SPRING 2022

Newsletter

SURFACE

Surface imaging, analysis & metrology news from Digital Surf

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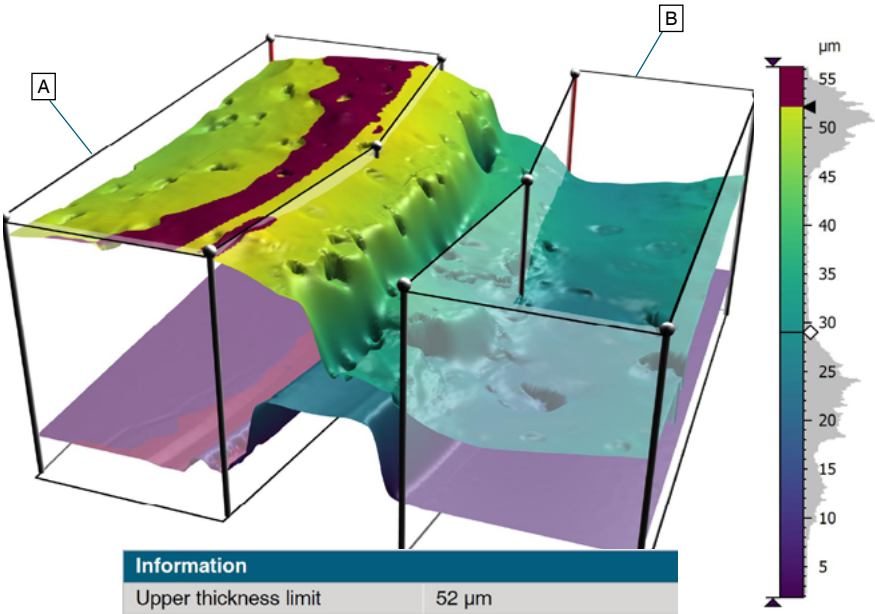
IN THIS ISSUE

MOUNTAINS® 9.2 WHAT'S SHOWING AT CONTROL 2022?



Information			
Upper thickness limit	52 µm		
General parameters	**Unit**	**Value**	
Volume	µm³	233518	
Shapes	**Unit**	**A**	**B**
Mean thickness	µm	50.7	22.2
Thickness standard deviation	µm	2.25	2.99
% inside tolerance	%	69.6	100

With spring comes a new version of Mountains®!

And features for thickness analysis, bandpass filtering, contour analysis, Shell analysis and much, much more!

... Turn to page 2 ...

Watch our
WEBINARS

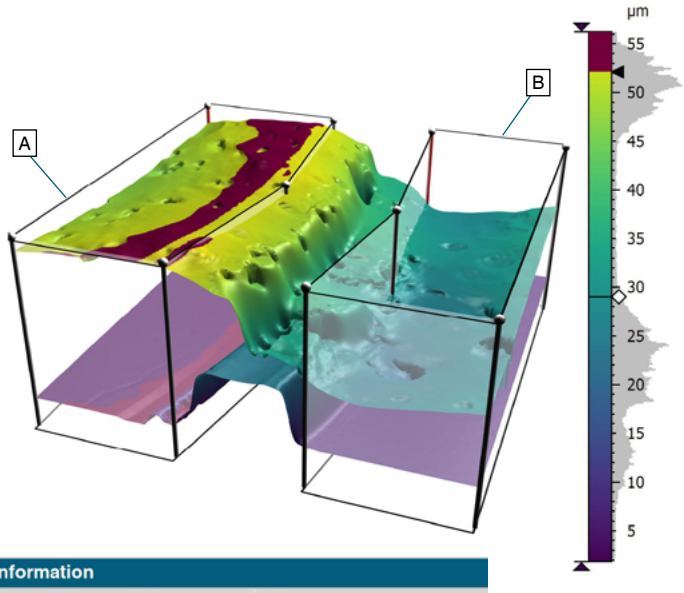
Register for our webinar

Mountains® 9.2 will be on show at the Control trade fair in Stuttgart taking place May 3-6.

You can also get a sneak peek of all the new features by signing up for our webinar: bit.ly/webinar-Mountains-9-2

MOUNTAINS® 9.2 PREVIEW THE NEW FEATURES NOT TO BE MISSED

Spring is upon us and with it a new version of Mountains® surface analysis software. In-person events have kicked off again, and the Digital Surf team will be proudly showcasing features included in the new release at the **Control trade fair**, taking place in Stuttgart May 3-6. Let's preview some of the highlights!



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Above. *Thickness analysis in 3D view mode*

A TOOLBOX FOR ANALYZING THICKNESS, WEAR & DEPOSIT

A major new element delivered with version 9.2 is an extensive range of features for users studying **surface thickness**.

Any two surfaces (measured simultaneously or not) can be aligned to form a "thickness pair" which can then be analyzed with regards global thickness parameters (mean, maximum/minimum, standard deviation etc.) or values at a specific point, along a line or over a zone.

Maximum/minimum thickness limits can be defined in order to graphically visualize "out-of-limit" zones.

Finally, users can generate stunning **3D thickness visualizations** and cross-section them to get two-profile **2D analyses** of membranes with interactive measurement cursors.

NEW BANDPASS-FILTER BANK OPERATOR

Characterizing samples at specific wavelengths allows better study of functional correlations.

A **Bandpass-filter bank Operator** makes its debut in Mountains® 9.2, providing a way to apply multiple bandpass filters with increasing cut-offs.

The tool provides a new way to perform multi-scale analysis, as an alternative to wavelet analysis and scale-sensitive fractal analysis.

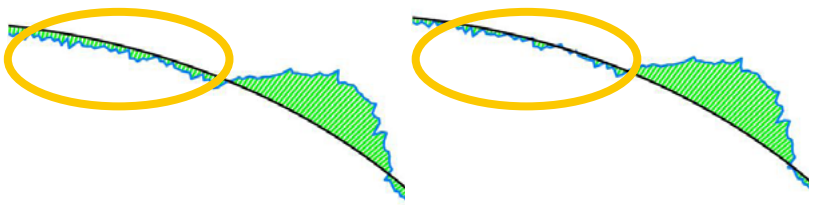
READ MORE => PAGES 8-9

CONTOUR ANALYSIS: EXTENDED OPTIONS

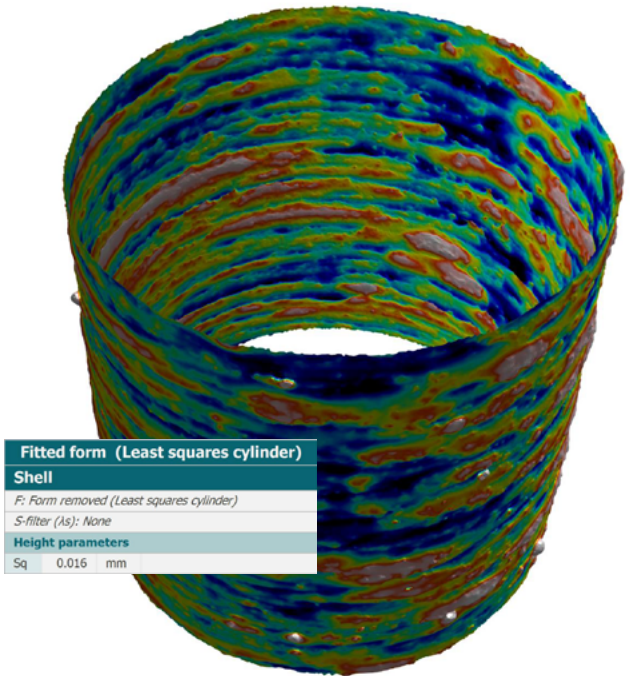
Contour and **Advanced Contour** Analysis are extremely popular tools amongst Mountains® software users.

In version 9.2, both modules have been enriched with:

- a new **robust fitting method** allowing users to exclude defects on measured components from calculations (see below);
- the ability to **fit a circle with a fixed radius** when comparing with nominal form;
- a new **Settings dialog** for improved usability.



Above. Left. *Defects on the profile prevent correct circle fitting.*
Right. *With new robust fitting, defects are excluded and fitting is correct.*



Above. *New Form fit operator on Shells. Data courtesy of Huddersfield University.*

SHELL (FREEFORM SURFACE) ANALYSIS COMES OF AGE

The latest release offers a number of new innovative features focused on the analysis of Shell (freeform surface) data.

These include:

- **automatic leveling** of surfaces extracted from Shells or Point Cloud datasets;
- new **Fit form Operator**: fit a geometric form on a Shell or Point Cloud to visualize form deviations (see above);
- quicker **meshing of Point Clouds** with automatic modes;
- improved **mesh optimization on Shells**;
- generation of Surface+Image studiables from Shells containing color information;
- conversion of Surfaces to Shells;
- conversion of Shells to Point Clouds.

NEW FOR CROSS-TECHNOLOGY

General usability improvements also feature heavily in version 9.2. Those working with **very large datasets** (several thousands or millions of pixels) will experience a faster, smoother experience as Mountains® algorithms have been dramatically optimized for this kind of processing.

Furthermore, **data substitution**, a well-loved feature allowing users to update an entire analysis document for another sample in one click, has been extended to studies using multiple studiables.

The Particle Analysis feature has been updated with new options for displaying **Statistics by class**, allowing comparison of values from different particle classes using statistical parameters.

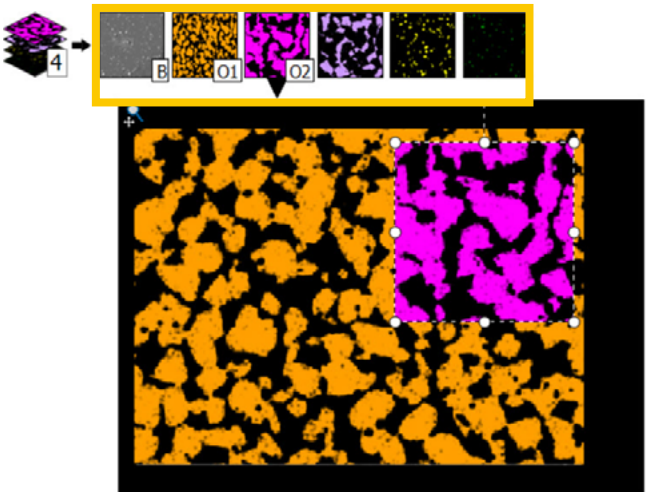
FEATURES FOR CORRELATION, SPECTROSCOPY & SPM

Since its launch in version 9.0, **MountainsSpectral®** for correlation and spectroscopy continues to serve the needs of users processing data from spectroscopic techniques.

The **Colocalization** study continues to accommodate new features with improved automation features allowing users to manage axis settings, overlays and to manipulate layers more easily. Positioning methods and studiable size management have also been enhanced.

Similarly, **multi-channel data manipulation** has been made easier and noise elimination in chemical images has been enabled by a "set minimum value to zero" tool.

Two new Operators await users of Scanning Probe Microscopy: **Derive Operator** on IV curves/spectra and **Adjust Z-offset** for more meaningful comparisons between studiables.



Above. *Colocalization thumbnails allow easy layer management.*

READ MORE & UPDATE

Check www.digitalsurf.com for full details of the 9.2 release (coming May 2022). Access to the new version is free for users with an active **Mountains® Software Maintenance Plan**. To find out more about your Maintenance options, please contact sales@digitalsurf.com

SEAMLESS SOFTWARE INTEGRATION **EMPOWERS QUALITY CONTROL 4.0**

Following an initial partnership agreement announced in 2016, **Digital Surf** and **Bruker**, a world leader in advanced surface metrology, have developed a fully integrated analysis solution based on the Mountains® platform, enabling unprecedented throughput for quality control in precision manufacturing. **Samuel Lesko**, Director of Technology and Applications at Bruker explains the process and highlights the benefits for users in industry.

CHALLENGES IN ADVANCED MANUFACTURING

The manufacturing and production industries have rapidly evolved over the past 10 years, faced with significant challenges both in finding resources to run production but also in manufacturing under tighter tolerances for surface texture and 3D feature dimensions.

The strict tolerances required in advanced manufacturing pushes the need to have very repeatable metrology systems as part of the manufacturing line. Oftentimes a robot is used to exchange parts between the production tool and metrology equipment, leading to a fully automated process that removes some of the variability found with human operators.

Through the same automation path, results from a metrology tool are transferred on to a central server that keeps track of trends or abnormalities (Statistical Process Control, SPC). This evolution is often referred to as Industry 4.0, where manufacturing is highly automated and directly integrated with surface metrology.

FEATURES FOR QUALITY CONTROL

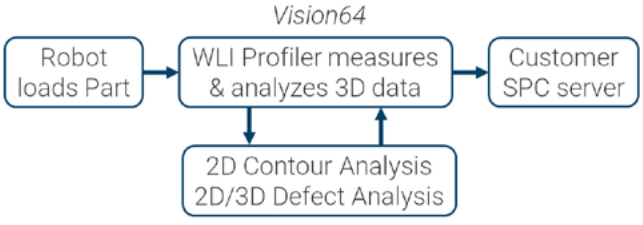
The advanced precision engineering industry manufactures various parts ranging from medical (orthopedic hip cup, knee joint, etc.) to automotive (injector, cylinder, etc.) In any of these applications, areal texture and roughness, local flatness, as well as topographic defects or deviation of three-dimensional (3D) features play a critical role in meeting the certification compliance requirements for medical devices or efficiency/functionality for mechanical parts.

Industry 4.0 requires surface metrology tools that not only measure but also automatically generate and save reports with dynamic naming, log results in a database together with batch ID and/or part number and apply advanced 3D dataset processing to achieve the exact parameters required.

INTEGRATING MEASUREMENT AUTOMATION AND SOFTWARE ANALYSIS

To meet these requirements, Bruker and Digital Surf collaborated to enable full integration of measurement software acquiring data from a white light interferometry (WLI) optical profiler with Mountains® analysis software.

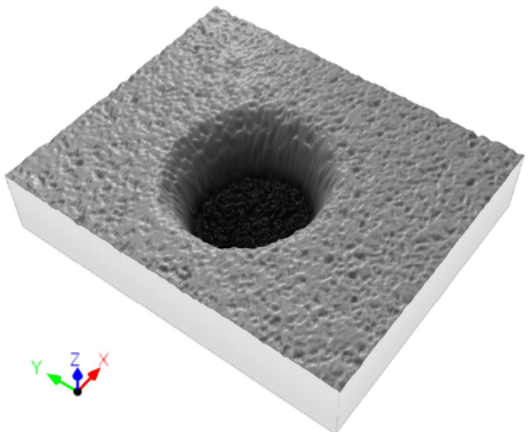
Robot inputs, such as part serial number or measurement conditions (objective, measurement mode, etc.) are transferred to Bruker's Vision64 measurement software, and results such as diameter variation or classification of defects are obtained by direct communication with Vision64 Map analysis software (see figure below).

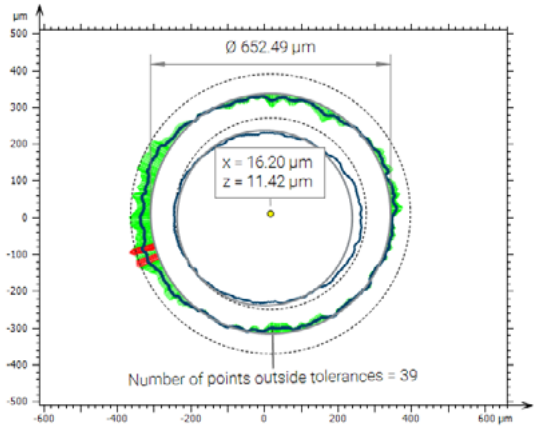


Vision64 Map

The measurement software seamlessly communicates with Digital Surf's advanced surface and contour solutions in both directions. Through this bi-directional data exchange, the measurement software can automatically save and/or print a report for each measured part. It is also capable of reporting results to an SPC server via a comma separated variable (CSV) file.

Bruker's WLI optical profiler contributes to the high throughput requirements with fast large areal topography measurement combining





Filter: Pit: Only results of type 'A' are taken into account.			
Number of values after filtering: 27/95			
Parameters	Unit	Mean	Max
Maximum depth	µm	1.122	2.077
Filter: Scratch: Only results of type 'A' are taken into account.			
Number of values after filtering: 31/95			
Parameters	Unit	Mean	Max
Length	mm	0.067	0.155

Parameters	Value	Unit
Name	Via	
Measured by	?	
FLTt - Flatness parameters - ISO 12781	2.761	µm
x - Point coordinate 1	16.20	µm
z - Point coordinate 1	11.42	µm
Diameter (Rabs) - Dimension 2	652.49	µm
Number of points outside tolerances - Deviation 3	39	

Above. *Automotive injector inspection report with scratch and pits defect analysis on top surface (left) and deviation versus desired diameter (right).*

sub-nanometer vertical and sub-micron lateral resolutions. Paired with the particle analysis, defect classification and advanced contour capabilities of Vision64 Map, it provides an extremely powerful analysis solution, successfully meeting metrology automation demands.

AUTOMOTIVE INJECTOR INSPECTION

One example of this fully integrated process is the analysis of an automotive injector. This application requires the control of many aspects that are all equally critical for the part's quality, based on a single measurement.

Diameter size and roundness with quantification of deviations are automatically assessed using advanced contour tools while flatness and vertical defects are screened by the parameters table and particle analysis features. Ranking of top surface defects is further established via the classification tool thus flagging up scratches, which can be responsible for leak paths.

Finally, the relative shift between top and bottom diameter is automatically calculated with the advanced contour tool.

CONCLUSION

The full integration of Bruker's WLI optical profiler acquisition system and Mountains® software analyses enables demanding quality control in advanced manufacturing processes. The success of this solution is based on a unique combination of flexible and robust analysis toolkits, such as particle analysis and advanced contour, together with high metrology performance. All together, these ingredients provide a sustainable agile solution to the challenges raised in Industry 4.0.

LEARN MORE

Bruker 3D optical profilers
www.bruker.com/MetrologySolutions

Surface analysis software expertise
www.digitalsurf.com/software-solutions/profilometry

SNOW SURFACES INVESTIGATED *IN SITU* IN STUDY ON SKI FRICTION

Did you know that snow is actually pretty hot? It generally exists very close to melting temperature, making it difficult to study in the field. Due to external parameters, its physical characteristics can change very quickly. But as **Felix Breitschädel** of the Norwegian Olympic Sports Center tells *Surface Newsletter*, a novel measurement device is changing our understanding of the surface of snow and constitutes a promising method for future research.

INTRODUCTION

It is said that each snow crystal is unique. The original shape and size of snowflakes heavily depend on the climate during precipitation. There is a wide range of shapes to expect due to variations in temperature, humidity, and exposure time just to name a few. From small needle-like shapes to perfectly beautiful symmetrical crystals, everything is possible.

Traditionally, optical cameras and microscopes have been used to capture snow crystals. A comprehensive description of the surface of snow is crucial for understanding the tribological system between skis and snow.

METHODS

The GelSight Mobile™ surface scanner makes it possible to scan snow surfaces *in situ* in a non-destructive way. Its elastomeric gel precisely conforms to the three-dimensional structures of the snow surface without breaking single dendrites (Figure 1).

Mountains® software offers powerful tools for analyzing grains and particles on surfaces and quantifying selected parameters of interest such as particle density, particle count and statistical distribution.

RESULTS

In previous studies, we have seen a great variety in how snow crystals can look in prepared cross-country ski tracks. Both the type, shape, and size of grains show significant differences between fresh natural (Figure 2 left), artificial and transformed snow (Figure 2 right).

In this example, transformed natural snow is analyzed by applying particle analysis tools. The raw

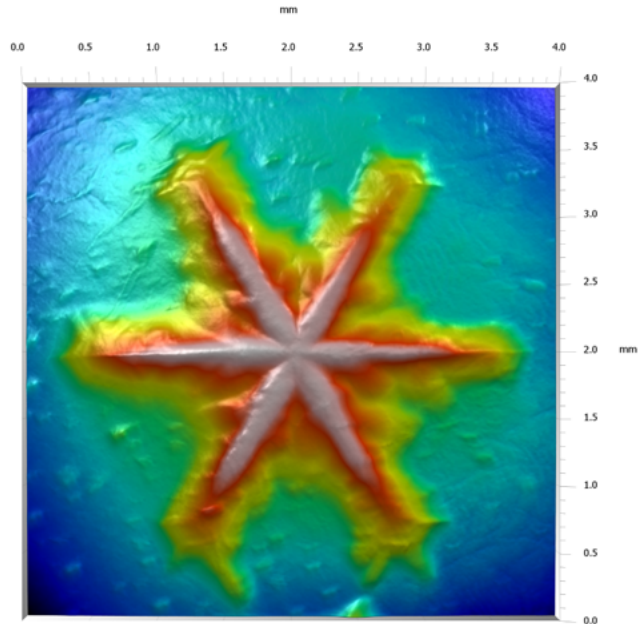


Figure 1. *Snowflake captured with GelSight Mobile™ and visualized in Mountains® software (4 x 4 mm).*

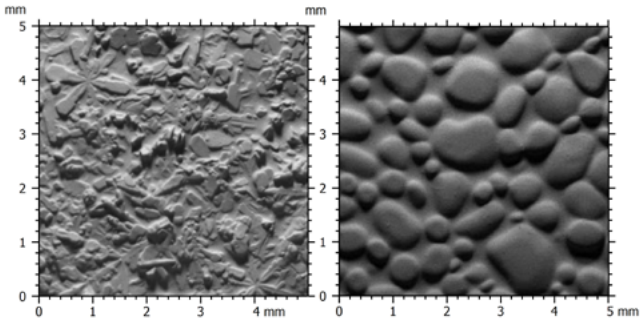
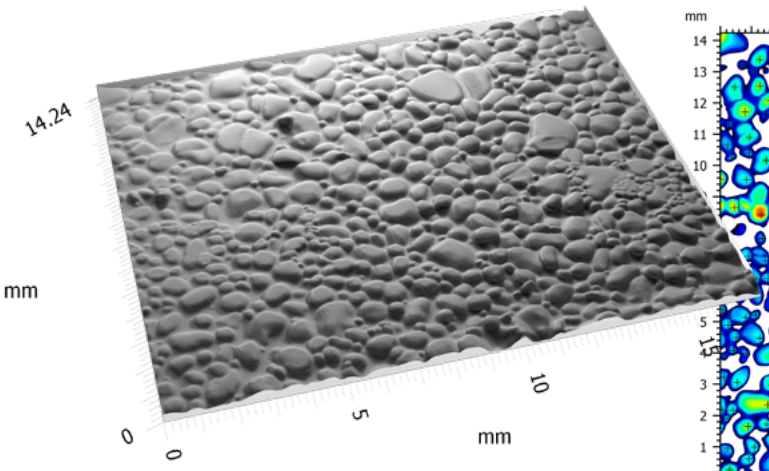


Figure 2. *Examples of new (left) and transformed snow (right), each at 5 x 5 mm.*

3D data file was processed in the following way: to eliminate small irregularities, the Mountains® Remove Form Operator was used in combination with a metrological filter (Figure 3).

The snow grains are identified by the threshold detection method which identified 501 particles



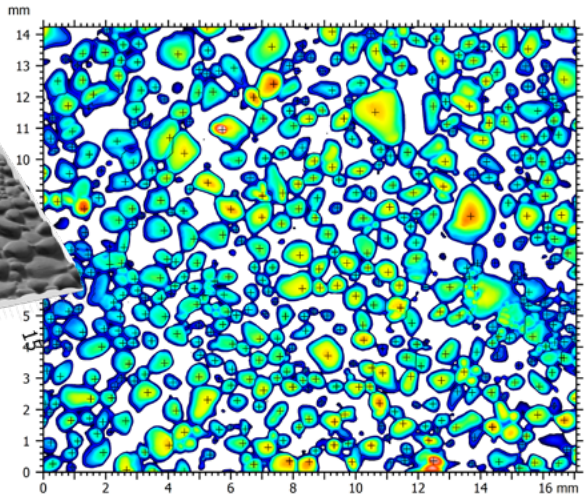
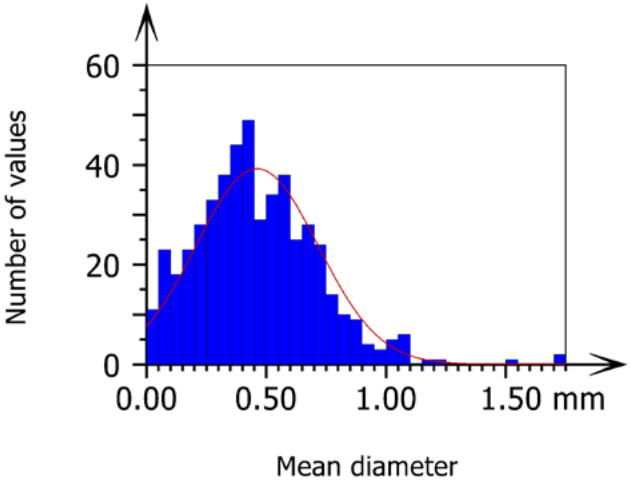


Figure 3 (above). *3D visualization of the Gelsight scan.*
Figure 4 (above right). *Snow grains are detected above a chosen threshold value. The lowest parts were removed to clarify the results.*
Figure 5 (below right)*. The unweighted histogram shows the number of values per mean grain diameter (in mm).*

Information		
Method	Threshold detection	
Particles to detect	Above a threshold value	
Threshold 1	35.83	µm
Number of particles	501	
Coverage	46.7	%
Density	2.062	Particles/mm²

within the 17.1 mm x 14.2 mm surface (Figure 4). It is interesting to note that detailed information about each individual particle can be displayed if required.

One simple way to characterize snow grain size distribution is to look at the histogram for the mean diameter (Figure 5). The shape of the particles can also be characterized by the roundness of the grains.



DISCUSSION

To understand the tribological mechanisms that come into play in skiing, it is essential to study the two surfaces that are in relative motion to each other, the ski base and the snow surface. Modern, handheld measurement instruments make it possible to collect an extensive amount of data from relevant locations and in varying conditions.

Important information can be extracted easily in combination with a powerful analysis tool, like that available in the Mountains® software particle analysis package.

Knowledge about the real contact between skis and the track will enhance further research in the field of sliding friction and hopefully contribute to more outstanding performances from athletes in the future.

ABOUT THE AUTHOR

Felix Breitschädel, PhD is head of Technology and Equipment at the Norwegian Olympic Sports Center (Olympiatoppen), he is also connected to the Centre of Sports Facilities and Technology (SIAT) at the Norwegian Technical University in Trondheim (NTNU) and a partner of Gelsight Inc.

INSTRUMENTS AND SOFTWARE USED

GelSight Mobile TM 0.5X handheld device by Gelsight Inc. + MountainsMap® software.

FURTHER READING

Laboratory testing of cross-country skis – Investigating tribometer precision on laboratory-grown dendritic snow. S B. Auganæs, A. F. Buene, A. Klein-Paste. Tribology International, Vol 168, 2022, 107451, ISSN 0301-679X, doi.org/10.1016/j.triboint.2022.107451

WHAT IS A BANDPASS FILTER AND HOW SHOULD I USE IT?

The combination of a high-pass filter and a low-pass filter may be used to establish a narrow bandwidth which can help to study surface behavior at a particular scale. Digital Surf's senior surface metrology expert **François Blateyron** provides further explanations on this type of filtering, a tool for which is released with Mountains® 9.2.

THE CONCEPT OF BANDPASS IN SURFACE ANALYSIS

Roughness and waviness are two convenient names to designate scale-limited profiles.

A waviness profile is filtered using a low-pass filter, which means that low frequencies (long wavelengths) pass and high frequencies (short wavelengths) are attenuated.

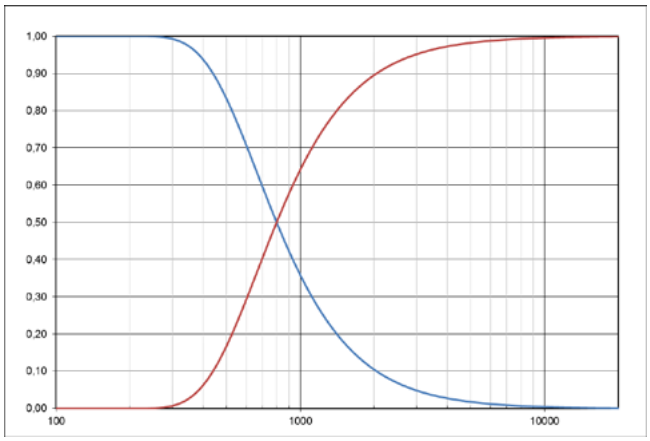
A roughness profile is obtained by the opposite process, using a high-pass filter which attenuates long wavelengths. Each profile receives a subset of the frequencies contained in the original profile. In this sense, they are band-limited, or scale-limited.

When both low-pass and high-pass filters are applied consecutively with the same cut-off value, wavelengths below and above the cut-off are attenuated and only the wavelengths around the cut-off value are transmitted.

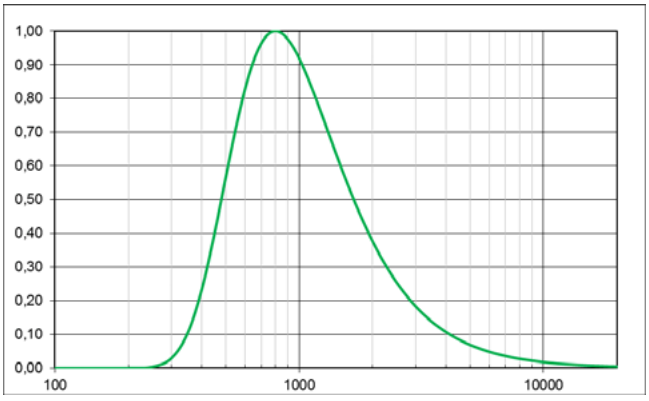
Both types of filter have an attenuation factor of 50 % at the cut-off, so the transmitted wavelength is multiplied by ¼. By construction, this factor can be compensated by multiplying the result by 4 to obtain a transmission of 100 % at the cut-off. This is what is done in the VDA2007 standard to detect dominant wavelengths.

This type of filter is known as a **bandpass filter.** It isolates a narrow bandwidth at a particular cut-off and allows us to analyze the behavior of the surface at that scale. Sweeping the value of the central cut-off, from the smallest to the largest wavelengths, enables **multi-scale analysis**.

Due to the shape of the Gaussian transmission characteristics, the bandpass curve is non-symmetrical. This is due to the fact that roughness is in fact obtained by subtracting waviness from the original profile. However, in signal and audio processing, low-pass and high-pass filters are symmetrical by construction. It is possible to apply the same principles to surface analysis and obtain a symmetrical filter.



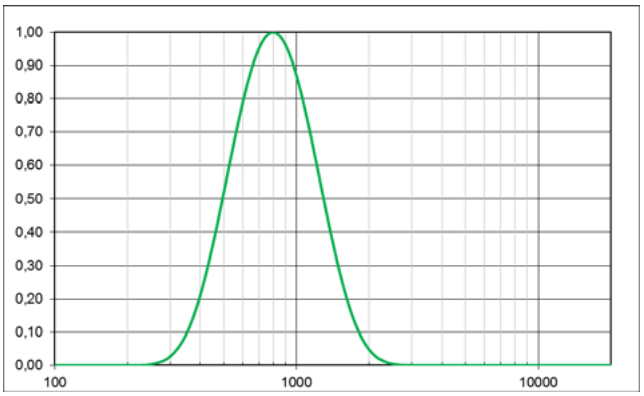
Above. *Classic Gaussian transmission characteristics for a cut-off of 800µm (blue curve for roughness, red one for waviness).*



Above. *Combined transmission characteristics, compensated with a factor 4, form the elementary bandpass filter. Transmission is on the vertical axis, wavelengths on the horizontal axis, in µm.*

FILTER BANK

Multi-scale analysis using bandpass filters can generate a series of profiles or a series of surfaces, each filtered at a different cut-off value. This



Above. *Transmission characteristics of a symmetrical Gaussian bandpass filter.*

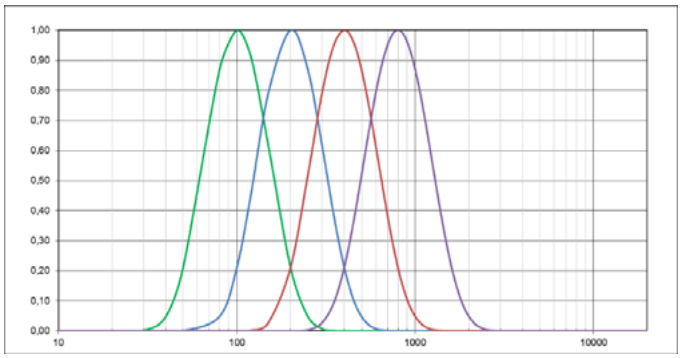
illustrates the concept of "filter bank" which decomposes the spectrum into individual bands, like an audio graphical equalizer. The number of scales can be defined by the number of bands per octave, an octave being the interval between a wavelength and its double or its half.

Symmetrical filters can be cascaded to obtain second, fourth or eighth orders that have more selective transmission curves with less overlap. They can be used to decompose the spectrum into more bands.

NEW MOUNTAINS® OPERATOR

The new Bandpass-filter bank Operator, released with Mountains® 9.2 decomposes a profile or a surface into a series of bands that can then be analyzed using surface texture parameters. Functional correlation may be carried out to identify active bands, where correlation is higher. This can help in identifying the range of scales to be used to control a particular function on a workpiece.

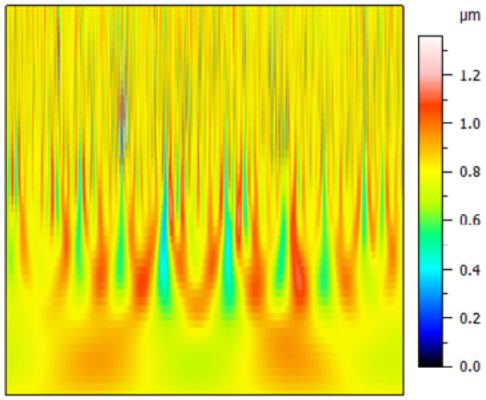
The tool also provides a new way to perform multi-scale analysis, as an alternative to wavelet



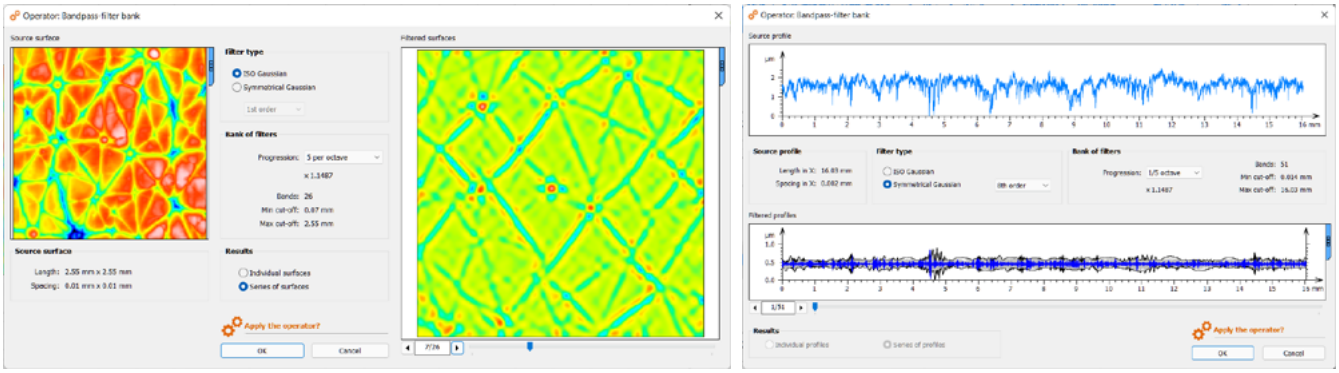
Above. *Four symmetrical bandpass filters centered at each octave.*

analyses or scale-sensitive fractal analyses, both already available in Mountains®. Bandpass-filter banks have the advantage of using tools that are easier to understand, based on the well-known Gaussian filter.

Physical phenomena are usually multi-scale in nature, so complex surfaces should be analyzed using multi-scale tools, to capture this complexity, and Mountains® software now offers a full range of these.



Above. *Example of multi-scale analysis on a profile, using a Gaussian filter bank.*



Above. *Mountains® version 9.2 offers a new Bandpass-filter bank operator for surfaces (left) and for profiles (right).*

ADDITIONAL RESOURCES

- ***Surface Metrology Guide:*** guide.digitalsurf.com/en/guide-metrology-standards.html

HORIBA AND DIGITAL SURF PARTNER TO LAUNCH GRAPHYX SOFTWARE RANGE

For the correlative analysis of Raman, AFM, AFM-Raman, cathodoluminescence and fluorescence data and microscopy images (optical, scanning probe microscopy, electron microscopy)

April 12, 2022
Palaiseau, France and Besançon, France

World leader in Raman microscopy and nanoscopy, HORIBA Scientific and Digital Surf, creator of the Mountains® software platform for image and surface analysis in microscopy and metrology, announced the release of graphYX, a new software range for users of HORIBA's Raman spectroscopy solutions, comprising two product levels: graphYX and graphYX-3D.

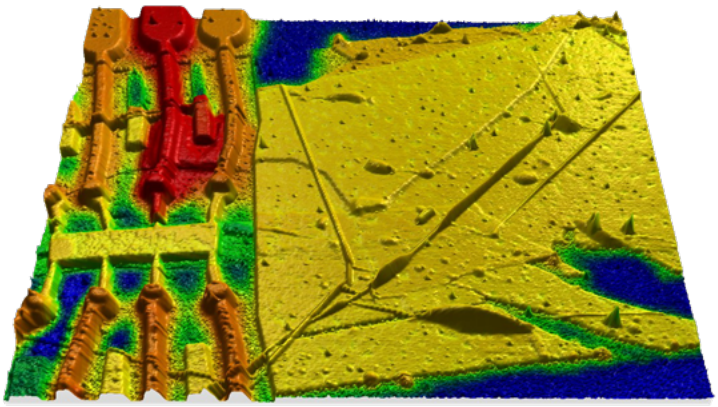
graphYX, powered by Mountains® technology, is an app included in HORIBA's LabSpec 6 software suite that allows users to highlight features of their samples by combining multimodal images obtained from SEM, Raman, CL, AFM, NanoRaman, EDX, EBSD, FTIR and other techniques. It will be delivered as standard on instruments such as the HORIBA AFM-Raman and nanoGPS navYX.

graphYX software, when combined with nanoGPS navYX, provides a complete solution for quickly relocating points of interest and overlapping map data on the sample surface.

nanoGPS navYX is a multimodal and multiscale solution that facilitates sample study and collaboration between researchers using different analytical tools at different locations.

graphYX users will benefit from the following features:

- **Colocalization tools** allowing the correlative analysis of data from several sources or several datasets from the same instrument (these can be from multiple users and multiple labs):
  - **from a single instrument:** study sample kinetics, monitor evolution over time, overlap data from more than two modalities (Raman, photocurrent, epifluorescence, darkfield etc), optimize palette, contrast and brightness of the various components of multivariate analysis;
  - **from multiple instruments:** correlate optical microscope images with SEM images, adjust orientation, scale and size of images generated by SEM, AFM, and optical microscopes;



Above. *KPFM-FM signal overlaid on topography using graphYX-3D software. Device: graphite gate/hBN/bilayer graphene / hBN on SiO2/Si. Sample courtesy of A. Reserbat-Plantey, ICFO, Spain.*

- Quick **enhancement and correction** of images and chemical maps.
- **Interactive document layout and workflow** allowing users to track and modify each individual analysis step at any time.
- **Compatible** with multiple types of HORIBA analyzers.
- Combine graphYX with nanoGPS navYX to quickly **relocate points of interest and overlapping map areas** on samples.
- graphYX-3D adds **3D topographic image rendering** for techniques such as AFM and AFM-Raman.

"*graphYX opens up a new world of possibilities for users of HORIBA's leading analytical solutions. Its compatibility with a wide range of instrument technologies makes it truly unique and will make life easier for our customers working in fields ranging from automotive to semiconductor manufacturing and materials research*" stated Laurent Fullana, President of HORIBA France.

"*We are thrilled to announce this partnership with HORIBA, a company highly regarded for its expertise in Raman spectroscopy. graphYX brings Mountains® powerful range of analytical tools for microscopy data analysis to those working with data from multiple sources, increasing research productivity and driving innovation even further*" said Christophe Mignot, CEO of Digital Surf.

WHAT'S HOT ONLINE

POPULAR ON LINKEDIN

Our team headed up north to the lovely town of Saint-Valery-sur-Somme where they met with the SPM community. And yes, while the sightseeing was nice, meeting everyone in person again was even better! bit.ly/3KaNqJ6

SPOTTED ON FACEBOOK

Our latest Back to basics webinar in which Alexis took you through some of Mountains® core features, got record high views! bit.ly/3J5KFaB

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Control International trade fair
May 3-6, 2022 | Stuttgart, Germany

Conference on Surface Integrity (CIRP)
June 8-10, 2022 | Lyon, France

Met & Props Conference
June 27-30, 2022 | Glasgow, UK

Digital Surf

HQ, R&D Center
16 rue Lavoisier
25000 Besançon - France
Tel: +33 38150 4800
contact@digitalsurf.com

www.digitalsurf.com

Surface Newsletter, April 2022
Editor : Christophe Mignot
Content editor : Clare Jamet
Contributors : Laure Aubry, François Blateyron, Felix Breitschädel, Eugenia Capitaine, Samuel Lesko.