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10 years with Mountains®

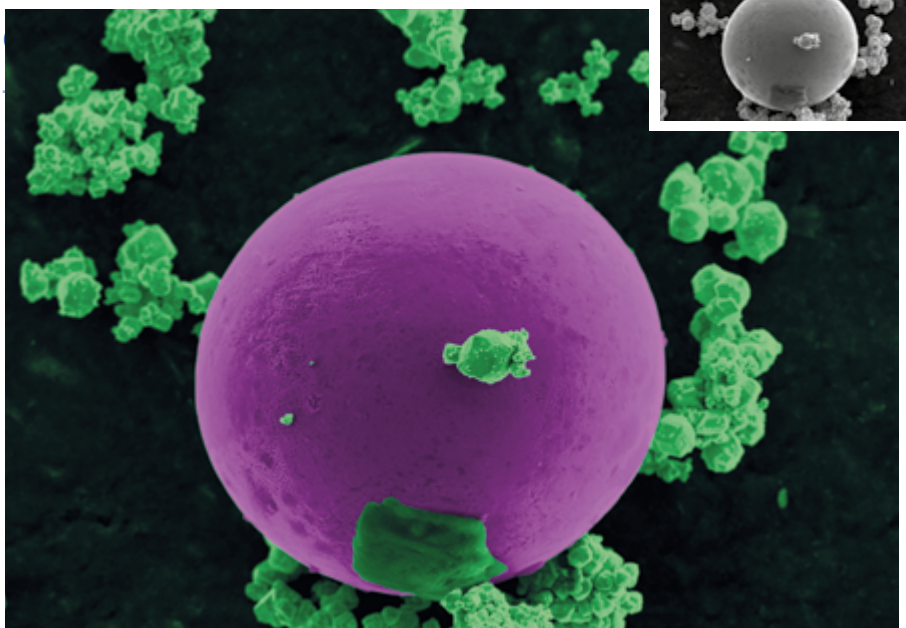
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Mountains® SEM software

Get more out of your SEM images!

Mountains® 7 software new Click & Color tool saves hours compared to SEM coloring techniques using image editing software.

Go from black and white to color effortlessly in just a few clicks:



Example – colorization of a SEM image of a tin calibration specimen (image courtesy of JEOL)

[Read more overleaf](#)



Quantitative CL microscopy

A precious ally for failure analysis in optoelectronic devices

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Do I need to use an S-Filter on a surface, the same way a λ s filter may be used on a profile?

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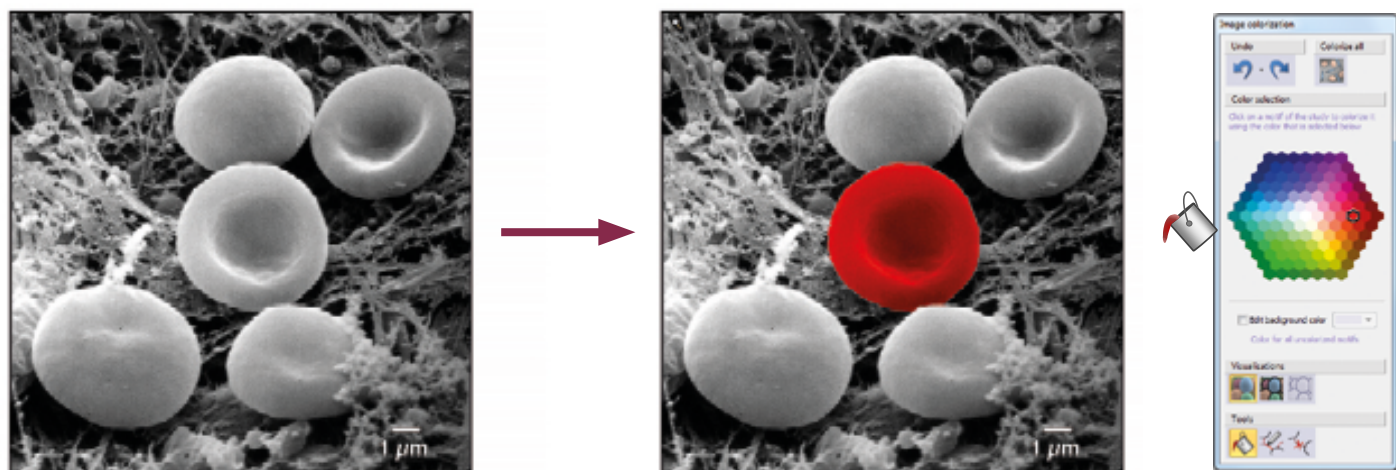
Visitors to the [Microscience Microscopy Congress \(MMC\) 2015](#) in Manchester, UK (June 29 to July 2) are invited to exclusively preview new Mountains® features at Digital Surf's stand 705.

Get more out of your SEM images! *Continued from page 1*

Mountains® 7 software for scanning electron microscopes opens up a new dimension in SEM analysis with a range of new tools including new colorization and extended 3D reconstruction techniques.

New built-in Click & Color tool

Go from the image on the left to the one on the right, in just one click!



Blood cells - Image courtesy of Thierry Thomasset Université Technologique de Compiègne

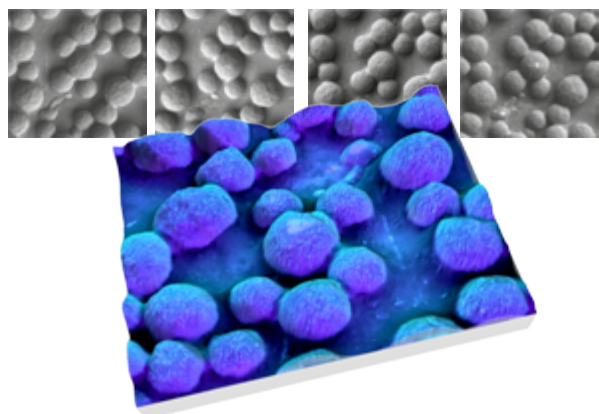
In SEM image analysis, colorization can really help make the image easier for the human eye to see, thus yielding more usable information about the sample.

However, manually coloring parts in SEM images, for example with image editing software, can be very time consuming.

A new version of Mountains® 7 software, available from fall 2015, will offer a fast and easy built-in alternative.

Simply pick a color, then apply it to any object in your image. It's that simple, thanks to new image segmentation. Limits around objects can still be changed manually using intuitive contour redefinition.

Automatic bi-colorization



Another way of using color to really bring out detail in SEM images is made available to users as part of the 3D reconstruction process.

When reconstructing a 3D model from four images obtained from a 4-quadrant scanning electron microscope (see page 4 of the current issue), Mountains® allows you to choose a set of two complementary colors to colorize the image and make it easier for the eye to interpret.

A different color is associated with each image pair, resulting in a much clearer perception of surface relief.

Example: toner particles colorized using a purple/blue palette in the 3D reconstruction dialog

SEM image correction, the Mountains® way

Noise, image distortion or deformation, poor contrast or brightness... many different factors can result in unsatisfactory SEM image output.

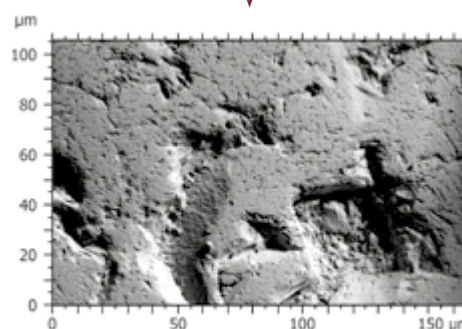
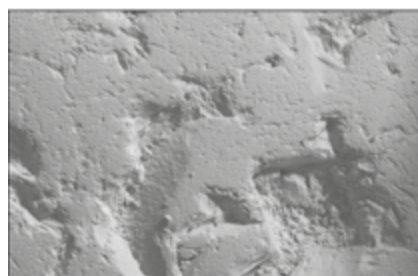
Mountains® software for SEMs has all the tools you need to optimize and correct images, making them ready for further analysis.

In the **Operators tab**, users may access a range of powerful tools enabling image correction:

- **Spatial filter:** apply a filter to denoise, smooth or detect shapes
- **Enhance:** adjust contrast and brightness manually or automatically
- **Retouch:** retouch an area of the image to correct defects
- **Invert color:** invert color and intensity information
- **Homogenize lighting:** homogenize the lighting effect on an image

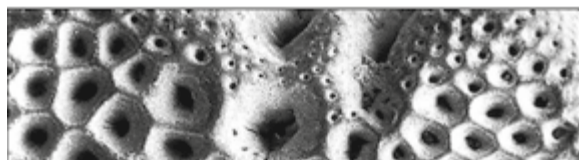
Example: spatial filter and homogenize lighting tools applied to a SEM image of a quartz/feldspar surface.

Credit: Amphibol / CC-BY-SA-2.5



Instant 3D enhancement of SEM images

The scanning electron microscope (SEM) is widely used in various fields of industry and science because it is one of the most versatile imaging and measurement instruments.



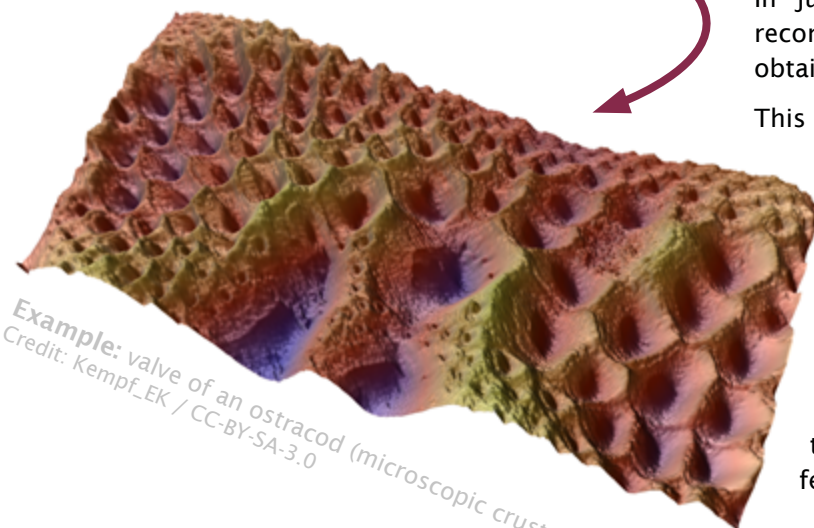
However, up until now, building a 3D model from single SEM images in order to better visualize nanostructures has proved virtually impossible.

Now Mountains® 7 is making the impossible a reality!

In just a single click, 3D topography can be reconstructed from a gray-scale SEM image obtained using an oblique electron beam.

This new function is made possible by a unique Mountains® "shape from shading" technique.

Contrary to the 3D reconstruction techniques from 2 and 4 SEM images detailed in the following pages, the values of the Z-axis of the reconstructed topography in the case of single-image reconstruction do not have a metrological value. However, this technique goes a long way in helping the human eye visualize and detect surface features.



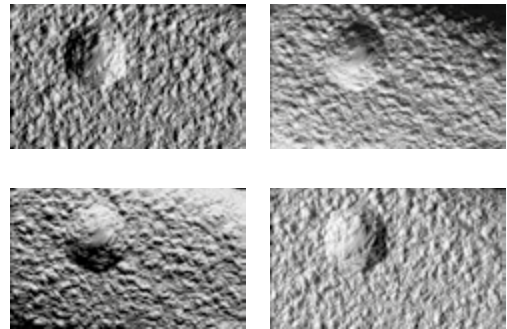
Example: valve of an ostracod (microscopic crustacean).
Credit: Kempf_EK / CC-BY-SA-3.0

3D reconstruction from 2 or 4 SEM images in seconds

Mountains® 7 software allows users to quickly reconstruct 3D surfaces from

- a stereo pair of scanning electron microscope (SEM) images obtained at different tilt angles (it is also possible to use a single anaglyph image)
- four images obtained using a four quadrant detector.

Reconstructed surface topography (X, Y and Z axes) is calculated in length units.

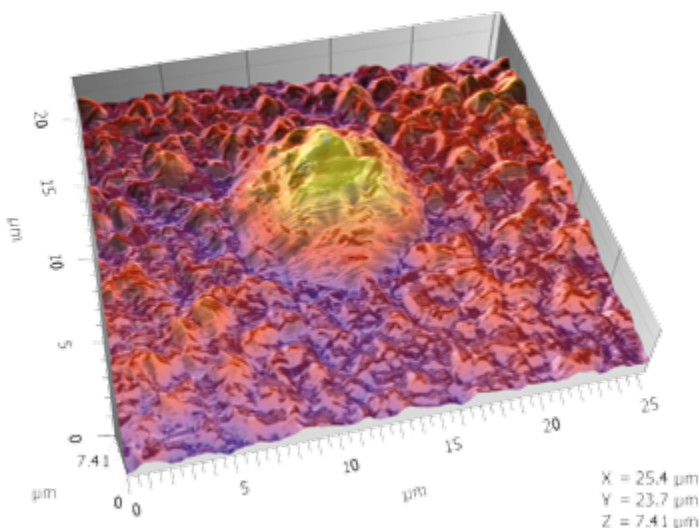
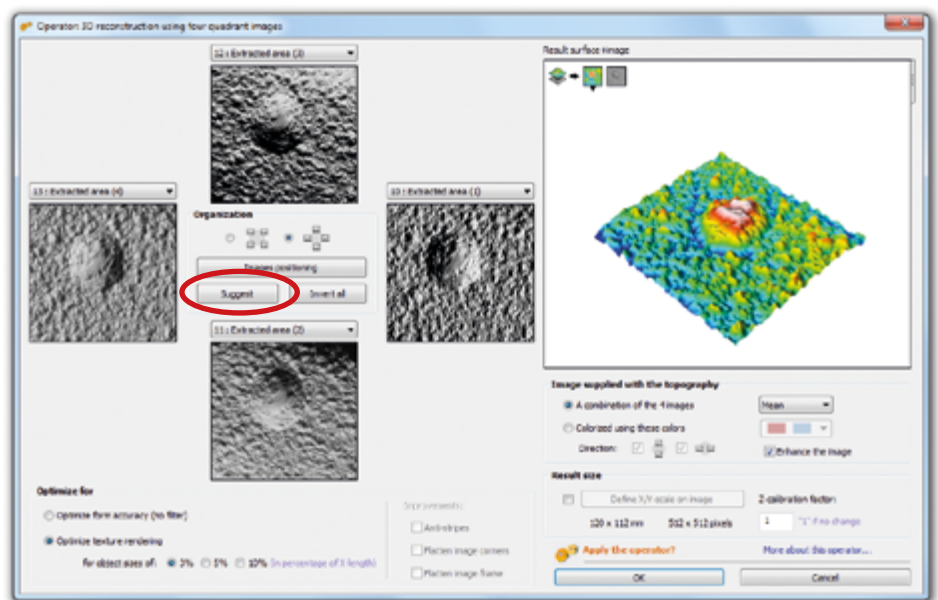


Example: 4 SEM images of a feature on copper grid

New feature:

Click on the new **Suggest** button in the Quad image reconstruction dialog and Mountains® automatically positions the 4 images in the correct order.

If you're not satisfied with this result, the images can still be positioned manually using the drop-down lists above each image.



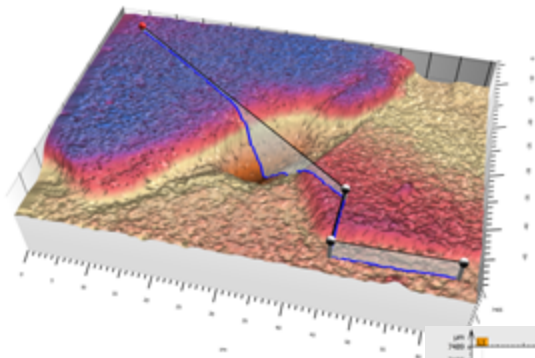
Watch the Mountains video tutorial



www.digitalsurf.com

Result: 3D reconstruction with X, Y and Z axes in µm.
Courtesy of LNE (French National Metrology Institute)

Welcome to the world of Mountains® SEM metrology!



Example: 2D profile extraction from a 3D surface allowing step height analysis.

Courtesy of www.semimaging.eu



In the case of good quality stereo image pairs and 4 quadrant images, once reconstruction is complete, Mountains® allows users to perform measurements on the reconstructed surface.

SEM users now have access to the entire range of powerful metrology tools provided by Mountains®.

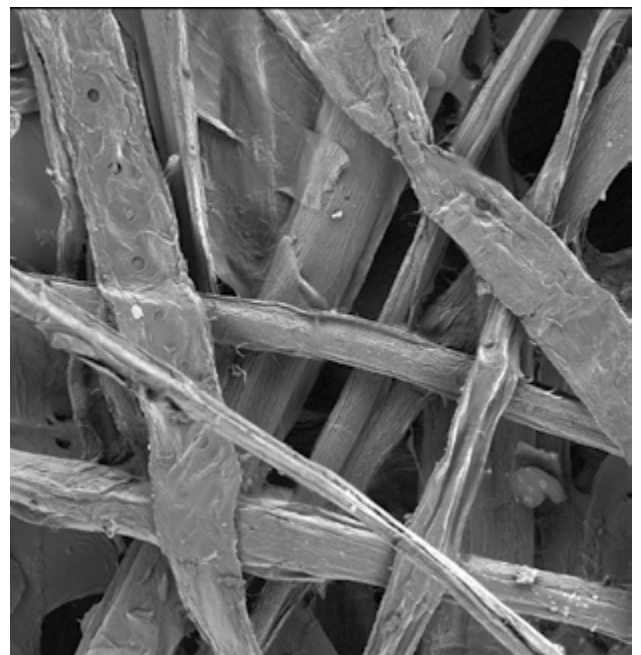
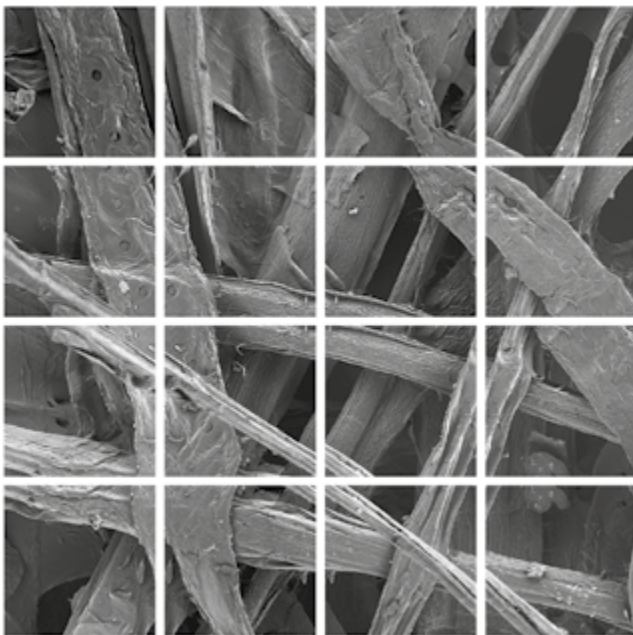
These include fast and accurate surface geometry analysis which spans from basic measurements (distance, angles, volumes, steps) to in-depth dimensional analysis.

Built-in tools for measuring surface roughness are also available. Mountains® makes it possible to separate the components of the reconstructed shape - form, waviness and roughness - in accordance with the latest international standards.

Easy, accurate stitching of SEM images

Mountains® software allows users to combine multiple SEM images with overlapping fields of view to produce a single high-resolution image.

In the **Operators** tab, click on:



Example: 4x4 array of overlapping images of Japanese Moriki paper (courtesy of Keysight Technologies).

Single image obtained by applying the Mountains® stitching operator

Quantitative cathodoluminescence microscopy, a precious ally for failure analysis in optoelectronic devices

A major preoccupation of the industry and research institutes working in the field of optoelectronics consists in constantly increasing device performance, improving processes and reducing costs.

Digital Surf's partner [Attolight](#) (based in Lausanne, Switzerland) is specialized in an innovative type of hyperspectral technology known as "Quantitative cathodoluminescence", or Quantitative CL, capable of quickly generating valuable data in cases where traditional spectroscopy techniques meet their limits.

This technology enables users to analyze thin films and optoelectronic devices in a very fast and efficient manner. This is particularly useful for identifying



process and material faults, performing quality control and accelerating the introduction of new manufacturing processes or new product generation.

In the example below, Quantitative CL technology coupled with the power of Mountains® software makes it possible to localize and identify degraded layers in state-of-the-art green laser diodes.

Stress analysis of a laser diode

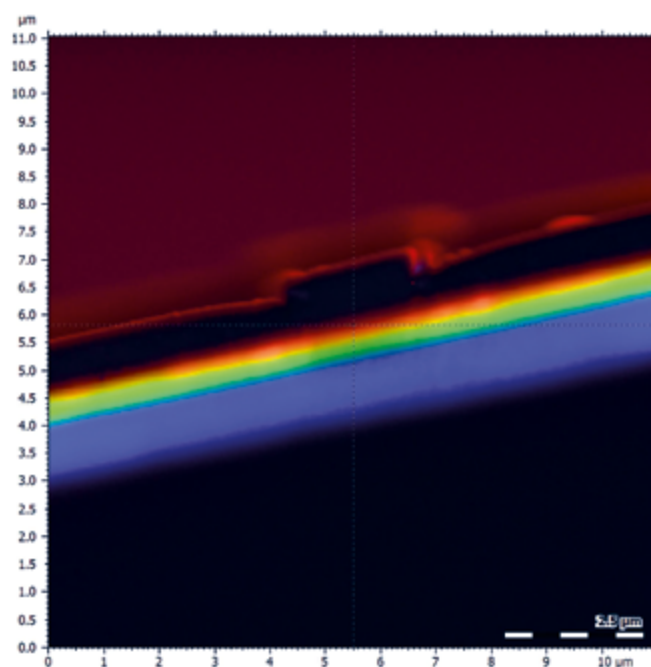
Attolight's quantitative cathodoluminescence (CL) microscope is used for fast and non-intrusive failure analysis in solid state lighting (LEDs and laser diodes) and high power electronics. Its excellent spatial resolution, combined with hyperspectral capabilities, allows layer-by-layer localization and identification of degradations in devices.

The image to the right shows a laser diode before deterioration caused for example by thermal or electrical stress.

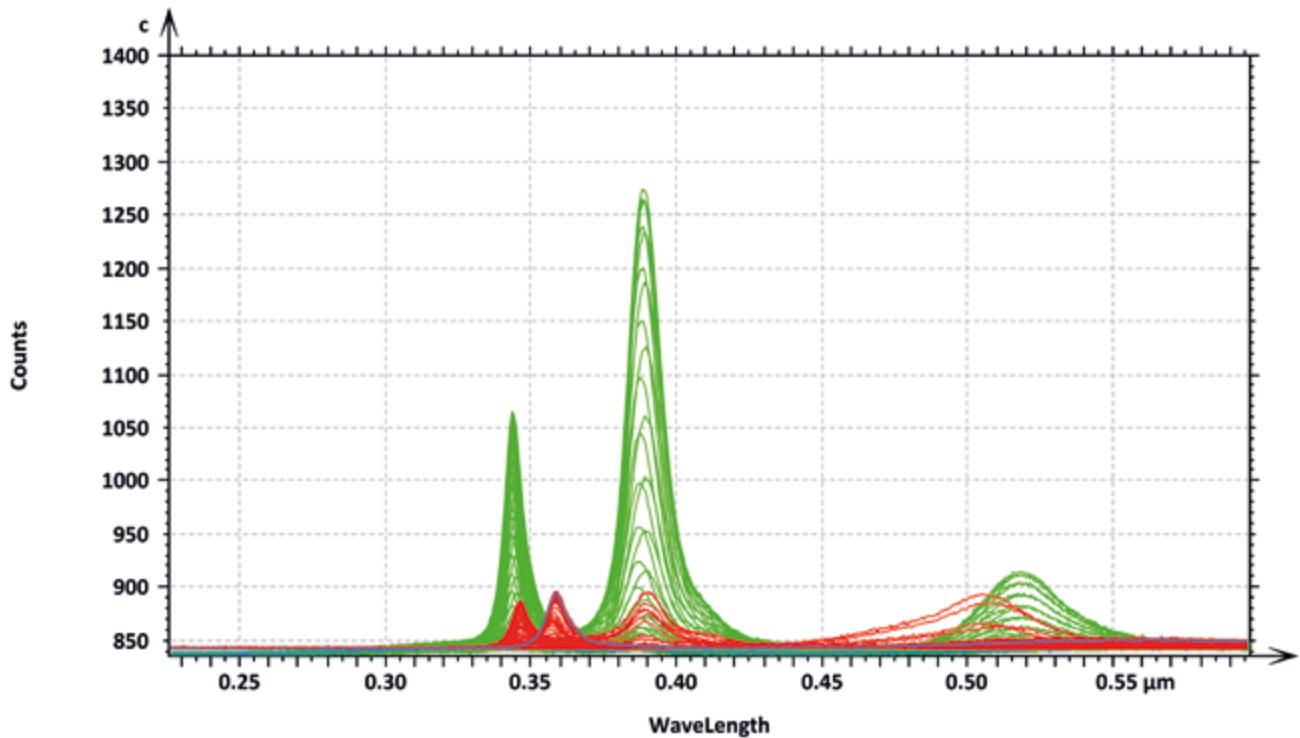
AttoMap software, based on Digital Surf's [MountainsMap® Hyperspectral software](#), proves to be the perfect tool for locating, characterizing and understanding this kind of defect.



Laser diodes (LD) are electrically pumped semiconductor lasers used in fiber optic communications, displays, barcode readers, laser pointers, CD/DVD/Blu-ray reading and recording etc.

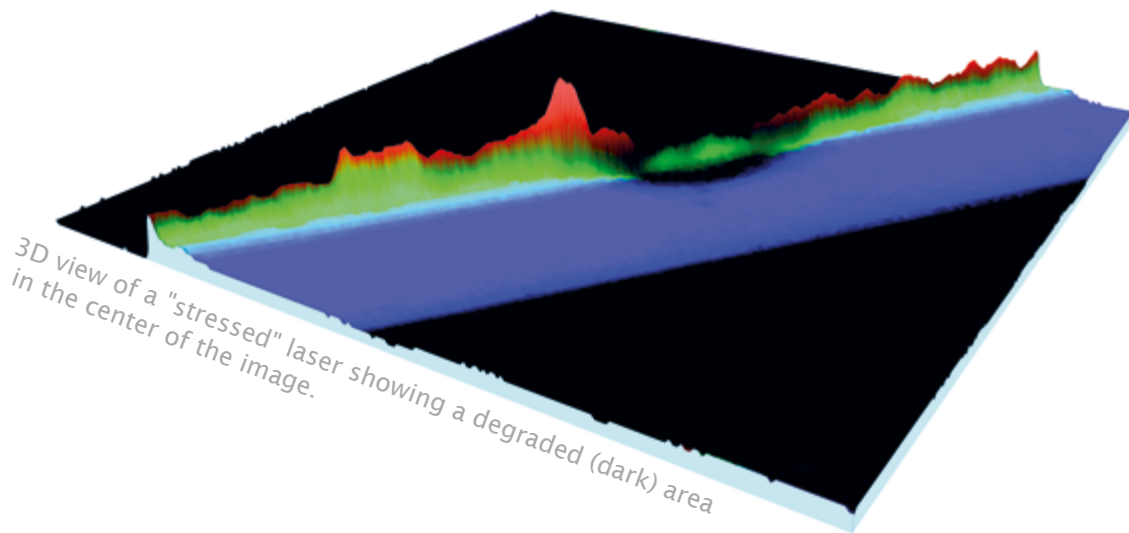


Hyperspectral image of an unstressed laser diode



As can be seen in the above chart, using the **Extract spectra** operator in Mountains® makes it possible to compare spectra from the two lasers.

Here the green curve represents the fresh laser and the red the damaged laser. The difference between the two can be precisely quantified.



Mountains® also allows users to transform RGB images captured by CL microscopes into 3D models, where the third dimension corresponds to the cathodoluminescence intensity.

This 3D map can be viewed at any zoom level and angle and in real-time which greatly facilitates inspection. In this particular case, the 3D view clearly shows the damage caused to the laser.

Acknowledgments: David Gachet, Attolight; Profs. Matteo Meneghini and Enrico Zanoni, University of Padova

Do I need to use an S-Filter on a surface the same way a λ_s filter may be used on a profile?

In this section of the Surface Newsletter, Digital Surf's ISO expert François Blateyron sheds light on an important aspect of surface metrology.

In this issue, he explores the delicate art of applying filters to a surface in order to prepare it for analysis.



The S-Filter defined in ISO 25178 is a low-pass filter that attenuates component scales that are shorter than the nesting index of the filter. It is similar to the λ_s profile filter that attenuates wavelengths shorter than the cut-off value. This micro-roughness filter was established for profile measurements in order to reduce instrument noise, attenuate stylus tip effects and make measurements more comparable between instruments of different makes or between a measurement done on the shop floor and another one done in a metrology lab.

Using a λ_s filter on a profile

Profile measurements are usually several millimeters long and have lateral spacing usually in the order of a micrometer. This means that the number of points per profile is at least several thousands. The ISO 4288 standard provides tables that link the maximum spacing of data with the stylus tip radius and the value of the micro-roughness cut-off λ_s to be used.

While this low-pass filter allows better comparisons between different profilometers, it also removes high frequencies that might be of interest in understanding the function of the workpiece. Users always try to purchase profilometers with the highest resolution and sensitivity, but they remove a lot of information contained in the profile by using a λ_s filter. Note that the German standard VDA2006 does not authorize the use of the λ_s filter for profile evaluation!

The S-Filter: handle with caution!

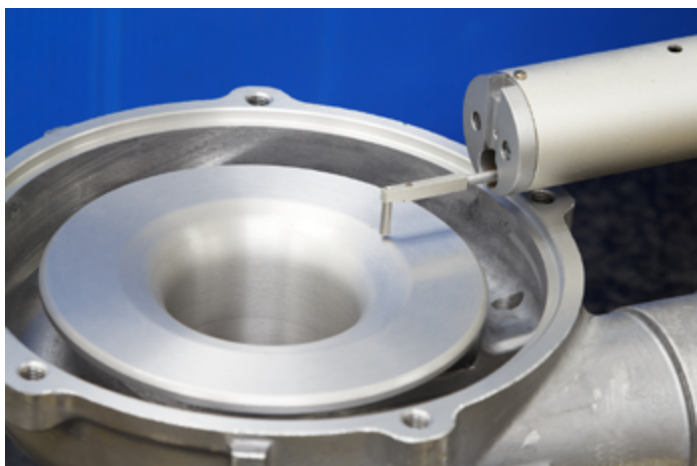
With an areal measurement (i.e., on a surface), there are usually several hundreds of points in X and Y on a relatively small physical area. This is particularly true for optical profilers which have a field of view between half a millimeter and 2-3 millimeters. Applying a low-pass filter on such measurements may lead to an important loss of resolution in small details.

Although the S-Filter is described in ISO 25178 for areal measurements, it should only be used in particular cases i.e. to limit the bandwidth of the instrument. In most other cases, this filter will not be required.

How can I apply an S-Filter in MountainsMap®?

To implement an S-Filter in MountainsMap®, use the **Standard Filter** (in the Operators tab) and generate a waviness surface with a small cut-off (e.g. 2.5 μm). Use a **Gaussian or Spline filter** as they are both well adapted to such usage. The resulting surface can be considered as a primary surface, or an S-F surface if form removal is also applied.

Applying an L-Filter with a larger cut-off on the primary surface will produce an S-L surface, which is the equivalent of a roughness surface. Applying an S-Filter with a larger cut-off on the primary surface will produce the equivalent of a waviness surface.



Key points

- > An S-Filter removes scales smaller than the nesting index value of the filter
- > When used with a small nesting index value, it is similar to a λ_s filter on a profile
- > Such a filter should be used with caution on areal measurements to avoid information loss and can be omitted in most cases

> Read more in our surface metrology guide : www.digitalsurf.com/guide

Mountains® software on show at Control 2015

Alongside 917 other companies from 32 countries, Digital Surf was proud to present the latest features of Mountains® software at Control, the world's leading trade show for quality assurance, held in Stuttgart from 5-8 May.

Numerous international visitors from Europe, North America and Asia visited Digital Surf's stand in hall 3 where they were provided with a demonstration of the 3D capabilities of Mountains® software.

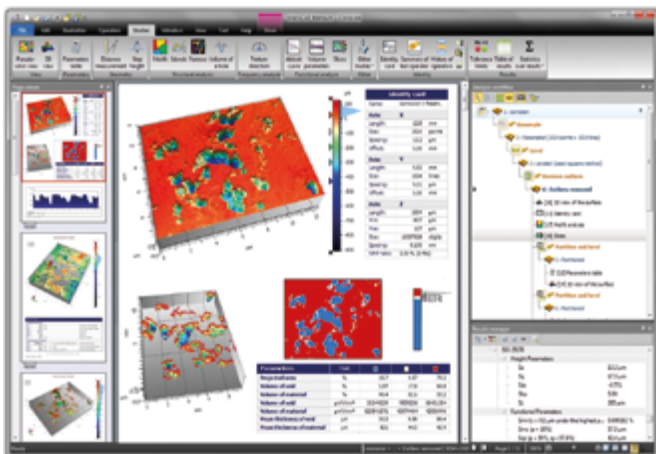
The Digital Surf team was on hand to answer our visitors' surface analysis software questions.

Mountains® software was also on show throughout the trade fair on many of our partners' stands.

A big thank you to all who made Control 2015 a big success. We look forward to seeing you next year in Stuttgart!



LMI Technologies' MikroCAD, now powered by Mountains®



LMI Technologies recently announced new MikroCAD software, based on Digital Surf's industry standard Mountains®, has been integrated into the company's optical 3D precision measuring systems.

MikroCAD submicron 3D scanners plus the new software provide a complete solution for metrology and quality control of functional surfaces and small parts, including shiny, hard, soft and deformable surfaces (paper, rubber textiles etc.), road surfaces, laser engraving, spot welding, gears and cutting tools.

Read more: www.digitalsurf.com/en/press.html

Need information on Mountains®? We have the answer!

Our online information center has recently been redesigned to give users direct access to a variety of resources on Mountains® software and surface metrology.

- Browse through our media library where you can download brochures, Surface newsletters, videos, press releases and MountainsMap® product data sheets.
- Read the online surface metrology guide which provides comprehensive information relating to current ISO 16610 and ISO 25178 standards.
- And much more!



Visit www.digitalsurf.com/medialibrary

A decade of continuous evolution in surface analysis

Antony Caulcutt was head of marketing at Digital Surf from 2005 to 2014 and editor of Surface Newsletter. He retired in April 2015, but not before taking a look back at how Mountains® software has evolved over the last ten years.

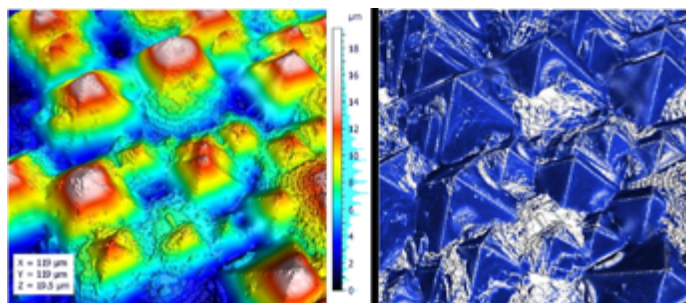
Ten years ago when I joined Digital Surf I was a complete stranger to the world of surface imaging, analysis and metrology. With some trepidation I learned things that were obvious to its inhabitants but certainly not to me! For example, the surface data sets obtained by microscopes can contain anomalies which must be removed before you can analyze the surfaces. So you need to start by applying filters – needless to say all available in Mountains®!

However what impressed me the most during my 10-year tour of duty at Digital Surf is the way that Mountains® evolved to meet the needs of different instrument families. In 2005, Mountains® was a reference in the analysis of surface topography data (X,Z and X,Y,Z) obtained by scanning profilometers, optical profilers and scanning probe microscopes (SPMs). In 2015, thanks to the work of highly professional and well-coordinated R&D, sales and support teams, coupled with feedback from partners, Mountains® has a much broader range.

Let's make a short visit to just seven of the major milestones it has been my privilege to witness over the past decade.

► Overlaying color images on 3D surface topography

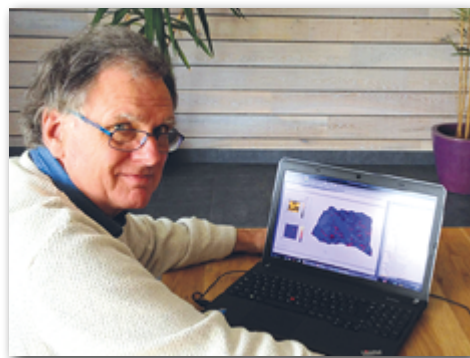
Multi-channel 3D optical profilers generate topography, color image and intensity image data sets. Overlaying the color image or intensity image on the 3D topography makes it easier to detect features and defects.



Read more:

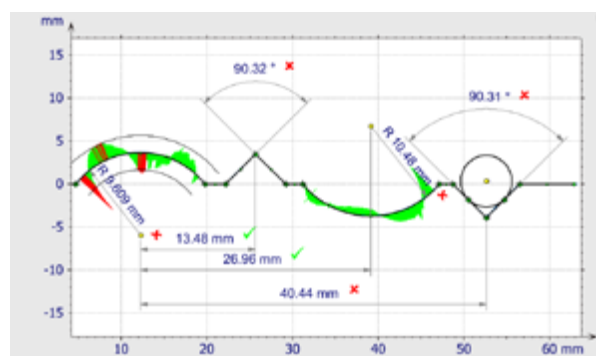
[MountainsMap Imaging Topography data sheet](#)

Images courtesy of Carl Zeiss



► Carrying out geometric dimensioning and tolerancing

Intuitive icon-driven geometric dimensioning of cross-sectional (X,Z) profiles and parametric (X,Y) profiles extracted from surfaces, coupled with optional graphical form deviation analysis, means that contour analysis is both accurate and fast.

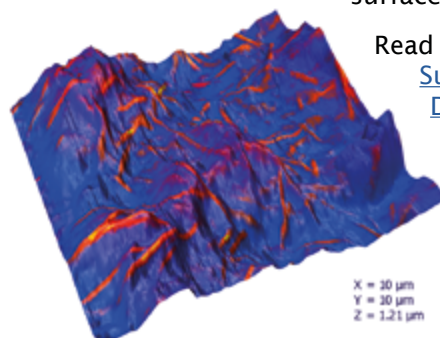


Read more:

[Surface Newsletter, April 2009](#)

► Seeing the correspondence between multi-physics layers and surface topography

SPMs can generate multi-layer data sets including topography, phase and current. Again overlaying non-topography layers on 3D topography can lead to important insights into component behavior. For example here the self-assembling fiber current signals (red features) follow the contours of the undulating surface texture (blue).



Read more:

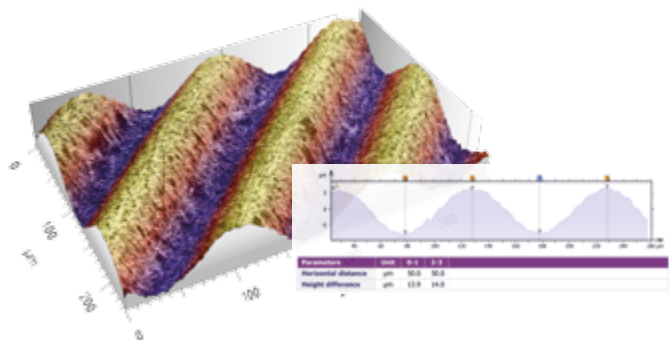
[Surface Newsletter, December 2010](#)

[MountainsMap SPM data sheet](#)

Images courtesy of ICMAB-CSIC, Barcelona, Spain

► 3D reconstruction of surface topography from SEM images

SEMs generate 2D images in black and white. 3D reconstruction of surface topography from sets of 2 or 4 SEM images or anaglyphs makes it possible to visualize surfaces in 3D and to carry out metrological studies.



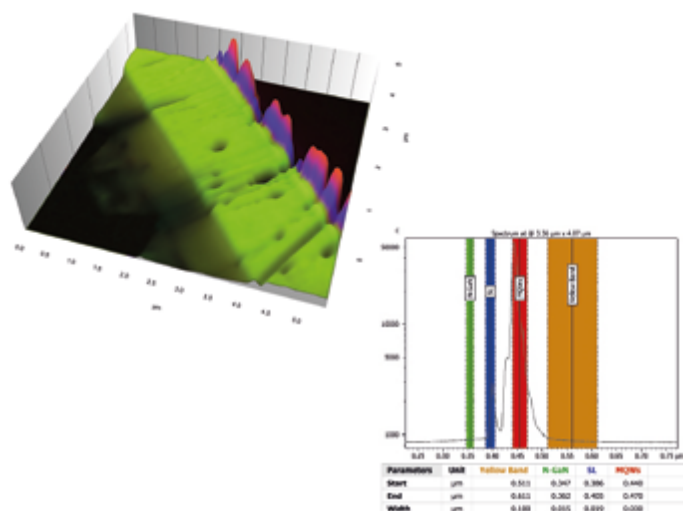
Read more:

[MountainsMap SEM data sheet](#)
or [p.4 of this Surface newsletter](#)

► Seeing hyperspectral features in 3D and color

Imaging spectroscopy generates hyper-spectral data cubes. Using Mountains® you can convert hyper-spectral cubes into 3D color maps, making it easy to locate nanoscale features and defects.

In this example, colors are assigned to spectral bands corresponding to features of interest (here gallium nitride and quantum wells) and the features are visualized in 3D.



Read more:

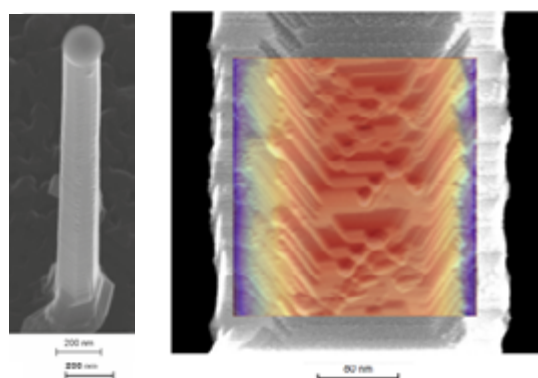
[Surface Newsletter, November 2014](#)

Images courtesy of Attolight

► Combining data from different instrument types

Combining surface data from different microscopes (for example STM and SEM or AFM and fluorescence) or from different detectors (for example secondary electron and backscattered electron) often provides significant additional information.

Here colocalization is performed with SEM and STM images. While the sub-nm Au clusters are barely seen on the SEM image, they are well resolved in the STM image and are predominantly found on the downward facets of the nanowire sidewall.



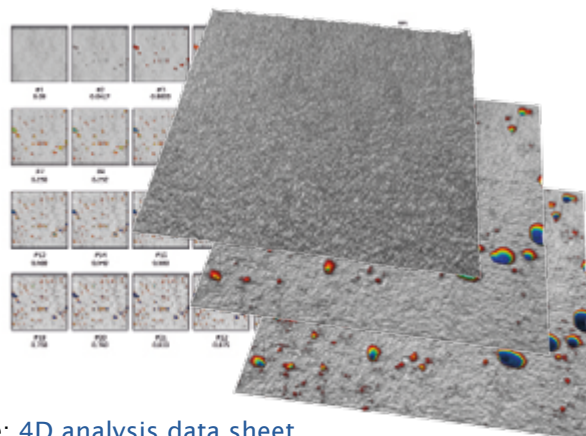
Read more:

[Surface Newsletter, November 2011](#)
or [Colocalization data sheet](#)

Images courtesy of IEMN, Lille, France

► Observing and quantifying surface dynamics

The observation and quantification of surface evolution with respect to time, temperature, magnetic field or another physical dimension can significantly improve our understanding of laboratory, industrial and natural processes. Here, surface evolution of an acid attack on glass over time is analyzed (data from an AFM).



Read more: [4D analysis data sheet](#)

Images courtesy of LNE (French National Metrology Institute)

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MountainsMap® Premium Software with all the options, free for 30 days!



[Contact us for an update](#)

Contact us for information about updating MountainsMap® 6 or earlier software to the latest version of MountainsMap® 7



[Watch a Mountains® 7 tutorial](#)

Get the most out of Mountains® 7 by watching one of our tutorial videos



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Learn more about Mountains® 7 software
- download a Mountains® 7 brochure in English or Japanese



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Microscience Microscopy Congress, Manchester, UK - Stand 705 - 29 June - 2 July 2015



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