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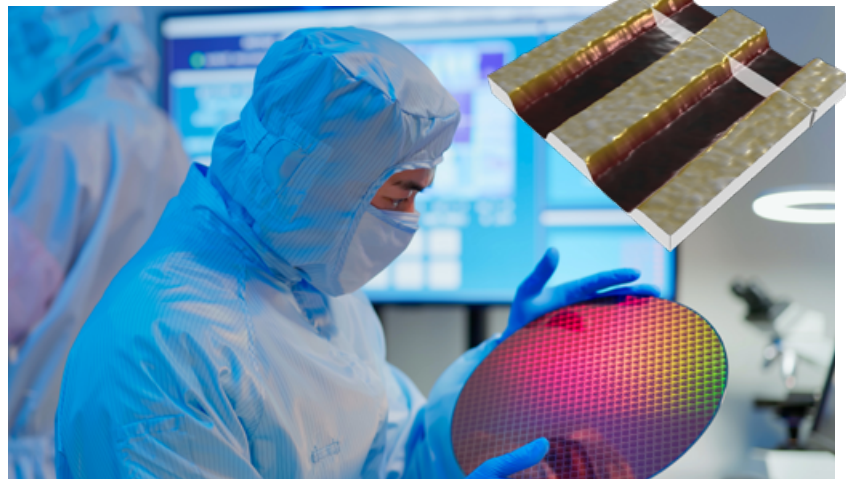
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THE SURFACE ANALYSIS TOOLS OPTIMIZING SEMICONDUCTOR PRODUCTION PROCESSES



Precision and process control are more critical than ever in today's semiconductor industry.

As devices grow smaller and fabrication steps more complex, engineers are turning to integrated software solutions to make sense of multi-source data and streamline analysis.

From critical dimensioning to overlay measurements, advanced tools are helping improve efficiency and yield.

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Watch a
WEBINAR



Did you know there is a whole host of free webinars waiting for you on the Digital Surf website?

Head on over to our Webinar Library & become a Mountains® software expert in no time!

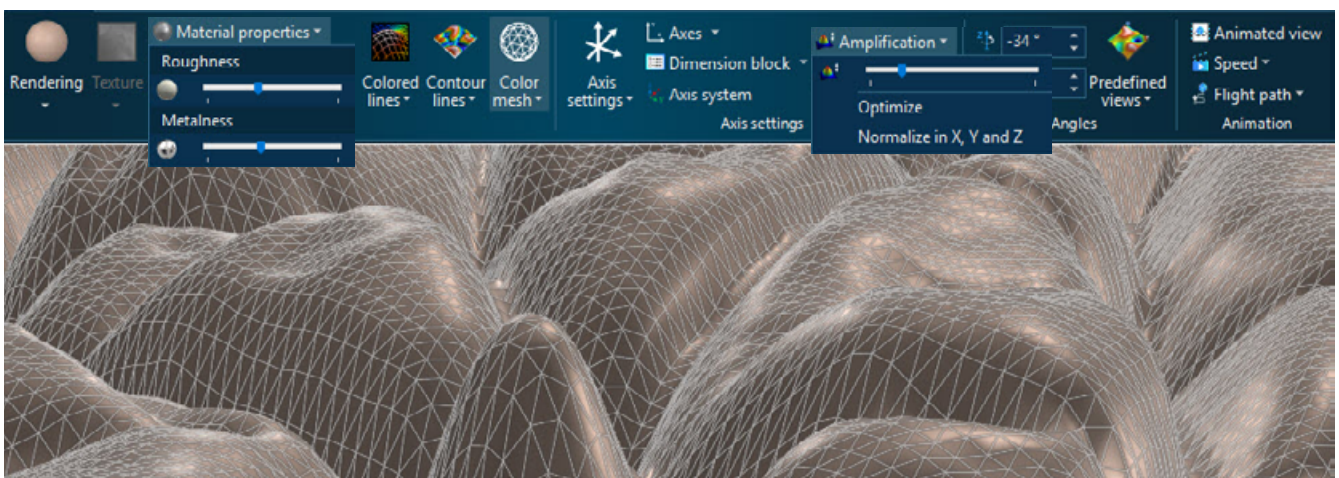
Check it out:

www.digitalsurf.com/learning/webinars/

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MOUNTAINS® 11 WHAT'S ON THE HORIZON?

Digital Surf is set to preview **version 11** of its flagship **Mountains® software platform** at the upcoming Control 2025 trade show. Scheduled for official release late spring, this major update promises an impressive leap forward for users across surface metrology, microscopy and spectroscopy. From next-level 3D rendering to streamlined workflows and new analysis tools, Mountains® 11 raises the bar in performance and productivity.



Above. Version 11 sees the introduction of the newly developed Mountains® 3D rendering engine.

EXPANDED PRODUCT FAMILY

With version 11, the Mountains® software family broadens to include two new product offerings designed to meet the diverse needs of scientific and industrial users.

MountainsSEM® Image Analysis is specifically aimed at users performing 2D SEM image analysis, and offers features such as semi-automatic object colorization, particle analysis and correlative analysis with EDS maps.

Meanwhile, **MountainsSPIP® Nanospectral Starter and Expert** will cater to SPM users working at the nanoscale with techniques such as nano-IR and TERS.

A NEW DIMENSION IN 3D VISUALIZATION

Version 11 introduces a powerful **new 3D rendering engine**, delivering sharper, smoother and more responsive visualizations.

Users can now apply realistic **Roughness and Metalness effects**, layer color meshes onto

rendered surfaces and adjust resolution and amplification with **intuitive sliders**. These enhancements are cross-technology and available to all users.

Upcoming improvements specifically for users working with profilometry data include **visualization of thresholding and leveling planes on surfaces in 3D** (NB. available Sept. 2025).

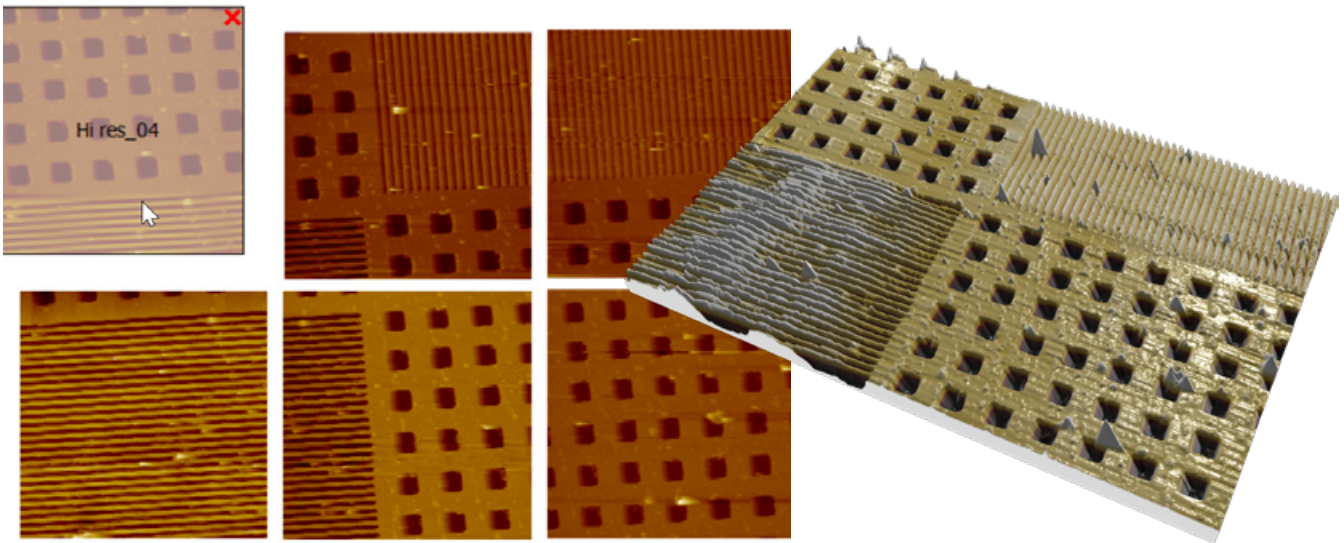
THE DOCUMENT JUST KEEPS GETTING SMARTER

Crafting clean, presentation-ready reports is faster than ever in Mountains® 11.

Users can now **copy and reuse parts of their workflows** - such as preprocessing steps - across documents, helping teams save time and maintain consistency.

A **"Batch export"** option now allows multiple documents to be converted to PDF or RTF with a single click.

The addition of **visual guides and auto-alignment** makes organizing content within documents simpler and more precise.



Above left. The popular cross-technology Stitching operator has had a major makeover.

Finally, a new **Navigation box** gives users a quick overview and faster access to regions of interest, while the redesigned **"Home" screen** and a **new visual theme** modernize the interface.

NEXT-GEN STITCHING ACROSS INSTRUMENT TECHNIQUES

The upgraded **Stitch operator** offers a cross-platform solution for stitching measurements in profilometry, SEM, SPM and light microscopy.

Its usability has been enhanced with better visualization, a Grid wizard for arranging data and selective stitching for refined control over included datasets. Performance gains ensure faster processing of large or overlapping images, especially valuable for workflows involving corrected data.

ENHANCEMENTS ACROSS THE BOARD

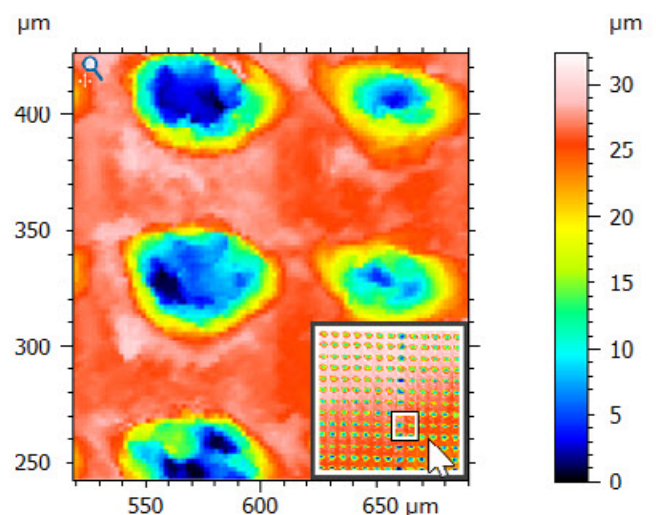
Additional upgrades include new analytical tools for profilometry like **determination of the correlation scale in Scale-Sensitive Fractal Analysis**, expanded **Rk/Sk study options** and better automated management of **exclusions on profile leveling**.

Users working with Shells (freeform data) can now **compare CAD on portions** and **fill holes** in

scans. Point cloud data can now be exported in **.PLY format**.

SEM users benefit in particular from a new **fiber classification feature** and **better 4-quadrant reconstructions**, while light microscopy and SPM gain new **edge-preserving filters** to clean up noise without blurring crucial details.

Spectroscopy users will appreciate new **exponential/logarithmic curve fitting options** for advanced lifetime mapping.



Above. A Navigation box makes it easier to explore your data.

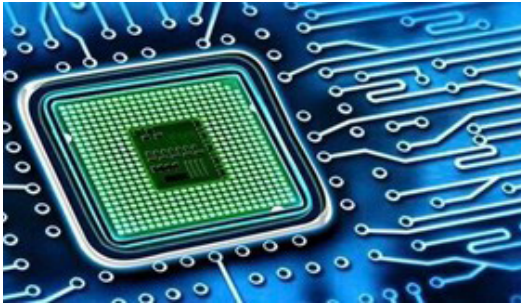


LEARN MORE & UPDATE

Check www.digitalsurf.com for full details of the v11 release (available late spring 2025). Access to the new version is included for users with an active **Mountains® Software Maintenance Plan**. To find out more about your Maintenance options, please contact sales@digitalsurf.com

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ADDRESSING THE CHALLENGES OF PRECISION SURFACE ANALYSIS IN SEMICONDUCTOR FABRICATION



Semiconductor fabrication is an intricate process that demands extreme precision at every stage, from lithography and etching to packaging and testing. Defects or inconsistencies at the microscale and nanoscale can significantly impact device performance, yield and reliability. *Surface* newsletter explores how engineers and metrologists are using **advanced surface**

measurement techniques such as profilometry, scanning electron microscopy (SEM) and atomic force microscopy (AFM), coupled with **specialized multi-modal analysis software** to address the challenges they face.

A UNIFIED SOFTWARE PLATFORM

In semiconductor R&D and manufacturing environments, data is often generated using a variety of instruments and imaging techniques. Bringing together information from profilometers, SEMs, AFMs and other tools can be a challenge.

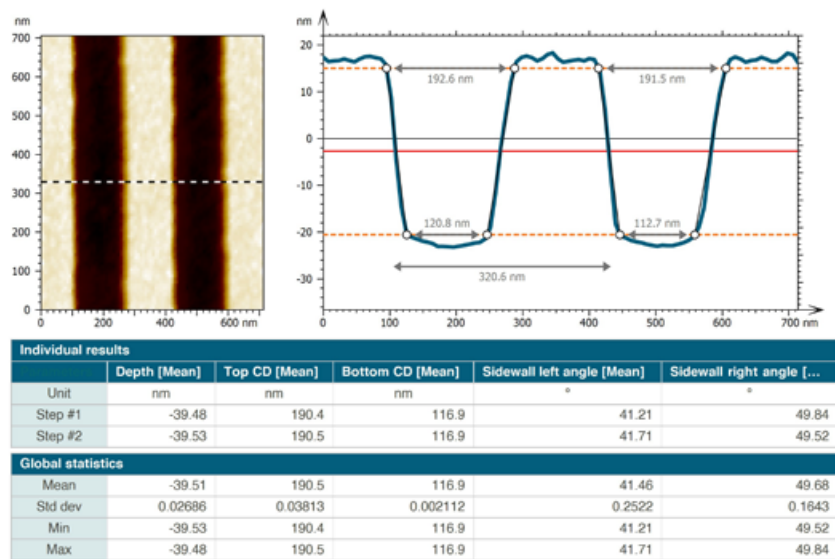
A unified analysis environment helps streamline this process, enabling engineers and researchers to interpret results more efficiently, compare findings across instrument technologies and make faster, data-driven decisions. Enter Mountains® software, a solution designed to support this type of cross-device analysis and help users gain a clearer understanding of complex surface structures.

TARGETED TOOLS FOR THE SEMICONDUCTOR INDUSTRY

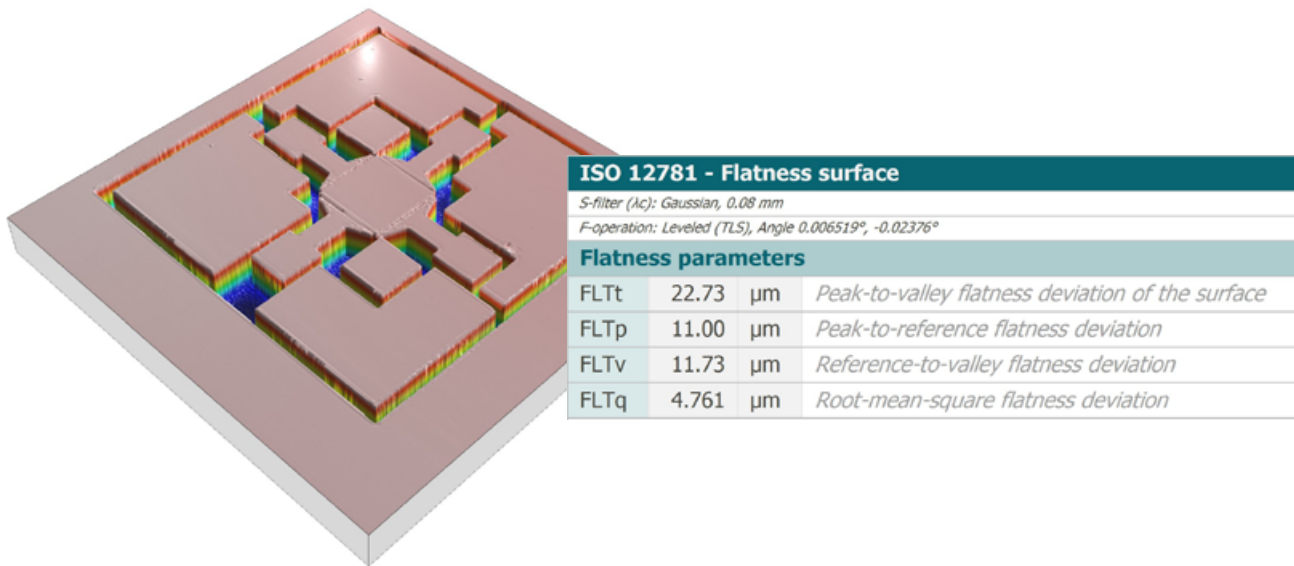
Over the years, the Mountains® platform has built up an impressive set of dedicated solutions for semiconductor manufacturers working in wafer inspection, chip analysis and PCB assembly. These include tools for:

- ▶ **Critical dimension analysis:** characterization of trenches and nanometric structures in semiconductors with AFM and profilometry.

- ▶ **Control of Line Edge Roughness (LER) and Line Width Roughness (LWR)** to ensure uniformity in circuit patterns.
- ▶ **Advanced topographical analysis** to allow users to accurately calculate semiconductor surface flatness parameters.
- ▶ **Through-silicon via (TSV) critical dimensioning** to ensure uniformity of vias, a crucial factor for reliable electrical connectivity.
- ▶ **Overlay measurement** to detect misalignment between layers in semiconductor structures which can lead to device failure.
- ▶ **High aspect ratio structure assessment** (deep trenches, nano-pillars etc.)

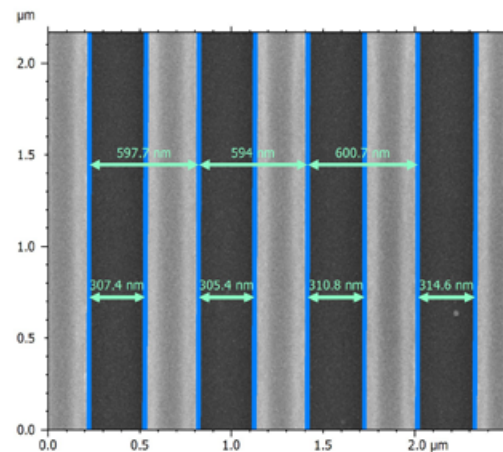


Above. Critical dimension analysis in semiconductor fabrication with AFM.



Above. Advanced topography analysis tools for semiconductor & MEMS surfaces including flatness parameters.

- ▶ **Edge detection:** identification of holes, bumps and other structures, essential for detection of defects and process optimization.
- ▶ **Analysis of thermal deformation of packaging** to pinpoint issues with warpage.
- ▶ **Automatic detection and analysis of step heights** in semiconductor structures.
- ▶ **Feature detection and pattern analysis** to ensure compliance with design specifications.
- ▶ **3D reconstruction of SEM data** to achieve deeper insights into nanoscale structures.

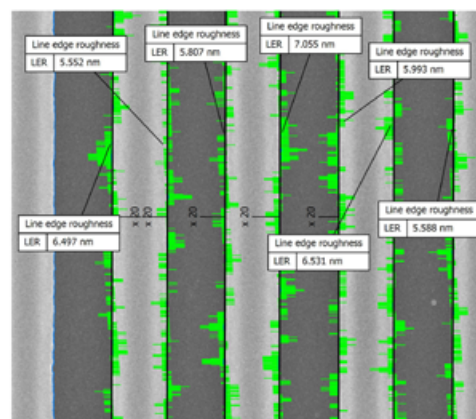


AUTOMATE YOUR SEMICONDUCTOR WORKFLOW

Whether you are optimizing line roughness, verifying vias or analyzing step height variations, Mountains® software provides the added benefit of enabling you to easily automate your processes, thus dramatically reducing analysis time.

No-code automation tools for the semiconductor industry include:

- ▶ statistical documents, for identifying trends in large volumes of data
- ▶ automatic generation of analysis reports
- ▶ export of numerical data for processing with other statistical tools.



Above. Line edge roughness and deviation mapping on scanning electron microscope data.



LEARN MORE & TRY IT OUT

- ▶ For more information, visit www.digitalsurf.com/application-fields/semiconductors
- ▶ Try the tools out on your own semiconductor data: www.digitalsurf.com/free-trial

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HARNESS THE SUPERPOWERS OF THE MOUNTAINS® DOCUMENT



Did you know the humble document in Mountains® is hiding some pretty extraordinary abilities? From automating complex workflows to creating interactive tutorials, it's more than just a place to lay out your results.

In this article, **Christophe Mignot, CEO of Digital Surf**, lifts the curtain on the document's hidden powers and how they can make your work easier, smarter and surprisingly fun.

THE DOCUMENT AT THE HEART OF DATA ANALYSIS

Since its early development, Mountains® software has adopted a distinctive approach to image and surface analysis that places the document at the center of the process. Unlike traditional technical software solutions that rely heavily on multiple floating windows, Mountains® integrates analysis directly into a structured document, allowing users to view and organize their work as they go.

This document-based system offers more than just page layout. As users process their data, everything is automatically arranged on document pages. With version 11, this functionality has been further refined with **improved tools for positioning studies on the page**.

The flexibility to annotate, illustrate and comment on each step of the analysis makes the document not only a workspace but also a medium for communication, reproducibility, and documentation. Features like **unlimited undo/redo** and the ability to **save and revisit work at any time** add to the ease of use.

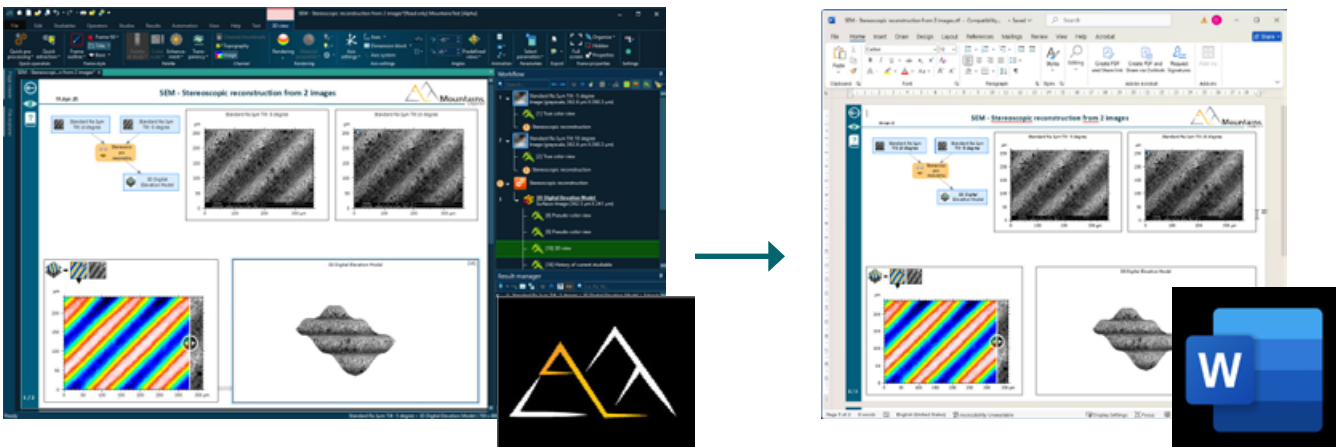
INTEROPERABILITY: FROM MOUNTAINS® TO WORD (AND BEYOND)

Need to share your analysis with someone who doesn't use Mountains®? No problem. Thanks to RTF export, you can open your Mountains® document directly in Microsoft® Word, with layouts, text and structure preserved. This makes reporting and collaboration a lot easier.

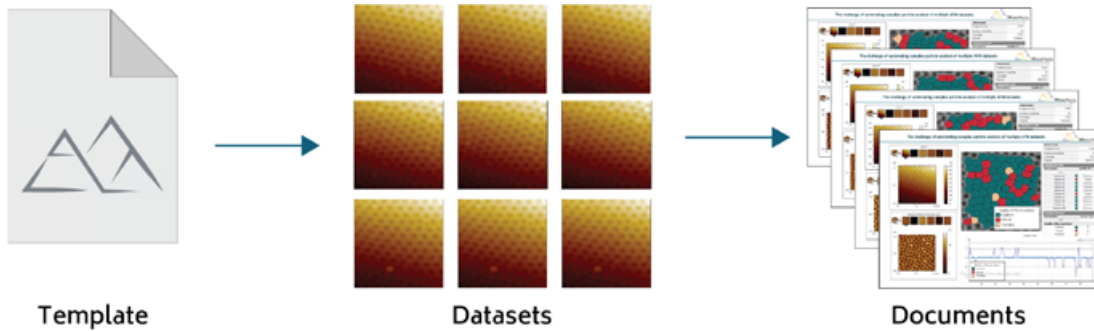
PDF export remains a favorite, of course, especially for sharing read-only reports. And now, **batch PDF export gets a boost** too: apply a document template to a group of datasets and Mountains® can churn out a full set of reports in just a few clicks. It's a huge time-saver for labs and teams handling repetitive analyses.

DATA EXPORT: CURVES, STATS, IMAGES

Your analysis doesn't live in a vacuum. We understand that you'll often need to use your data elsewhere, whether for presentation, publication or further processing.



Above. Move directly from Digital Surf's Mountains® to Microsoft® Word RTF format.



Above. No-code automation: apply any document as a template and process batches of data.

That’s why the document isn’t just a place to see your results, but also a hub to *extract* them. From profile curves and topography maps to numerical values and statistical summaries, virtually every element you work with can be exported. Copy images to your clipboard, save datasets as files or export graphs for external plotting tools, the possibilities are limitless!

AUTOMATION, NO CODING REQUIRED

What if your analysis could run itself? In Mountains®, it practically can.

Every document is more than a static report: it’s a living, reusable workflow. Once you’ve set up an

analysis sequence, you can apply it to other datasets with just a couple of clicks. Whether you’re working with two samples or two hundred, the same protocol can be reused over and over again, saving you hours of manual effort.

And the best part? You don’t need to write a single line of code. The software lets you build powerful analysis pipelines intuitively. With version 11, this process is even more flexible: you can now **copy and paste parts of a workflow** from one dataset to another using simple drag-and-drop actions. It’s a fast way to scale up or tweak your process without starting from scratch.

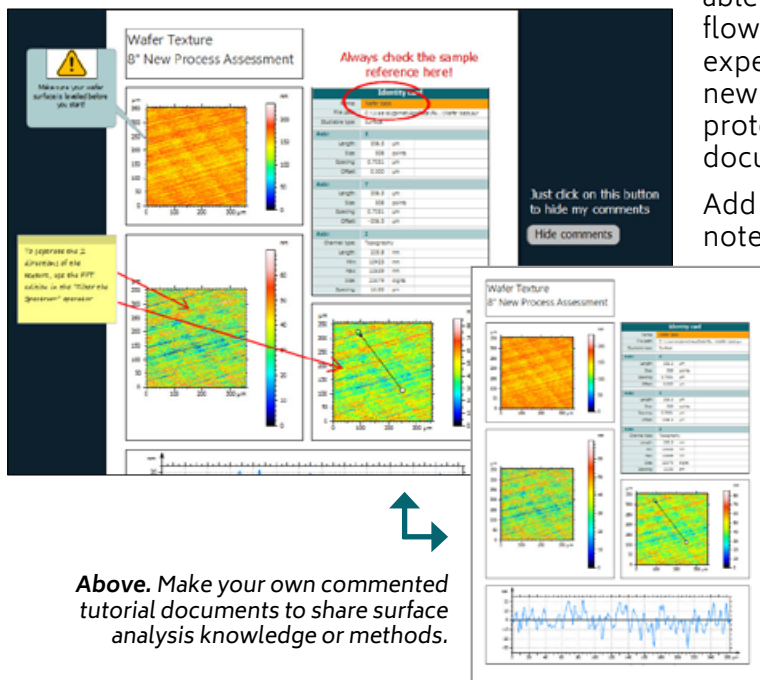
BUILT-IN TRAINING TOOLS

Mountains® documents are also incredibly teachable. Once you’ve fine-tuned your analysis workflow, you can turn it into an interactive learning experience for others. Whether you’re training new students or team members, standardizing protocols across a lab or handing off a project, the document becomes a fully annotated guidebook.

Add arrows, comment bubbles, images, sticky notes, and custom instructions to walk colleagues through each step. When they’re done reviewing, all those comments can be hidden with a single click, leaving behind a clean, ready-to-use protocol.

But it doesn’t stop there. You can even build full discovery paths using index pages and internal links, turning your document into a mini training course or internal knowledge base.

In conclusion: a good understanding of the document’s advanced features will unlock your productivity!



Above. Make your own commented tutorial documents to share surface analysis knowledge or methods.



WANT TO SEE THESE FEATURES IN ACTION?

Join us for our upcoming webinar, where we’ll present a live demonstration and explore the Mountains® document superpowers in greater detail: bit.ly/3G6O8dk



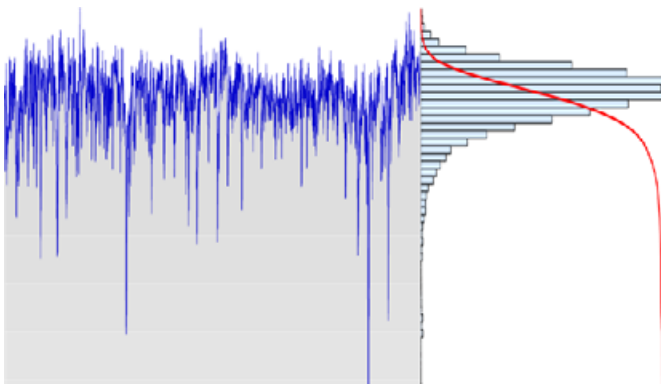
WHAT ARE THE BENEFITS OF PARAMETERS BASED ON MATERIAL RATIO?



Many users consider that roughness is (only) represented by **Ra** (on a profile) and **Sa** (on a surface). While these are among the most commonly used parameters, they are often the least meaningful when it comes to fully understanding surface texture. Among the wide range of available parameters, those based on **material ratio**, that is represented by the Abbott curve, are certainly amongst the most valuable for understanding surface characteristics. **François Blateyron, Digital Surf's senior surface metrology expert**, explains the benefits of these parameters and why users should move beyond **Ra** or **Sa** for evaluating the functional behavior of mechanical components.

HEIGHT DISTRIBUTION

Profile or surface heights can be represented as a **statistical distribution** showing the percentage of data points that fall within each height range (bin). This distribution is essentially a histogram of heights, and provides a fundamental view of surface topography.



Above. A profile (left) and its height distribution (right) in blue with Abbott curve in red.

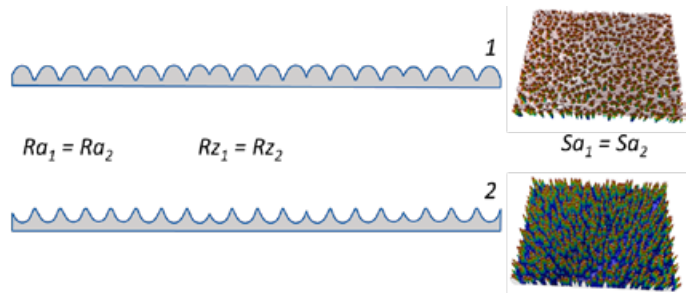
ABBOTT CURVE

The Abbott curve is built by summing the height distribution values, from the highest to the lowest value, corresponding to 0% to 100% on the Abbott curve. It provides the material ratio value in % for a given depth taken from a reference that is by default the highest point.

BEYOND ROUGHNESS HEIGHT

The following illustration shows two profiles with identical **Ra** and **Rz** values but clearly different functional behavior. Imagine if you had to walk barefoot on one of them, you would probably

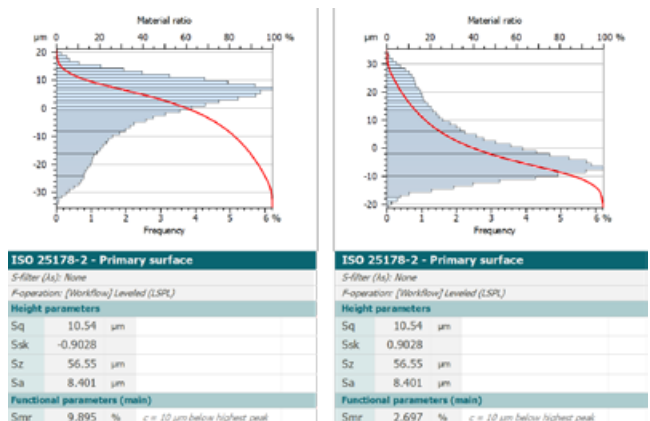
prefer the first one! This highlights how height-based parameters alone cannot distinguish between functionally different surfaces.



MATERIAL RATIO PARAMETERS

The following two height distributions clearly show how the texture is distributed between plateaus and deep valleys.

Traditional height parameters (**Sq**, **Sa**, **Sz**) cannot distinguish between such surfaces. However, material ratio-based parameters such as **Ssk** (skewness) and **Smr** (material ratio) can.



Above. Distribution, Abbott curve and parameters for surface 1 (left) and surface 2 (right).

- ▶ **Ssk** is negative when the surface has plateaus (flat upper surface) with a few valleys, pores or scratches, and positive when it has flat bulk regions with particles or ridges above.
- ▶ **Smr** represents the material ratio at a given depth and can be used to query particular values of the Abbott curve and set tolerances.

Additional useful parameters include:

- ▶ **Sku** (kurtosis) which indicates if the distribution is narrow or wide.
- ▶ **Smc**, the inverse material ratio that gives the height for a given material ratio.
- ▶ **Sdc**, the height difference between two material ratios.

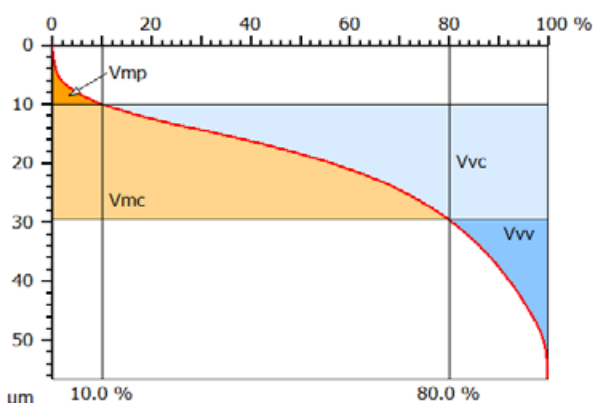
All of these also have equivalents on profiles: **Rsk**, **Rku**, **Rmr**, **Rmc**, **Rdc**.

LUBRICATION AND WEAR

Material ratio-based parameters, especially **volume parameters**, are highly effective for assessing mechanical functions like lubrication and wear.

Calculated from segments of the Abbott curve, they allow quantification of **material** and **void volumes**:

- ▶ **Vmp** is the material volume of peaks, that are most prone to wear during contact.
- ▶ **Vmc** is the material volume of the core, which corresponds to the main contact section.
- ▶ **Vvv** is the void volume of the valleys, that characterizes the volume of lubricant retained in the lowest parts of the texture.
- ▶ **Vvc** is the void volume of the core.



Information		
Filter settings	Unfiltered.	
Parameters	Value	Unit
Vmp	0.0002408	mm ³ /mm ²
Vmc	0.009986	mm ³ /mm ²
Vvc	0.00959	mm ³ /mm ²
Vvv	0.001779	mm ³ /mm ²

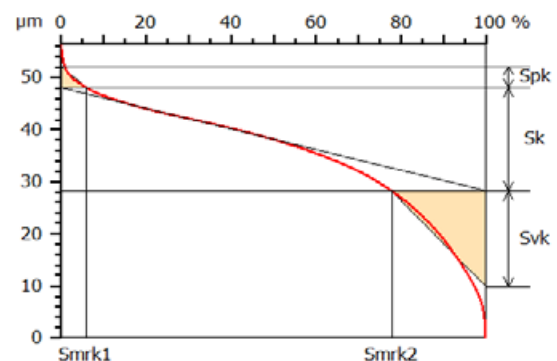
These parameters are available for profiles in ISO 21920-2, with **Rvmp**, **Rvmc**, **Rvvc** and **Rvvv**.

AUTOMOTIVE PARAMETERS

The **Rk** family of parameters has long been used in the automotive industry for characterizing profiles.

These parameters are calculated by graphical construction on the Abbott curve. They include:

- ▶ **Sk** (core height)
- ▶ **Spk** (reduced peak height)
- ▶ **Svk** (reduced valley height).
- ▶ **Smrk1**, **Smrk2** (material ratios of the separations between domains).



Information		
Filter settings	Unfiltered.	
Standard	ISO 25178-2	
Parameters	Value	Unit
Sk	19.82	μm
Spk	4.109	μm
Svk	18.46	μm
Smrk1	5.819	%
Smrk2	77.72	%

Originally developed for profiles (in ISO 13565-2, now included in ISO 21920-2) with **Rk**, **Rpk**, **Rvk**, **Rmrk1** and **Rmrk2**, these parameters have helped optimize engine efficiency for over 30 years and are now being adopted in other industries.

FINAL THOUGHTS

There is far more information to extract from a texture than just its height. Parameters based on material ratio, sometimes calculated with an appropriate filter, provide valuable control of the workpiece function.



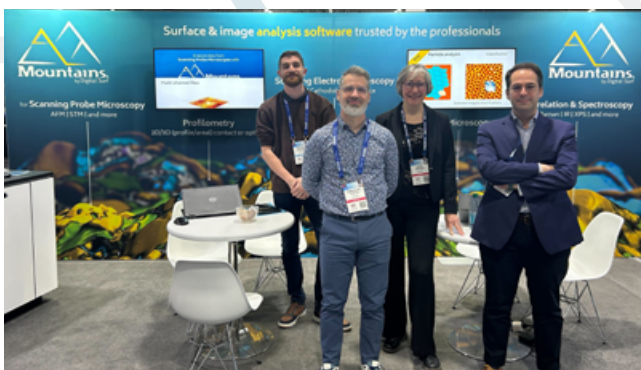
For more on material ratio and other surface parameters, visit our **Surface Metrology Guide** guide.digitalsurf.com

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TRADE SHOW REVIEW

Last November in Bordeaux, FR, we were proud to sponsor & attend the “**Contrôle & Métrologie Optique**” conference, a French event dedicated to optical control & metrology. François, our surface metrology expert, held a presentation to demonstrate Mountains® key features dedicated to surface analysis.

The **MRS Fall Meeting** has become a regular event for Digital Surf now. Anne, Emmanuel, Nicolas and Mathieu were present in Boston, MA last December to attend the 2024 edition. This year again, they met scientists & researchers from all over the world, as well as some of our valued partners & customers, to discuss their applications in the field of materials research.



Above. The Digital Surf team at MRS Fall Meeting

Emmanuel and Nicolas headed for Boston again in March to attend the **Pittcon conference**. Taking place from March 3-5, the exhibition gathered over 6,900 participants with a wide range of applications, in particular in the field of spectral analysis. Our sales team was thrilled to provide the visitors to our booth with live demos of Mountains® software.



Above. Emmanuel & Nicolas at Pittcon 2025



Above. Scanning Probe Microscopy Meeting 2025

Mathieu and Nils visited our Belgian neighbors to take part in the **Forum des Microscopies à Sondes Locales (Scanning Probe Microscopy meeting)** which took place from March 31 to April 4 in Spa, Belgium. Every year, this event gathers the French speaking SPM community in an informal and friendly environment. The Digital Surf team was pleased to take this opportunity to discuss the latest trends in AFM image analysis.

LATEST PRODUCT NEWS

The Mountains® software platform continues to grow with two new custom partner products released in the past few months:



- ▶ In January, Peak Metrology and Digital Surf jointly launched **Peak Metrology Surface Analysis**, a profilometry software package powered by Mountains® technology, designed for precision surface data analysis. This software offers comprehensive surface characterization across industries. bit.ly/PeakMetrologySurfaceAnalysis
- ▶ In March, Delmic and Digital Surf introduced **CL Workspace**, a software suite powered by Mountains® technology, designed to enhance cathodoluminescence (CL) data analysis for Delmic's imaging systems. bit.ly/CLWorkspace

WHAT'S HOT ONLINE

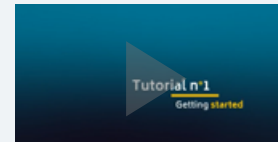


POPULAR ON LINKEDIN

We recently organized a training session on MCubeMap analysis software with our partner Mitutoyo. Great knowledge & delicious dinners were shared. See more on our LinkedIn page: bit.ly/4i51pAh



Have you been to our YouTube channel?



We have lots of quick, helpful videos, as well as tutorials on Mountains® software basic and advanced features, check them out: bit.ly/2U2I2za



LOVED ON FACEBOOK

A new "mini" series is here! Pico, our tiny mountain mascot, has been preparing a few presentations of his favorite Mountains® software tools and how to best apply them to your data. See the first installment here : bit.ly/42cS1pS



Surface Newsletter

Know a friend or colleague who would be interested in receiving the *Surface Newsletter*?

Let us know:

contact@digitalsurf.com

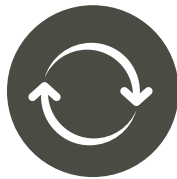
The newsletter is available for download on our website www.digitalsurf.com

Useful LINKS



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LEARN SURFACE METROLOGY

Dive into our free online surface metrology guide and learn about characterizing surface texture in 2D and 3D www.digitalsurf.com/guide



CATCH UP WITH US

Control | Booth 3418

May 6-9, 2025 | Stuttgart, Germany

In-Situ And Correlative Electron Microscopy conference (ICEM)

Jun 2-4, 2025 | Brno, Czech Republic

Euspen Conference

Jun 9 - 13, 2025 | Zaragoza, Spain



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Surface Newsletter, April 2025

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