thermo scientific



Avizo Software for Materials Research

Materials characterization and quality control

ThermoFisher SCIENTIFIC

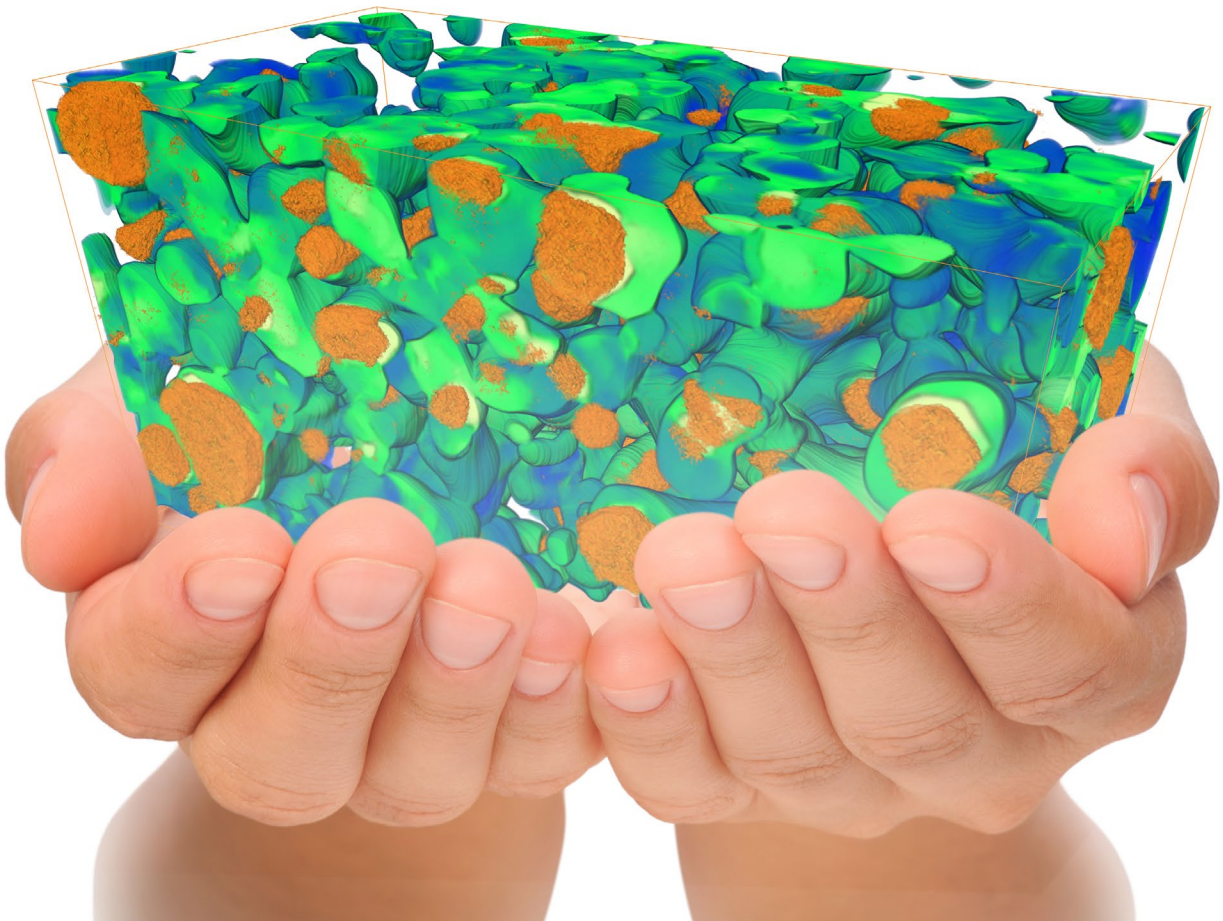
Industrial applications require stronger, lighter, cleaner and safer materials every day.

For new developments or for better characterization of existing materials, Thermo Scientific™ Avizo™ Software allows for a better understanding of structure, properties and performance.

No matter what modality is used to acquire digital data, Avizo Software provides optimized workflows for materials characterization. It also features image processing tools, simulation modules and capabilities for advanced defect analysis.

On the cover: Porosity and permeability analysis of fiber reinforced concrete.
Courtesy of EMPA.

- Ceramics, glasses and porous media
- Metals, alloys and powders
- Composites, polymers and fibrous materials
- Biomaterials
- Batteries
- Additive manufacturing
- Semiconductors
- Food and agriculture



From sample to knowledge

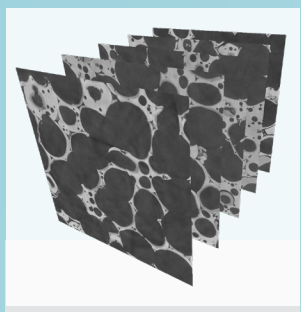
From straightforward visualization and measurement to advanced image processing, quantification, analysis and reporting, Avizo Software provides a comprehensive, multimodality digital lab for advanced 2D/3D materials characterization and quality control.

Digital workflow



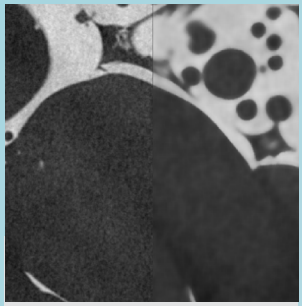
Data acquisition

- X-ray tomography: CT, micro-/nano-CT
- Electron Microscopy
- Synchrotron



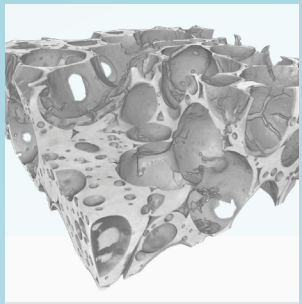
Import

- Raw images
- Multi-modality
- Very large data



Filtering and pre-processing

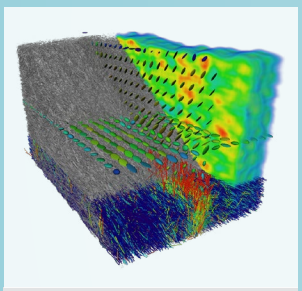
- Noise reduction
- Image artifact reduction
- Background correction



Visualization

- Interactive high-quality visualization
- Direct manipulation of objects

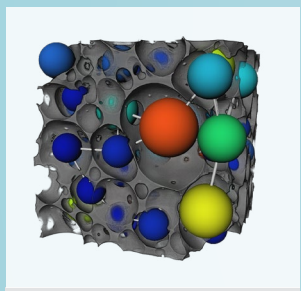
Specialized tools



Fiber analysis

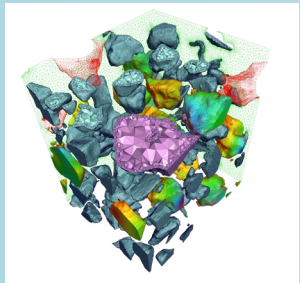
- Individual fiber extraction
- Fiber statistics (per fiber and local): Orientation, distribution/density, length, …

Courtesy of EMS Grivory



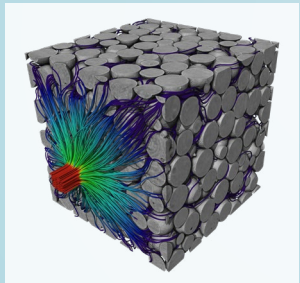
Porous materials characterization

- Pore & throat size distribution, pore connectivity, pore shape
- Graph model generation
- Tortuosity and permeability measurements for porous media



Meshing for FEA/CFD

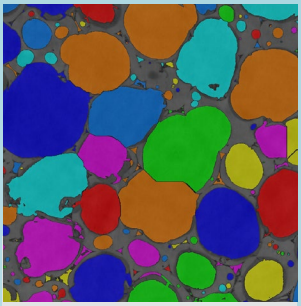
- Generation of 3D mesh direct from 3D images
- Extremely fast generation
- Large dataset handling
- Export to FE-solvers



Simulation of physical properties

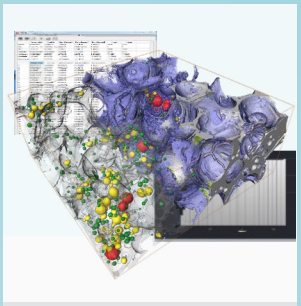
- Absolute permeability
- Thermal conductivity
- Electrical resistivity
- Molecular diffusivity

Courtesy of Dominique Bernard ICMCB-CNRS



Segmentation

- Automatic and supervised segmentation algorithms



Measurement and analysis

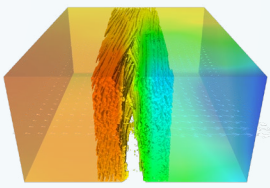
- 200+ measures available
- Custom measures
- Statistics



Courtesy of Zellwerk GmbH

Presentation

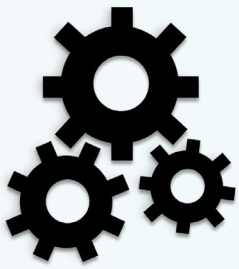
- Snapshots and 3D videos
- Advanced presentation scenario
- 3D stereo devices



Materials deformation analysis

- 3D internal displacement and strain measurements

Courtesy of L. Laiarinandrasana & T. Morgeneyer (Centre des Matériaux Mines ParisTech), and L. Helfen (European Synchrotron Radiation Facility; Karlsruhe Institute of Technology)



Recipe for automatic analysis

- Design and perform advanced data analysis scenario as an automated high-level workflow
- Increase productivity while keeping full power and flexibility of comprehensive data analysis toolset



Amira-Avizo Python

- Access to hundreds of scientific algorithms from the Python eco-system
- Ultra-efficient memory management
- Fully compliant with Python scripting conventions

Large Data Management

Automation

Customization

Avizo Software for materials research

Avizo Software provides a reliable, fully automatable solution for both research and industrial entities, allowing them to innovate faster, reduce time to market, and produce more reliable and better performing materials.

Ceramics, glasses and porous media

Characterization of porous material depends on the size, distribution, and shape of pores and possibly the channels connecting them. For other materials, such as ceramic or glass, understanding the distribution of the different particle types is of upmost importance for estimating performance of the material. Porosity, tortuosity and permeability are some of the important parameters that help characterize the material.

Avizo Software provides an advanced workflow for pore network characterization and particles analysis, including quantification of pores or particles in the material, their volume distribution, shape and distance, as well as computation of material physical properties such as porosity, tortuosity or permeability.

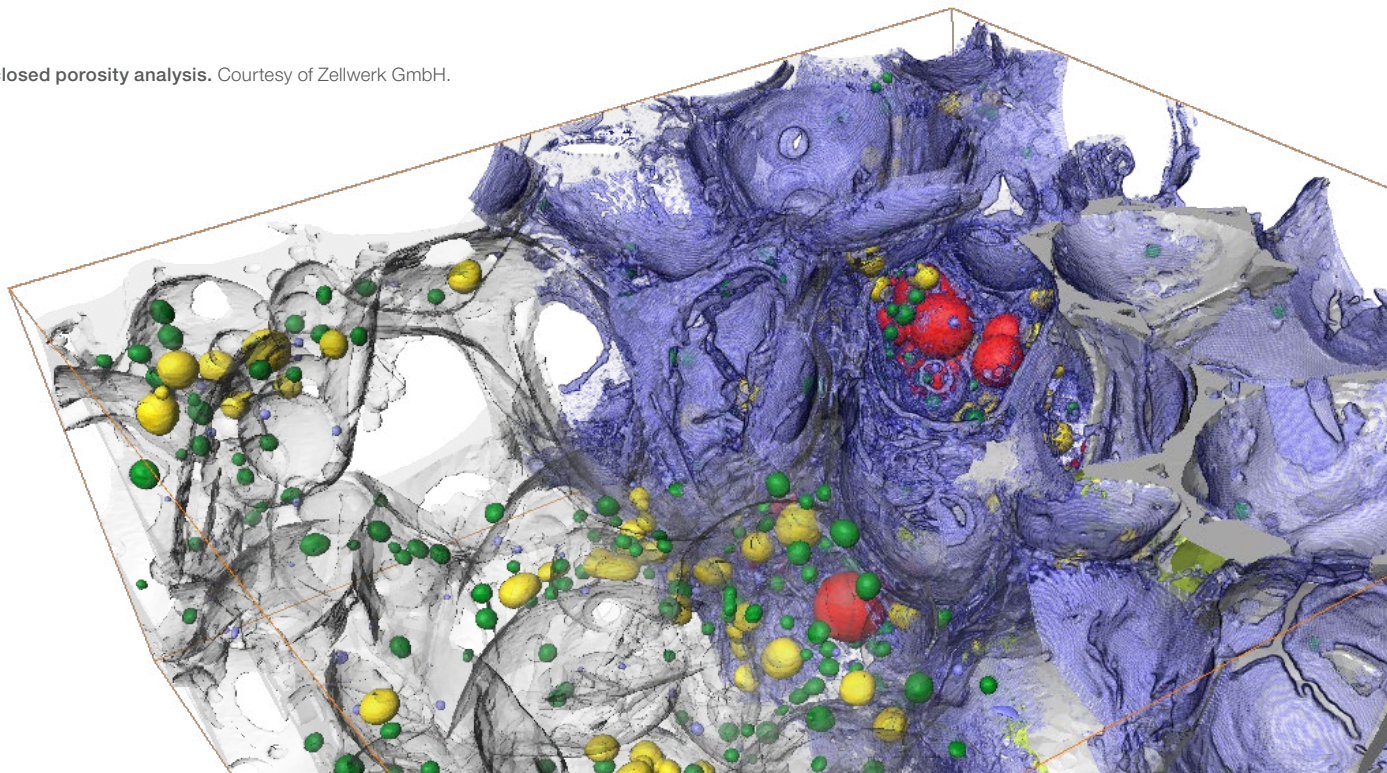
Metals, alloys and powders

Transportation, energy production, machinery, building materials and consumer products require development of metals that are lighter, stronger and more durable. New manufacturing techniques such as additive manufacturing require the development of new types of metal powders.

Avizo Software helps expose the structure-property relationship in metals and alloys. It enables you to fully understand the properties of steel and alloys, in order to quantify their structure and composition, as well as possible defects such as unwanted inclusions. Its advanced set of quantification capabilities allows you to measure the quality of metal powder used for additive manufacturing or to quantify grains distribution, just to name two examples. Sphericity and size distribution of each grain can be measured to assess quality and better understand properties.

Avizo Software's multi-modality support allows for the fusion of data coming from different EM detectors. It can merge, for example, SEM backscattered images with EDS or EBSD images of the sample, providing an even more efficient workflow from data to knowledge. Its multi-resolution support facilitates a powerful correlative workflow, from discovering areas of interest at the macro level to analyzing the sample at the nanoscale.

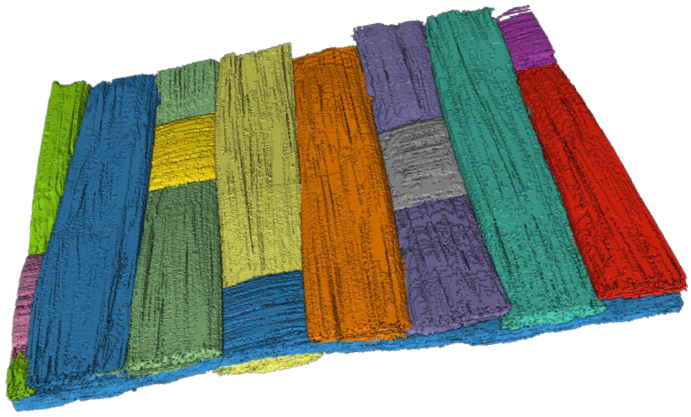
Open and closed porosity analysis. Courtesy of Zellwerk GmbH.



Composites, polymers and fibrous materials

Composite materials are making their way into many different application areas, ranging from aerospace to automotive and construction. Their properties improve stiffness and strength and allow for design of lightweight components at a reasonable cost.

Avizo Software allows for analysis of the fibers that reinforce composite materials, computing length, orientation and density. It also detects matrix defects such as voids or foreign debris, cracking or delamination, and richness or dryness. Avizo Software can analyze pore networks for the latest micro- and/or nano-porous composites, allowing researchers to gain a better understanding of the material properties and perform improved quality control on industrial parts made of composite material. Analysis of deformations of the material under physical constraints allows also for damage prediction of deficiencies.

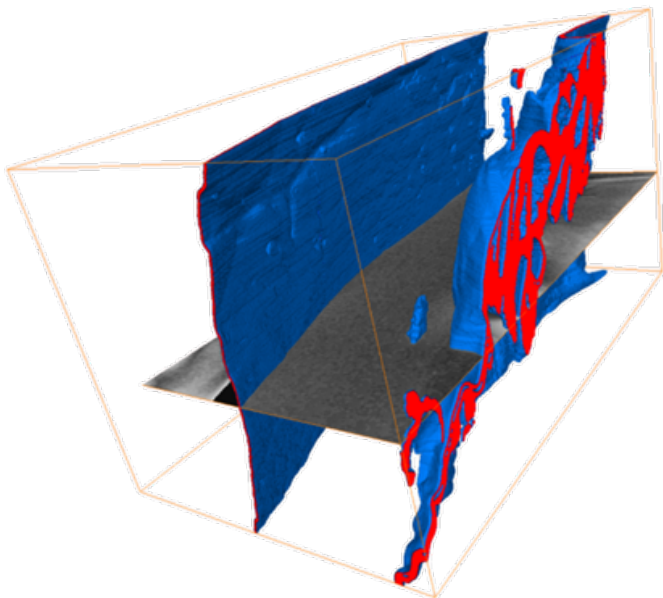


Evolution of damage during fatigue of woven composites.

Biomaterials

Recent progress in manufacturing and characterization of biomaterials has led to innovative development in tissue engineering and scaffold techniques.

Avizo Software can be used to characterize such highly porous media, while also quantifying pore distribution and size as well as high interconnectivity of the porous network. From there, mechanical strength and effective surface for cell attachment can be determined. Furthermore, Avizo Software can be used to validate experiments by generating Finite Element Analysis models and collaborating with FEA solvers, as well as performing deformation analysis from a material sample subjected to physical constraints.



Innovative interconnected porous biomaterial for tissue engineering. Courtesy of Prof. A. Largeteau and Dr. Mythili Prakasam, Institute of Condensed Matter Chemistry in Bordeaux and University of Bordeaux, France.

Batteries

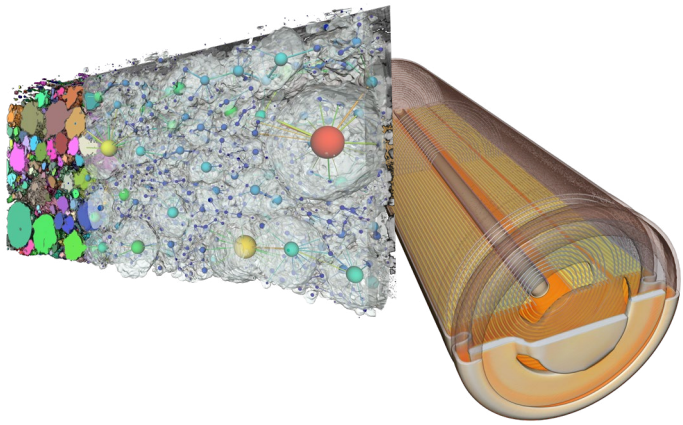
Battery and Solid Oxide Fuel Cell (SOFC) manufacturers need to refine their manufacturing process and increase product lifespan. They also need to reduce the weight and size of their energy storage devices as well as increase charge capacity while lowering production costs, ensuring safety and making the product healthier for the environment.

Thanks to advanced image processing and segmentation techniques, Avizo Software makes it possible to extract key quantitative parameters of the microstructure and macrostructure of the involved materials. At the macro level, Avizo Software can be used to assess the quality of the manufacturing process, looking into packaging, checking solder points, and detecting possible leakage or porosity and delamination. It can also examine the aging process, looking into foil, cathode and anode morphological changes or core leakage. At the microscopic level, Avizo Software allows for the estimation of the tortuosity and permeability of the porosity structure of electrode and separator; thus, effective transport parameters can be further used in the electrochemical performance simulation. Quantification of triple phase boundary (TPB), phase distribution and connectivity further allows for characterization of the cell's performance.

Additive manufacturing

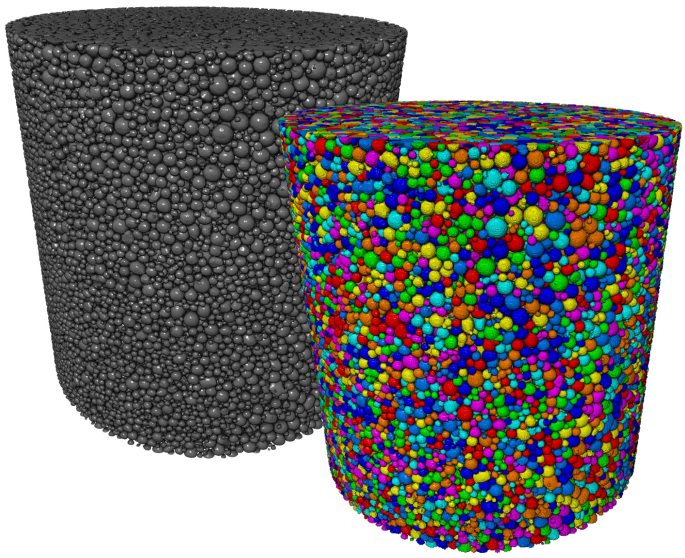
Additive manufacturing has emerged as a very promising manufacturing technique, allowing advanced design of complex industrial parts that used to require numerous sub-parts to be assembled together in the past and allowing for production of lighter and stronger innovative parts. Quality of the powder is essential to integrity of the part, and defect analysis is necessary for final quality check of a material sample or a produced part.

Avizo Software offers a complete range of tools from pre to-post printing quality control of industrial parts. Powder can be analyzed within Avizo Software to provide information such as shape and volume distribution, but also detection of pores or inclusions in the grain that can lead to important defect in the final part. Advanced automated defect detection can be applied on a sample or the final part to look for pores such as gas bubbles, inter-layers cracks, or lack of powder fusion for instance.

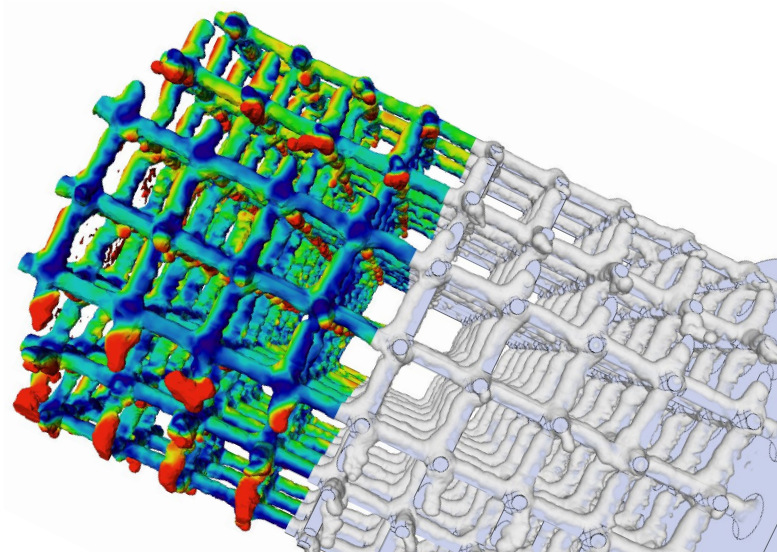


Battery Cathode. Active material connectivity analysis.
Data acquisition: Thermo Scientific Helios™ PFIB DualBeam™.

Li-ion cylindrical cell. Inspection of battery's structure.
Courtesy of Paul Shearing's group, University College London. Data acquisition: Thermo Scientific HeliScan™ microCT.



Ti64 powder analysis - Grain separation, porosity and sphericity analysis.
Data acquisition: Thermo Scientific HeliScan microCT.



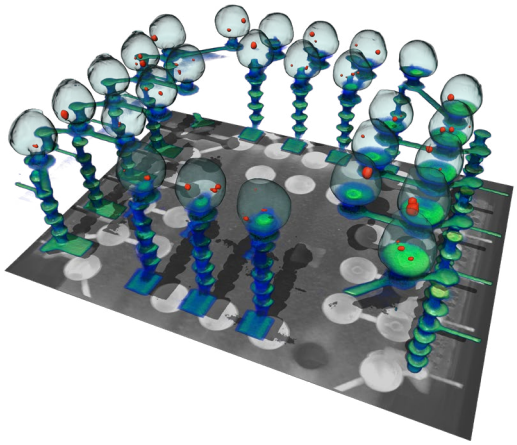
Additively manufactured scaffold inspection. A common issue in 3D printing is porosity in the printed parts and deviation from the ideal shape as defined by the CAD file.

A 3D printed scaffold was scanned with a Thermo Scientific HeliScan microCT and analyzed with Avizo Software to find the segment with the highest amount of porosity, for further study with a PlasmaFIB instrument. Thickness of the segments was also monitored and compared to the CAD file.

Semiconductors

Semiconductor device manufacturers and designers routinely push the boundaries of physics. Defect detection and failure analysis, performance and process evaluation, and materials characterization are key to successful commercialization of new electronic device.

Avizo Software's advanced 3D visualization and image processing tools allow for fast detection of defects such as issues linked to voids in the solder balls of a Ball Grid Array (BGA).

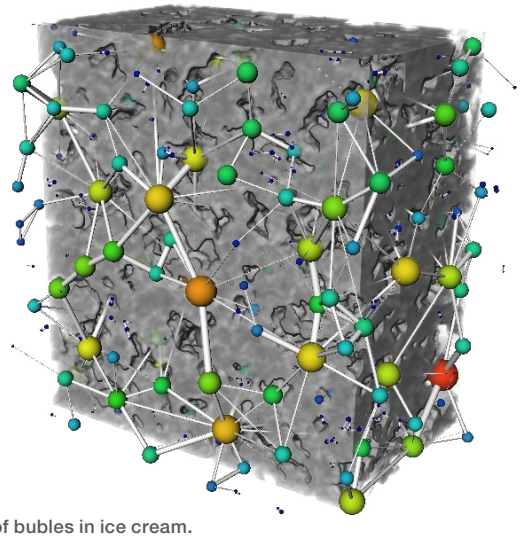


Segmentation of voids inside solder balls of a BGA - Ball Grid Array.

Food and agriculture

3D imaging techniques, such as X-ray micro-computed tomography (micro-CT), scanning electron microscopy (SEM), and magnetic resonance imaging (MRI), provide insights into food structure and how it changes in various situations, including processing operations.

Avizo Software's comprehensive food and seeds analysis toolset makes it easy to perform microstructural characterization and better understand the relation of microstructure to properties needed in food engineering, chemistry, microbiology and safety.



Analysis of bubles in ice cream.
Courtesy of Irstea.

Dedicated to Thermo Scientific TEM, SEM, FIB, DualBeam, and microCT systems, as well as Thermo Scientific correlative workflows, Avizo Software for Thermo Scientific Systems edition has been developed to fit with Thermo Scientific systems data acquisition and specific workflows.



Key features

Import and process image data

- Handle any modality, at any scale, of any size:
  - X-ray tomography: CT, micro-/nano-CT
  - Electron Microscopy
  - Synchrotron
- Support for multi-data/multi-view, multi-channel, time series, very large data
- Scaling, calibration, conversion, re-sampling
- Image enhancement, comprehensive filtering and convolution, Fourier frequency transforms
- Artifact reduction algorithms
- Advanced multi-mode 2D/3D automatic registration
- Image stack alignment, arithmetic, correlation, fusion

Visualize and explore

- Interactive high-quality volume
- Orthogonal, oblique, cylindrical and curved slicing
- Contouring and iso-surface extraction
- Maximum Intensity or other types of projections
- Vector and tensor visualization

Segment

- Thresholding and auto-segmentation, object separation, automatic labeling
- Region growing, snakes, interpolation, wrapping, smoothing
- Morphological processing, including watershed and basins
- Machine Learning-based segmentation
- Automatic tracing of individual fibers
- Skeletonization
- 3D surface reconstruction
- Grid generation for FEA/CFD

Analyze and quantify

- Intuitive recipe creation, customization, automated replay
- Built-in measurements, including counts, volumes, areas, perimeters, aspect ratios and orientations
- User-defined measures
- Results viewer with spreadsheet tool and charting
- Automatic individual feature measurements, 3D localization and spreadsheet selection
- Automated statistics, distribution graphs
- Feature filtering using any measurement criterion
- Data registration, deformation, comparison and measurements
- Porosity detection and measurement
- Fiber analysis
- Pre-processing for structural and flow simulations
- Import of CAD models for actual/nominal comparison

Present

- Animation and video generation
- Advanced key frame and object animation
- Mix images, geometric models, measurements and simulations
- Annotations, measures legends, histograms and curve plots
- Export spreadsheets, 3D models, high-quality images

Simulate

Image-to-simulation workflows:

- 3D image-based meshing for Finite Element and CFD
- Porosity/pore connectivity analysis and skeletonization for Pore Network Modeling
- Direct 3D image-based simulation: absolute permeability, molecular diffusivity, electrical resistivity, and thermal conductivity computation

Access ecosystems

- Python scripting API
- Custom C++ modules development
- MATLAB™ bridge

Professional services

We offer a comprehensive set of professional services. From training to consulting or custom development, our professional services experts are dedicated to helping you maximize your productivity with Avizo Software.

Training

Our custom training is designed to provide you with immediate and practical skills while keeping your specific goals in sight. We can help you quickly and effectively master all of Avizo Software's capabilities through focused training.

Various courses can be arranged, with typical durations ranging from one to three days. We can customize our training to best fit your needs. The training can be arranged on-site at your location or may also be delivered at one of our facilities.

Consulting

Our experts will help you get the best out of the constant innovations introduced in Avizo Software so you can benefit from them in your daily work.

We are your partner in creating solutions using Avizo Software. Custom-made consulting sessions can be performed at your facilities or remotely, depending on your needs. Our consultants can help you analyze your specific tasks and workflows and leverage your knowledge and specific expertise to get them implemented in Avizo Software.

Custom development

With 30 years of experience in 3D and image processing and hundreds of projects delivered to small and large organizations, we can provide you with a solution tailored to fit your specific needs.

We have the ability to customize and expand our software solutions at various levels, including, but not limited to:

- Building simple push-button solutions from entire workflows
- Integrating specific workflows
- Implementing our solutions into an existing process
- Creating support for custom file formats

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Find out more at **thermofisher.com/amira-avizo**

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