

Avizo Software for FIB-SEM

AI-assisted image analysis for FIB-SEM datasets in materials science

Thermo Scientific™ Avizo™ Software complements the focused ion beam scanning electron microscope (FIB-SEM) imaging workflow through flexible data operations, AI-assisted segmentation, and 3D visualization of FIB-SEM image stacks for advanced measurements of studied materials properties

Avizo Software supports researchers in maximizing the value of advanced FIB-SEM instrumentation by connecting high-resolution imaging with robust image analysis and quantitative interpretation.

From acquisition to insight: an end-to-end FIB-SEM workflow

Advanced FIB-SEM instruments generate high-resolution, information-rich, 3D datasets that are often complemented by one or more spectroscopic imaging technologies such as energy-dispersive spectroscopy (EDS), electron backscatter diffraction (EBSD), time-of-flight secondary ion mass spectrometry (ToF-SIMS), etc. These are combined with the latest ion technologies and milling strategies that permit ever larger datasets covering large regions of interest. These large and multimodal image stacks can be complex to analyze. At the same time, the field is shifting from qualitative studies of 2D cross-sections to true 3D measures of buried interfaces, particle sizes, grain boundaries, bulk material composition, and similar physical properties.

Meeting these demands requires integrated software solutions for efficient and reliable data interpretation. Avizo Software supports downstream workflows with tools for image stack alignment, co-registration with spectroscopy image data, 3D visualization, AI-based object identification, and quantitative analysis of size, shape, and localization, enabling a seamless transition from data acquisition to insight across diverse material sciences applications.

Key features

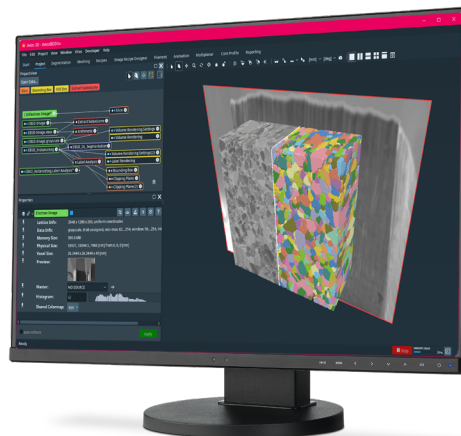
Transforms 3D FIB-SEM and complementary spectroscopy images into quantitative materials characterization

Reduces manual segmentation effort using AI deep learning tailored for electron microscopy (EM)

Extracts robust, statistically meaningful, morphometric, and spatial measurements at scale

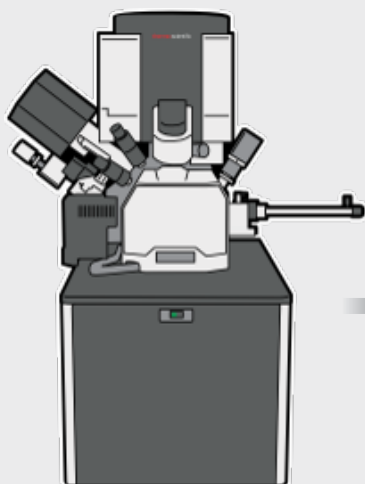
Support for advanced analysis such as pore network modeling, triple-phase boundaries, and fiber tracing

Enables 3D materials characterization in batteries, catalysis, geology, aerospace, metals, composites, and more



Automated metal grain analysis using EBSD in a Thermo Scientific™ Helios™ FIB-SEM combined with deep learning-based segmentation in Avizo Software.

Image acquisition with Thermo Scientific electron microscope



Helios FIB-SEM family
Scios FIB-SEM

Image analysis workflow in Avizo Software



Data import

Bring in and organize data



Pre-processing

Prepare and clean up data



Visualization

Display data effectively



Segmentation

Identify and isolate regions



Quantitative analysis

Extract and measure structures



Presentation of results

Create images, videos,
and reports

How Avizo Software transforms image stacks into reliable, analysis-ready datasets

Raw FIB-SEM datasets provide exceptional structural detail, enabling investigation of materials at nanometer resolution. However, imaging artifacts such as mechanical drift, noise, shear distortions, and curtaining can degrade image quality and limit accurate analysis. These artifacts can compound when combining EM images with another image series such as backscattered electrons+secondary electrons (BSE+SE) or spectroscopy image data like EDS.

Therefore, image pre-processing is a critical step in the workflow. Systematic pre-processing enhances data quality and prepares datasets for reliable 3D reconstruction, quantitative analysis, and AI-driven segmentation.

Avizo Software supports EM image pre-processing:

- Accurate stack alignment to compensate for drift and to help ensure spatial consistency
- Multi-dataset co-registration and flexible 3D transformations, such as mismatched fields of view between image series
- AI-based noise reduction permitting quicker imaging of beam-sensitive samples
- Curtaining correction and removing acquisition artifacts
- Reproducible, workflow-based processing to standardize data preparation across experiments

These capabilities help you transform high-resolution FIB-SEM data into reliable, analysis-ready volumes suitable for visualization, segmentation, and quantitative interpretation.

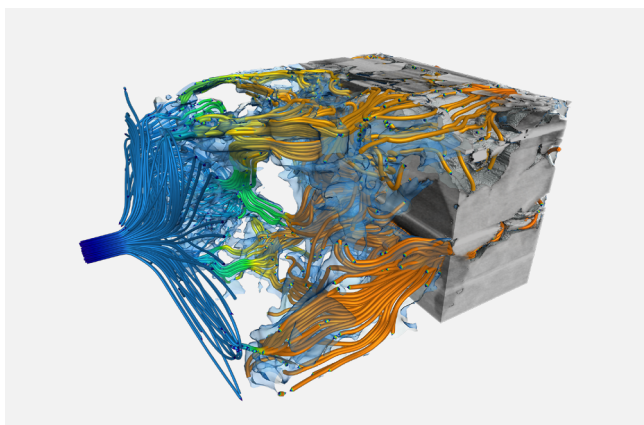
How Avizo Software cuts segmentation time from weeks to hours

Microscopists studying batteries, fuel cells, oil and gas reservoir cores, metal interfaces, porous polymers, and other materials can all face a major challenge: measuring 3D features in a time-efficient manner. When paired with Thermo Scientific™ FIB-SEM platforms, Avizo Software reduces time to measurement through AI-driven deep learning.

Avizo Software offers:

- Intuitive, code-free, user-friendly workflow for annotation, model training, and segmentation
- Simultaneous multi-class segmentation of distinct materials such as cathode and binder, shale and pore, and metal coatings in buried interfaces
- Near-instant AI-assisted object selection for rapid particle segmentation on a per-object analysis
- Full-volume, 3D, automatic object detection of particle-shaped objects with pre-trained models
- Deep-learning denoising with either pre-trained or customized models for reducing dataset-specific noise profiles

With minimal manual annotation, you can train AI models to accurately identify thousands of isolated structures across large volumes, substantially reducing analysis time from several weeks to a few hours while improving reproducibility and consistency.



Fluid flow simulation through nanoporous cracks within a chalk sample imaged with a Helios FIB-SEM and studied in Avizo Software.

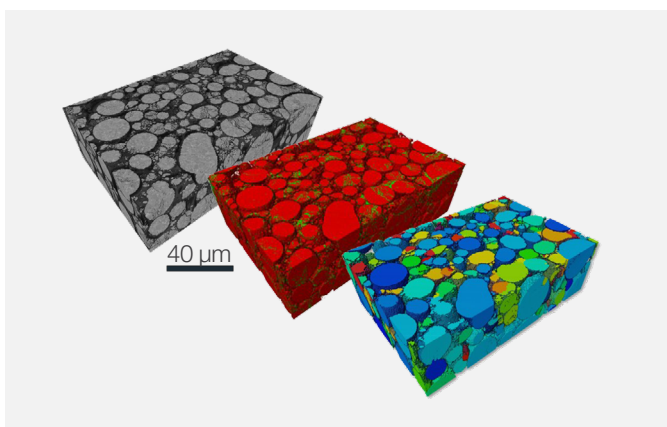
How Avizo Software extracts quantitative insights from complex 3D microscopy

After performing segmentation, Avizo Software enables comprehensive 3D quantitative analysis. You can measure volumes, surface areas, spatial distributions, and morphological parameters across thousands of features within a single dataset. Avizo Software extensions also allow pore network modeling and a unique 3D fiber tracing method.

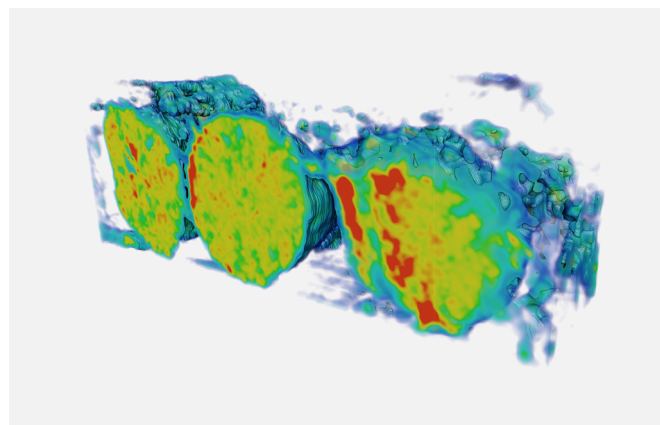
Examples include:

- Particle-level quantitative analysis, such as metal grain size and shape distribution within additively manufactured metal alloys
- Triple phase boundary measurement of the reactive regions in solid oxide fuel cell anodes
- Absolute permeability simulation within the pore phase of shale rocks, both for resource extraction and for carbon capture and storage

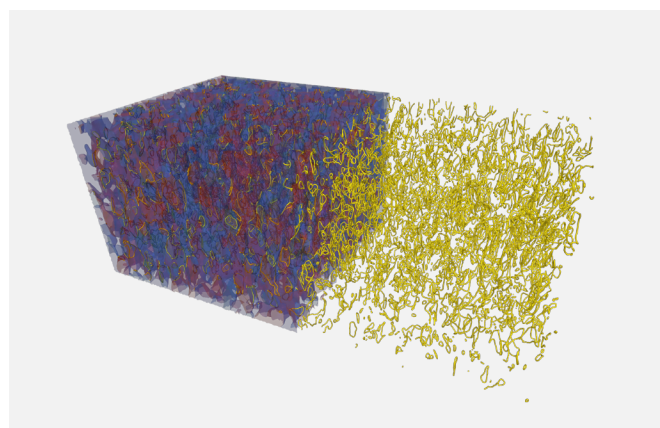
These capabilities allow you to extract statistically meaningful measurements from datasets that were previously too large or complex to analyze comprehensively.



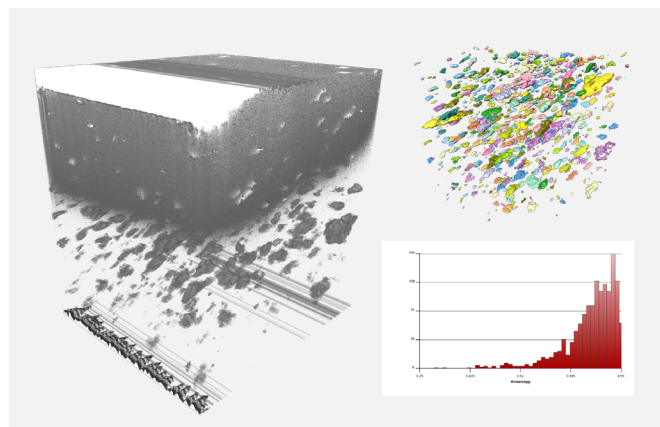
Battery cathode crack analysis showing a large 3D PFIB-SEM volume from an NMC cathode, acquired using a Helios PFIB-SEM. Material was segmented in Avizo Software from SE and several EDS channels. Secondary grains and cracks can be seen in red and green. The third image shows crack density per secondary particle. Sample courtesy: Shirley Meng, UCSD. doi:10.1016/j.joule.2022.12.001.



Understand lithium distribution to increase energy density. Cathode material imaged with a Helios FIB-SEM using FIB-SE and ToF-SIMS. Merged into a co-registered and quantitative 3D volume with Avizo Software.



Characterization of triple-phase boundaries (TPBs) in solid oxide fuel cells using the Thermo Scientific™ Helios Hydra™ PFIB-SEM multidetector imaging at low kV, combined with Thermo Scientific™ Auto Slice & View™ Software and advanced analysis in Avizo Software. Sample courtesy: Prof. Scott Barnett, Northwestern University.



Improving rubber processability and durability. This study of rubber polymer used a Thermo Scientific™ Scios™ FIB-SEM for image acquisition and Avizo Software for deep learning segmentation and measurements of additives that strengthen the rubber.

Features

Data import and handling

- Import and analysis of 2D and 3D datasets from electron microscopy, light microscopy, micro-CT, and spectroscopy images
- Support for large datasets and most established microscopy file formats

Filtering and pre-processing

- Image alignment, filtering, noise reduction, and artifact correction
- Multi-volume image co-registration and visualization
- AI-based denoising

AI-based segmentation

- AI-driven segmentation for complex 2D and 3D microscopy data
- Deep learning workflows with minimal ground-truth annotation
- Multi-class segmentation of layered materials, constituents within composites, heterogenous mixtures, and porous samples
- Robust performance on noisy and low-contrast datasets, including cryo-FIB-SEM and low-kV imaging

Measurement and analysis

- More than 200 built-in quantitative measurements
- Custom, user-defined measurements for application-specific analysis
- Extraction of volumes, surface areas, shapes, and spatial relationships at scale

Visualization and presentation

- High-resolution 2D and 3D visualization of volumetric datasets
- Animation, movies, and report generation

Workflow automation and usability

- DualBeam 3D Wizard for guided data preprocessing of typical FIB-SEM data
- Recipe-based automated workflows for efficiency and reproducibility
- Intuitive user interface for both novice and experienced users

Applications and support

- Applicable across batteries, fuel cells, geology, composites, polymers, metals, alloys, failure analysis, automotive and aerospace, and new materials characterization
- Professional training, consulting, and custom development services

 Learn more at thermofisher.com/avizo

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