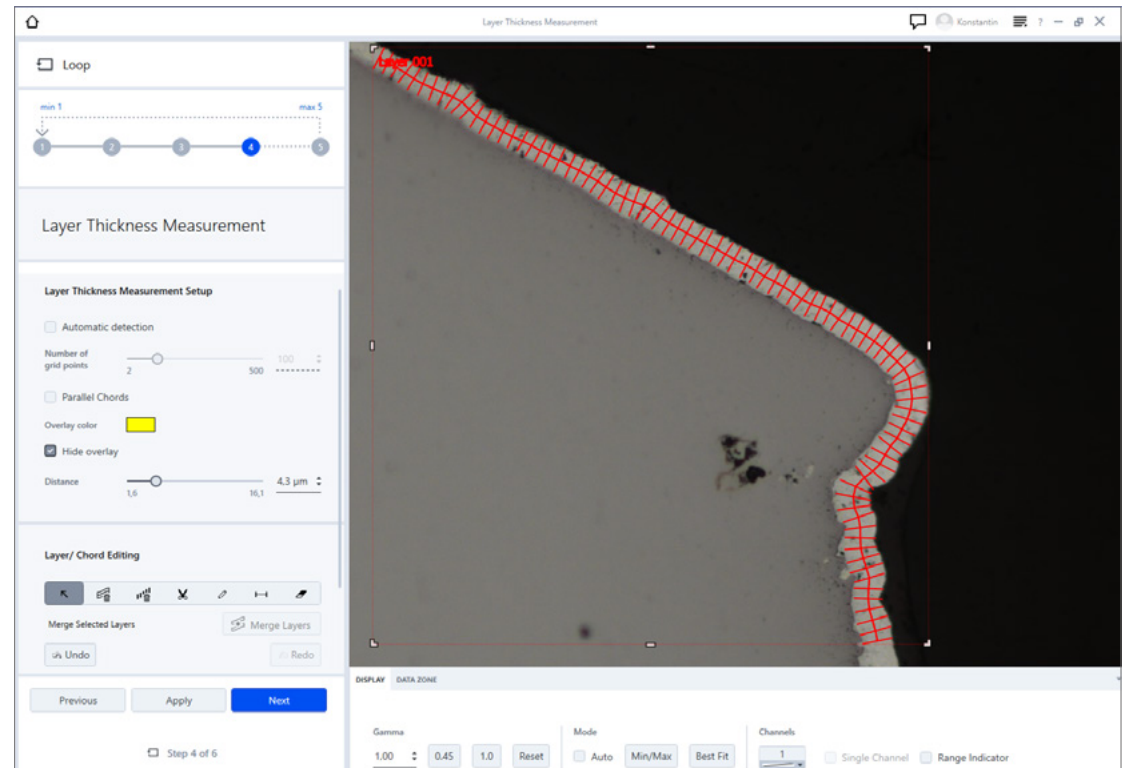
Get the results from your part in a clear report containing images, sample data and measurement values, such as the maximum and minimum chord lengths, mean, and standard deviation.

Image segmentation can be performed by the latest machine learning algorithms (see ZEN Intellesis).

The latest AI technology offers powerful machine learning models as an alternative to conventional image segmentation. Train your models directly in ZEN core with the ZEN Toolkit AI or perform semantic segmentation with deep learning models trained with arivis Cloud.

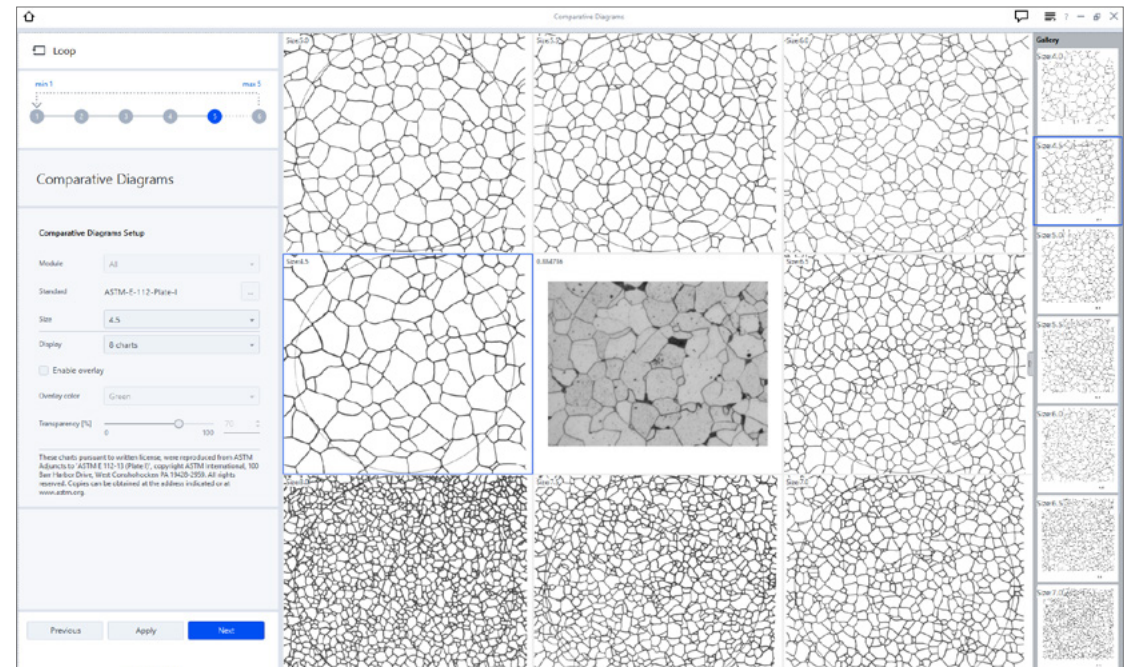**Supported Standards:**
- DIN EN ISO 1463:2004
- ASTM B 487 – 2007

Layer Thickness Measurement – automatic detection of a layer

ZEISS ZEN core at Work

Comparative Diagrams

Make your Wall Charts digital. Compare your sample under the microscope with comparative diagrams directly on your screen. Choose between different schematic micrographs with specific characteristics. These change gradually from image to image and may relate to grain size, carbide precipitation in steel, or quality of sample preparation. The module also provides a chart series creator to design your own comparison diagrams, e.g. for pass-/fail criteria in quality control or best target preparation images for your individual material microstructures.

Comparative Diagrams: Compare the sample with standardized or customized wall charts.

Supported Standards

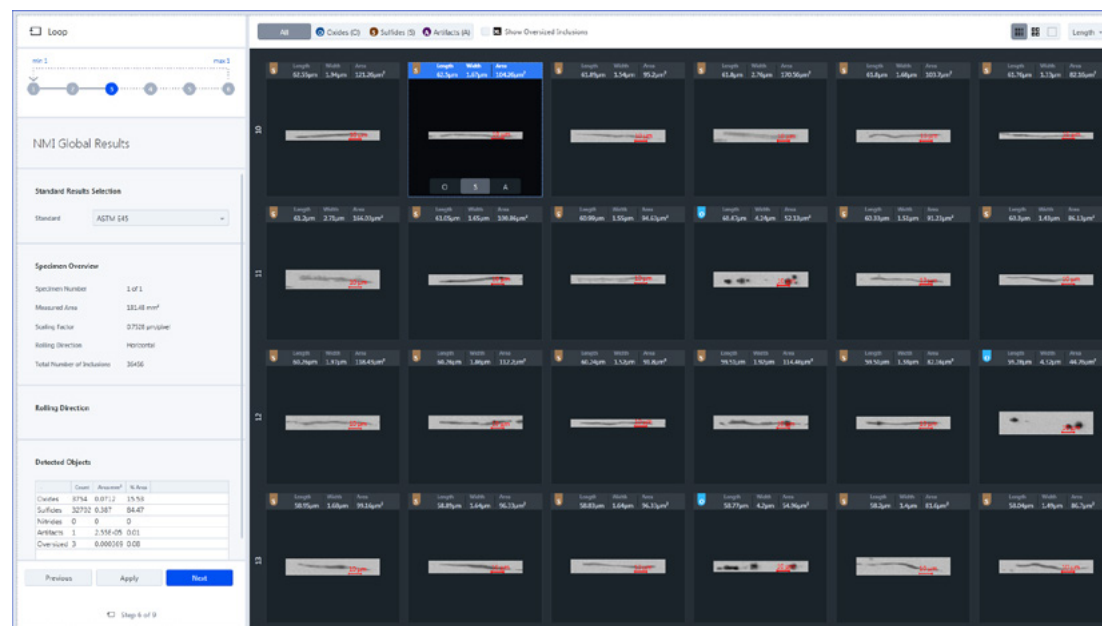| Grains:	Non-metallic inclusion (NMI):
DIN EN ISO 643:2020	ASTM E45
ASTM E 112-13 Plate I-IV	ISO 4967
GB/T 6394 2017 Plate I-IV	GB/T 10561
	EN 10247
Graphite:	DIN 50602
EN ISO 945-1:2019	

ZEISS ZEN core at Work

Non-Metallic Inclusion Analysis

The type and amount of non-metallic inclusions (NMI) in steels strongly affects the mechanical and physical properties of these steels.

Metallographic analysis of NMI is governed by industry standards that are supported by the modular and customizable ZEN core software which guides the user quickly and easily through the workflow, generating a report and inclusion gallery compliant with the standards.

ZEISS ZEN module Non-Metallic Inclusion Analysis confirms that manufacturing processes, grade and quality of the product meet strict specifications for impurities or defects that can cause a component to fail or impact its tensile strength, toughness and fatigue.

Powerful inspection views and automated deformation axis detection features make analysis easy, intuitive and repeatable. With additional GxP functionality, ZEN core users are able to offer their customers full traceability and data integrity in NMI analyses, meaning that grade certification is auditable, which is particularly advantageous for customers in regulated industries.

NMI user interface: Global Results view providing the option to toggle between the display of inclusion types oxides, sulfides, and artifacts.

Supported Standards

ASTM E45

ISO 4967

JIS G0555

GB/T 10561

EN 10247

SEP 1571

DIN 50602

ZEISS ZEN core at Work
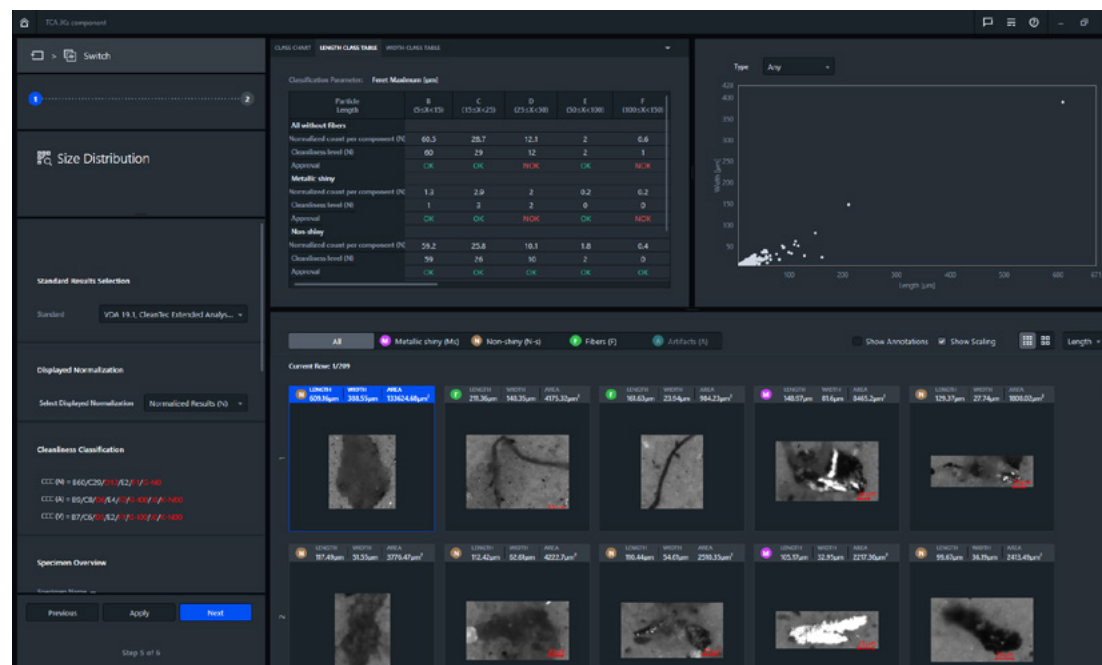
Technical Cleanliness Analysis

Technical cleanliness in production areas is vital for any company that aims to produce along globalized standards. Manufacturers and end users alike demand ever-higher quality standards to avoid contamination. Identifying critical contamination levels for components, parts, oil or hydraulic fluids—as well as for medical devices—is therefore essential to maintaining high quality production. Technical Cleanliness Analysis is your easy-to-use module enabling the identification, classification and height measurement of particles along standard-compliant analyses. Correlative microscopy lets you combine data from light and electron microscopes in a seamless workflow. Automated reporting puts major industry standards such as process data transfer of HYDAC extraction units at your disposal. Machine learning algorithms, as well as pretrained and trainable classification models provide additional productivity and improve the reliability of your cleanliness results.

One-scan Technology

Acquiring brightfield and crossed polarization images in just one scan speeds up both your workflows and the identification of contamination sources. ZEN core gives you access to extended analysis workflows and central data management—for example, GxP options for CFR

Technical Cleanliness Analysis user interface: Size distribution view

compliance such as electronic signatures and audit trails or global cleanliness structures.

Supported Standards:
Component Cleanliness

VDA 19.1

ISO 16232

Environmental Cleanliness

VDA 19.2 (Illig Value)

Cleanliness of Medical Devices in the Manufacturing Process:

VDI 2083, Part 21

Oil Cleanliness:

ISO 4406
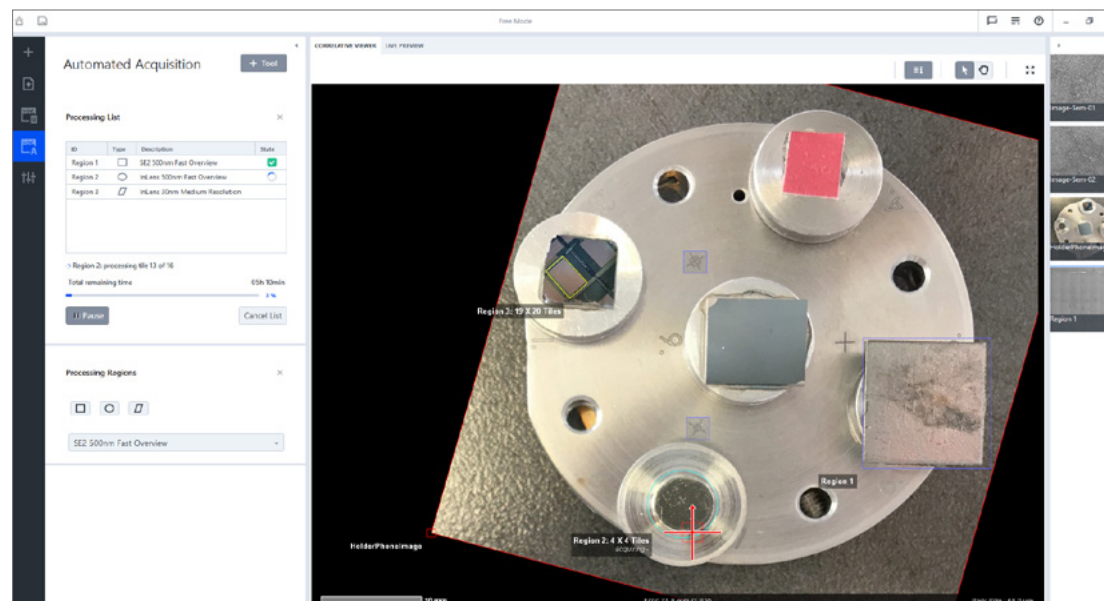
ISO 4007

NAS 1638

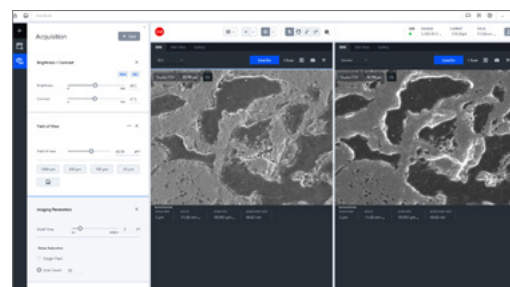SAE AS 4059F

ZEISS ZEN core at Work

Automated Imaging for Scanning Electron Microscopes (SEM)

ZEN core helps you correlate multiple image types with SEM data. The Automated Imaging module is your SEM toolkit for streamlined, automated image acquisition to maximize productivity.
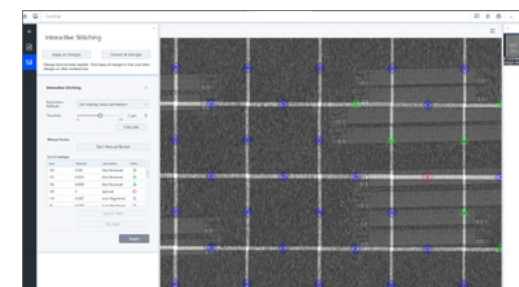
- Correlate images from multiple sources for a comprehensive multiscale understanding of your sample.
- Use the ZEN Connect Correlative workspace to efficiently place imaging regions at the desired locations on the sample.
- Acquire large tiled image sets for maximum information on multiple regions of interest.
- Stitch all tiles seamlessly and achieve perfect image quality over multiple length scales from mm to nanoscale resolution.
- Take advantage of automated acquisition using customized imaging protocols for flexibility to achieve the best image results.
- Create your library of protocols for consistent, reproducible imaging results to reduce operator variability in multi-users facilities.
- Schedule long unattended acquisitions of multiple mosaics for maximum productivity overnight or over the weekend.
- Ensure consistent image quality by using Autofocus and Autostigmator over long runs and large areas.

Operators can define rectangular, circular or even freehand regions for automated, protocol-based SEM acquisition, leveraging the ZEN Connect workspace. The red cross and box indicate the current stage position and FOV.

The Single Acquisition workbench allows multiple detector signals to be seen at the same time in configurable view containers including the chamber camera view. SEM imaging settings can be changed easily and single images get acquired with one click.

After an SEM mosaic acquisition the image is stitched by automated algorithms. In case these do not yield a perfect result, every individual seam can be reviewed and adjusted manually using the Interactive Stitching workbench
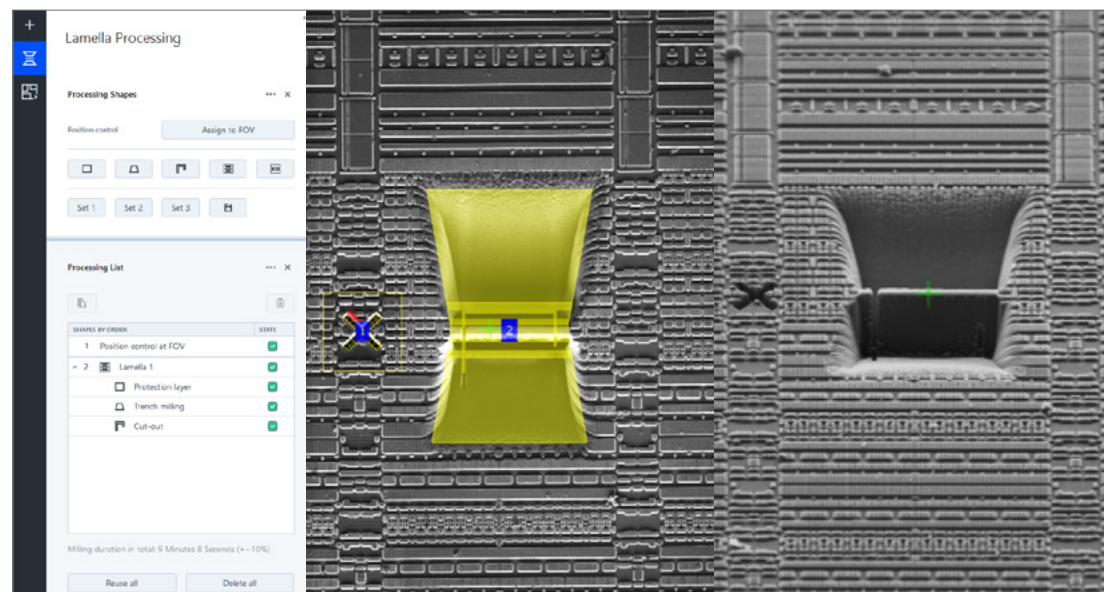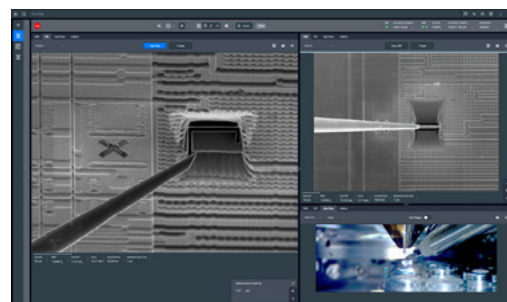
ZEISS ZEN core at Work

TEM Sample Preparation for ZEISS Crossbeams

ZEN core takes full control of ZEISS Crossbeam for the fast, easy and reliable preparation of samples for transmission electron microscopy (TEM) studies.

- Speed up your workflow with a task-specific workbench that shows only the controls you need.
- Run automatic routines for the preparation of single or multiple regions of interest.
- Experience ease-of-use with fully integrated micromanipulator control. Intuitively drive the manipulator needle by just clicking on SEM and FIB images.
- As a novice, enjoy high success rates from start on using guided workflows.
- Increase the productivity of your advanced TEM sample workflows for planar view and backside preparation. For example, changing the TEM sample support orientation from vertical to horizontal or back using the ZEN Sample Preparation holder is a simple one-click operation.

Automated TEM sample preparation. (left) Processing list. (center) FIB view with milling objects. (right) SEM view.

TEM sample preparation with intuitive manipulator control.
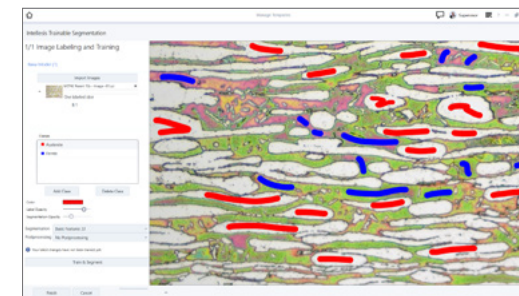
ZEISS ZEN core at Work

ZEN AI Toolkit

Automate your workflows and ensure that the results are reproducible, precise, and operator independent with the ZEN AI Toolkit including: automated image segmentation based on machine learning algorithms, automated object classification of segmented and analyzed images based on machine learning algorithms, AI-based denoising of images using noise-2-void algorithms and instance segmentation for cloud-based training and localized execution.

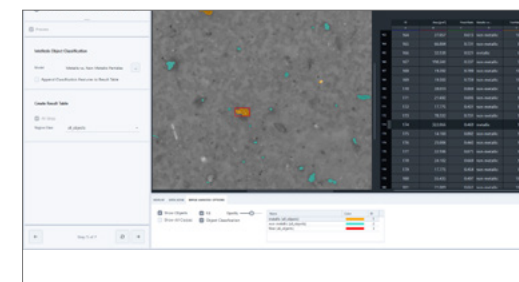**A Spotlight on ZEN Intellesis Segmentation**

Segmentation is one of the biggest challenges faced by today's microscopists. With ZEN Intellesis Segmentation you can leverage powerful machine learning algorithms fully integrated into ZEN core. The user-friendly training interface allows you to train classical machine learning models without the need to be an AI-expert. Use your own expertise to train the software and let it perform automated segmentation. Train and segment data acquired with multiple imaging modalities and easily achieve superior segmentation results of any of your data including 3D datasets and tiles acquisitions. You will also benefit from saving time in sample preparation as ZEN Intellesis Segmentation can adapt to your own preparation process. Reproducibility is guaranteed as the stored model can be used again, sample by sample, or retrained to handle new samples.

A Spotlight on ZEN Intellesis Object Classification

Sometimes segmenting objects such as particles, inclusions or grains is straightforward, but it can still be hard to classify them further into different types. Even machine learning-based segmentation techniques may struggle in this case because they only take the appearance of pixels into account and are unable to consider derived properties of pixel clusters (objects) as well. ZEN Intellesis Object Classification now offers an easy way to classify already segmented objects into sub-classes. Based on the same machine learning algorithms as ZEN Intellesis Segmentation, an object classification model can be trained to perform the classification automatically. Instead of looking at individual pixels, the model uses more than 50 properties measured per object to distinguish them. These derived measurements include all kinds of geometric as well as intensity-based features. Since ZEN Intellesis Object Classification works on tabulated instead of image data, the classification process is much faster than, for example, segmentation by specifically trained deep neural networks. Additionally, it is independent of the prior segmentation, whether it was done by classic thresholding or using machine learning.

ZEN Intellesis Segmentation user interface: All you have to do to teach the system how to segment the image is label a few regions by simply painting them in.

ZEN Intellesis Object Classification user interface in Job Mode: Particles that have been segmented e.g., via thresholding are further classified into metallic (orange) and non-metallic (green) particles based on measured properties. The results are listed in a table and indicated in the image. To evaluate their location and properties, individual objects can be selected and high-lighted in the image and table accordingly.
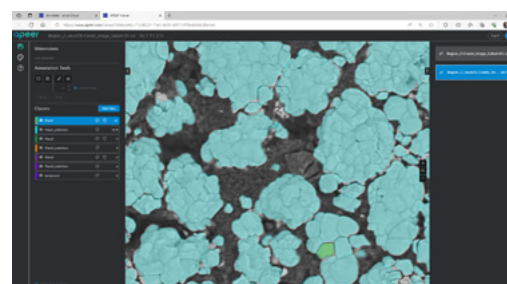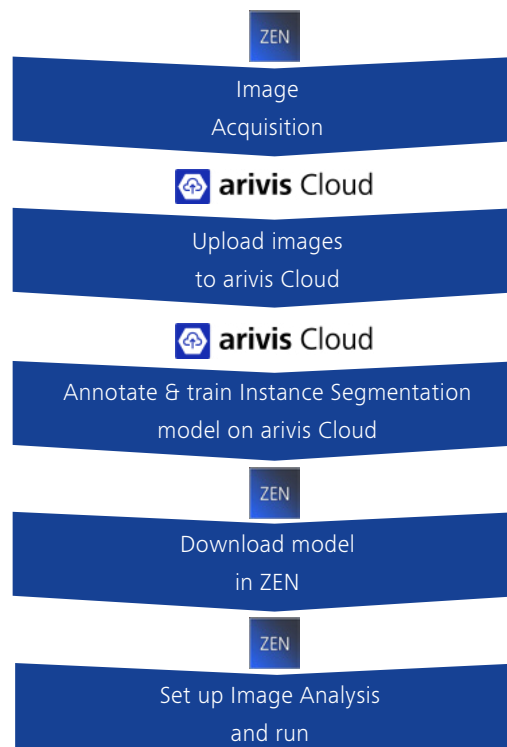
ZEISS ZEN core at Work

Instance Segmentation

Apply powerful AI-based tools for challenging samples: instance segmentation is particularly suitable in case of touching or overlapping objects. Typical application examples for materials science are dense battery samples. Ensure high performance training of your deep learning models by using arivis Cloud. As a next step, download your trained models into ZEN core and apply them to numerous workflows. The instance segmentation models are seamlessly integrated into ZEN core and can be used to segment any kind of data, including 3D datasets as well as images from different imaging modalities from LM to EM. A one-year subscription for arivis Cloud is now included in the AI Toolkit.

A training and an execution phase characterize a typical work-flow of instance segmentation, applied to a battery sample here. The illustration shows possible steps for both. The screen-shots visualize the streamlined GUI: During the training phase, an instance segmentation model is trained on arivis Cloud for a battery cathode (left, green: annotated particles, blue: prediction). During the execution phase, the deep learning model is applied to multiple datasets in ZEN core and allows to segment clustering and touching objects (right).

Training Phase
(once)

ZEN

Image
Acquisition

arivis Cloud

Upload images
to arivis Cloud

arivis Cloud

Annotate & train Instance Segmentation
model on arivis Cloud

ZEN

Download model
in ZEN

ZEN

Set up Image Analysis
and run

Execution Phase
(multiple times)

ZEN

Image
Acquisition

ZEN

Image Analysis using
Instance Segmentation

ZEISS ZEN core at Work

ZEN Connect: Quality Data Put in Context

Organize and visualize different microscopy images and data from the same sample in context, all in one place. For sample-centric analysis, ZEN Connect workflows enable you to get from a quick overview image to advanced imaging with multiple modalities. The correlation between images at different scales can be explored in the workspace and easily used for navigation. The interdependencies of different datasets can b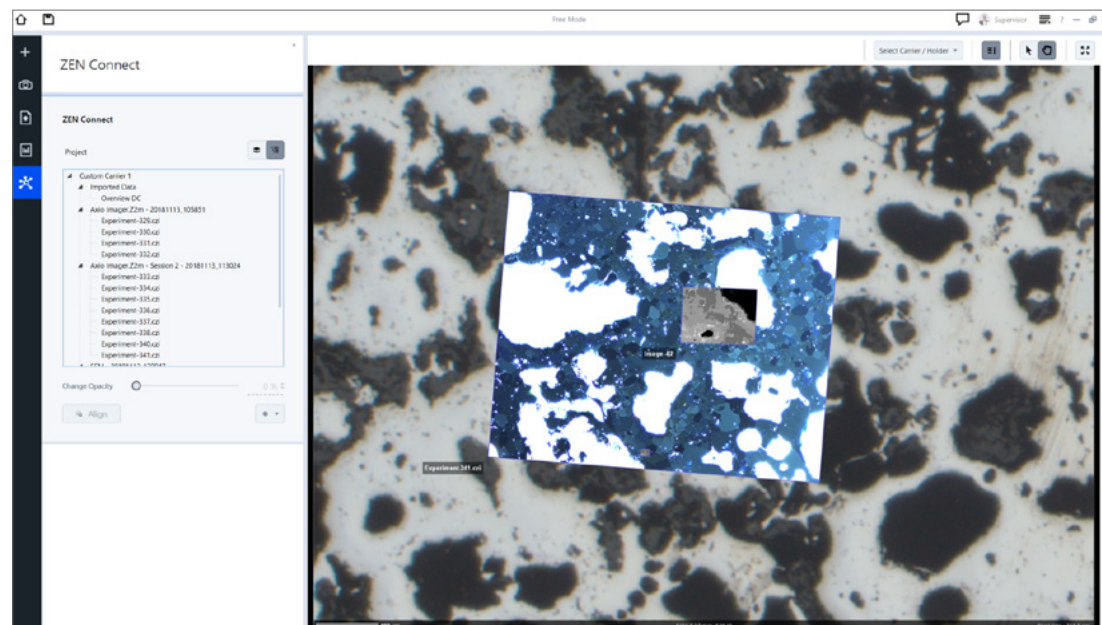e stored, exported and re-used in a Client Server Database. ZEN Connect also enables integrated reporting across the connected images, videos and datasets.
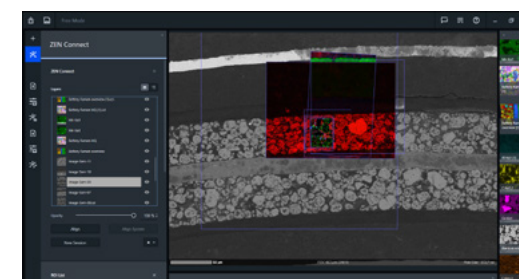
Correlative Microscopy

The correlative microscopy interface enables you to seamlessly transfer samples between different light and/or electron microscopes, then quickly and automatically relocate regions of interest to collect maximum relevant data with minimal effort.

- Organize and align data and images from multiple modalities in a sample-centric workspace.
- Import third-party images including even metadata when supporting the BioFormats standard.
- Import Horiba and Witec Raman maps and attach even non-image data at a chosen position in the workspace.

*ZEN Connect user interface. All images are aligned and well-structured in a single ZEN Connect project
Sample: 3D printed gear wheel; sample courtesy: T. Schubert, Aalen University, Germany.*

- Choose from different options to align your images precisely.
- Perform exportable line, angle and area measurements in the workspace within or across aligned images.
- Transfer samples and image data between ZEISS light and electron microscope systems.
- Relocate regions of interest automatically.
- Benefit from interpolated multichannel image export out of the workspace and easy-to-use video export.
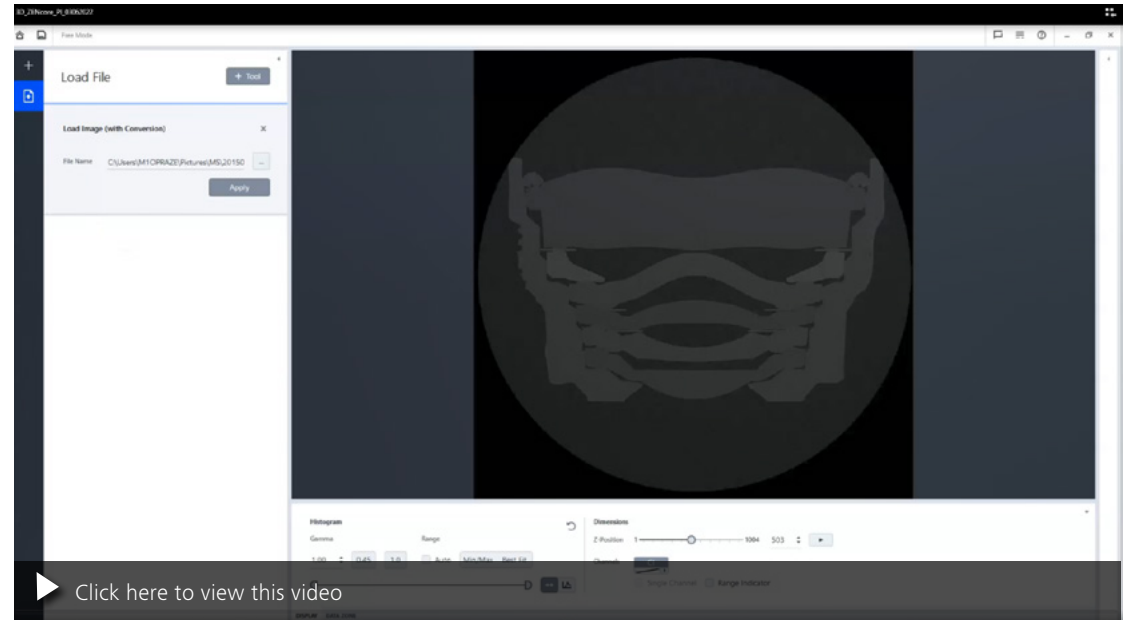

*Multi-modal experiment on a lithium-ion battery using
ZEN Connect showing the overlay of a SEM image and a Witec
Raman map displayed in the viewer of the Correlative Workspace.*

ZEISS ZEN core at Work

3D Visualization

The 3D viewer integrated into ZEN core lets you visualize datasets from ZEISS X-ray microscopes (XRM), micro-computed tomography systems (CT) and ZEISS FIB-SEMs (focused ion beam scanning electron microscopes). Explore data in 3D or try different render modes and vary settings for display or appearance. Clipping planes will allow you to view cross sections through all your data. Create snapshots of the 3D views for your reports. Or visualize data of correlative, multi-modal workflows done with XRMs and FIB-SEMs.

▶ Click here to view this video

Investigation of a camera lens of a mobile phone, done with a ZEISS X-ray microsope.

ZEISS ZEN core at Work

GxP Toolkit

The GxP toolkit enables traceable workflows through seamlessly integrated microscopy hardware and software to meet the requirements of industries such as pharmaceutical or medical. Every workflow available in ZEN core can be made GxP compliant.

The GxP module helps:

- **Quality Managers** who want to guarantee reproducible results and secured processes
- **Validation Engineers** who want to be able to validate their microscopy processes
- **Lab Managers** who need to document their microscopy processes
- **IT Managers** who need backup/disaster recovery functionality, and archive/database capability
- **Pharmaceutical Companies** who need to be compliant to e.g. FDA 21 CFR Part 11

Audit Trail of all user activities

Use a variety of tools and functionalities in combination with the required qualification and validation activities to maintain GxP compliance for your images, tables, and reports:

- User management
- Audit trail
- Release procedure of workflows
- Electronic signatures, incl. countersign functionality
- Checksum protection of process-critical data
- Disaster recovery
- Combination of different clients via database

User Management · FDA 21 CFR Part 11 compliant · Audit Trail · ZEN core GxP Module · Workflow Management · Electronic Signature · Disaster Recovery

ZEISS ZEN core at Work

Browse Results

Easily browse and access all results, even those generated from multiple instruments operated via ZEN core in one central location.

- Access data collected from individual systems or from multi-modal workflows.
- Store your results and templates centrally across systems, laboratories and locations.
- Organize your data through document tagging.
- Browse your assets with powerful sorting and filtering features including search term history and quick filters.
- Upgrade to database and multi-user systems.

Filtering and managing your results in the browse result view of ZEN core

ZEISS ZEN core at Work

ZEN Data Storage

As digitization continues to improve microscopic investigations, you're faced with an ever-growing mass of images and data that needs to be managed, all the more so in multi-user laboratories. ZEN Data Storage enables you to separate image and data acquisition from post-acquisition works, making everyone in the lab work more efficiently in a number of ways:

- It's easy for experts and non-experts alike to share instrument presets, workflows, data and reports.
- Access to all data from different microscope systems is a given, as is data from mobile and desktop devices – and from different locations too.
- You can access any ZEN Data Storage content with ZEN Data Explorer, a hybrid app for iOS and Android that lets you browse, view and annotate images and ZEN core job results.
- Existing image collections, including third-party images, can be uploaded automatically in the background or leverage the ZEN Data Explorer web interface.
- Use ZEN Data Explorer to access and explore even ZEN Connect projects.
- Group your images and data into collections, define read/write access and share them easily with your peers.
- With effortless correlation of data from different microscopes, you can perform multi-modal workflows and reap maximum information from your samples.
- Help your IT department implement security and backups by keeping all your data on one central server.

ZEN Data Explorer: The web-based app, included in the ZEN Data Storage server package, allows you to browse, view, and annotate images on smartphones and tablet devices.

ZEN Data Explorer: Web view allows you to access data on ZEN Data Storage from your favorite browser. It also supports the display of ZEN Connect projects.

Central Data Management
Central storage of images, analysis data, presets, workflows, and reports

■ ZEN Data Storage

Mobile Access
Data exploration on tablet computers, smartphones, and other mobile devices

■ ZEN Data Explorer

Your Flexible Choice of Components

General Base Functionality

General Functions	ZEN starter	ZEN analyzer	ZEN core	Description
General Workbenches	●	●	●	General image acquisition and image analysis functionality via workbenches
Job Mode		●	●	Configurable mode to guide operators through a pre-defined workflow
Basic Measurement	●	●	●	Basic functions for interactive measurement
Measurement	●	●	●	Extended functionality of interactive measurement
Online Measurement		●	●	Measurement of areas and non-area values in the live image
Topo View		●	●	3D visualization of topography images and hightmap representation
Reporting	●	●	●	Creation of reports containing detailed information
Report Template Creator (MS Word® Add-In)	●	●	●	Software to create report templates using MS Word®
ZEN Connect Entry	●	●	●	Interactive acquisition and contextual display of images in single- and multi-instrument workflows
Connection to arivis Cloud	●	●	●	Connection to arivis Cloud, a cloud-based platform to share, run, and customize microscopy workflows
arivis Cloud Advanced		●	●	Download individual modules from arivis Cloud and execute them locally for specialized tasks
CAD Import		●	●	Import CAD data to create overlay images
Connection to Confomap		●	●	Connection to Confomap for surface roughness analysis
Connection to GOM Inspect		●	●	Connection to GOM Inspect for advanced topography analysis
Qual Data Export		●	●	Create measurement files for Database like ZEISS PiWeb or qs-STAT
ZEN Data Storage Client	●	●	●	Seamlessly connect to ZEN Data Storage Server for central storage of documents and templates
Third-party Import		●		Import 3rd-party microscopy images and metadata into ZEN core

LM-specific	ZEN starter	ZEN analyzer	ZEN core	Description
Microscope Control			●	Control of light microscopes and devices via software
Camera Control	●		●	Control of cameras from software
Panorama	●		●	Manual acquisition of high resolution images; automated acquisition and stitching functionality on coded and non-coded stages
Manual Extended Focus	●		●	Manually acquire multiple images at different focus positions and combine them to an image with a greater depth of field

EM-specific	ZEN starter	ZEN analyzer	ZEN core	Description
Microscope Control			●	Control of scanning electron microscopes and devices via software

Your Flexible Choice of Components

Acquisition Toolkits		ZEN starter	ZEN analyzer	ZEN core	Description
Base Acquisition	Multichannel Acquisition	O		O	Enable routine applications:
	Time Series				■ Simultaneous acquisition of multiple (fluorescence) channels ■ Acquisition of images at defined intervals
Motorized Focus Acquisition	Motorized Extended Focus			O	Enable motorized applications on your microscope: ■ Automatically acquire multiple images at different focus positions and combine them to create an image with a greater depth of field ■ Determine the focus position of your sample
	Autofocus				
Motorized Acquisition	Motorized Extended Focus			O	Enable motorized applications on your microscope: ■ Automatically acquire multiple images at different focus positions and combine them to create an image with a greater depth of field ■ Determine the focus position of your sample ■ Record exact and high-resolved images of large samples by automatically scanning pre-defined areas
	Autofocus				
	Tiles & Positions				
Smart Acquisition	Guided Acquisition			O	Automatically identify interesting positions in overview images and create detail scans of respective positions
Linkam	Linkam (Hardware Control)			O	Interface to control Linkam heating and cooling stages
Coded Microscope	Coded microscope	O			Read out of coded microscope components

Toolkit		ZEN starter	ZEN analyzer	ZEN core	Description
Developer Toolkit	Macro Environment		O	O	Use Python programming language to generate customer specific macros
GxP	GxP		O	O	Ensure traceability and accountability of workflows (precondition for 21 CFR Part 11 compliance)
2D Toolkit	Image Analysis		O	O	Toolkit for 2D image analysis by creation of automatic measurement programs. Advanced processing functions included
	Advanced Processing				
3D Toolkit	3Dxl		O	O	Visualization of 3D data in ZEN core
	Advanced Processing				
AI Toolkit	ZEN Intellesis Segmentation		O	O	Complete toolkit for AI application including integrated training interfaces: ■ Automated image segmentation based on machine learning algorithms ■ Automated object classification of segmented and analyzed images based on machine learning algorithms ■ AI-based denoising of images using noise-2-void algorithms
	ZEN Intellesis Object Classification				
	ZEN Intellesis AI denoising				
	Instance Segmentation				

Your Flexible Choice of Components

Toolkit		ZEN starter	ZEN analyzer	ZEN core	Description
Connect Toolkit	ZEN Connect		○	○	Complete Connect Toolkit to extend the ZEN Connect functionality. Includes L-marker calibration for correlative LM to EM workflows and functionality for 3D data. Import 3rd-party microscopy images and metadata into ZEN core using Bio-Formats included.
	ZEN Connect 2D Add-on				
	ZEN Connect 3D Add-on				
	Third-party Import				

Application Toolkits		ZEN starter	ZEN analyzer	ZEN core	Description
Materials Apps	Grain Size Analysis		○	○	Toolkit for materials applications: ■ Determine grain sizes via different methods according to international standards ■ Analyze form, size and distribution of graphite particles in cast iron ■ Automated measurement of particle size and area content of multiphase samples, evaluation of porosity ■ Compare micrographs with standardized or customizable comparative charts (Wall Charts) ■ Automated or interactive thickness measurement of different layers AI "Ready" – pre-trained models can be run to evaluate data. They cannot be created or modified – these tasks require the AI Toolkit. Training can be done either in ZEN core or for Deep learning based models in arivis Cloud with arivis AI.
	Cast Iron Analysis				
	Multiphase Analysis				
	Comparative Diagrams				
	Layer Thickness Measurement				
NMI	Non-Metallic Inclusion Analysis		○	○	Automated imaging, classification and reporting of non-metallic inclusions in steel
TCA	Technical Cleanliness Analysis		○	○	Automated identification and classification of particles compliant to cleanliness standards
TEM Lamella Prep	TEM Lamella Preparation			○	Prepare lamellae for TEM investigation on ZEISS Crossbeam using automated workflows
Auto Liftout	Auto Liftout			○	Enables automatic liftout and attachment of readily prepared lamellae to a TEM grid
Automated Imaging	Automated Imaging			○	Acquire large EM tiles images on ZEISS FE-SEMs via defined imaging protocols

● included   ○ optional

ZEISS Service – Your Partner at All Times

Your microscope system from ZEISS is one of your most important tools. For over 175 years, the ZEISS brand and our experience have stood for reliable equipment with a long life in the field of microscopy. You can count on superior service and support - before and after installation. Our skilled ZEISS service team makes sure that your microscope is always ready for use.

Procurement

- Lab Planning & Construction Site Management
- Site Inspection & Environmental Analysis
- GMP-Qualification IQ/OQ
- Installation & Handover
- IT Integration Support
- Startup Training

Operation

- Predictive Service Remote Monitoring
- Inspection & Preventive Maintenance
- Software Maintenance Agreements
- Operation & Application Training
- Expert Phone & Remote Support
- Protect Service Agreements
- Metrological Calibration
- Instrument Relocation
- Consumables
- Repairs

New Investment

- Decommissioning
- Trade In

Retrofit

- Customized Engineering
- Upgrades & Modernization
- Customized Workflows via ZEISS arivis Cloud

Please note: Availability of services depends on product line and location

>> **www.zeiss.com/microservice**

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