Newsletter

FALL 2021

SURFACE

Surface imaging, analysis & metrology news from Digital Surf

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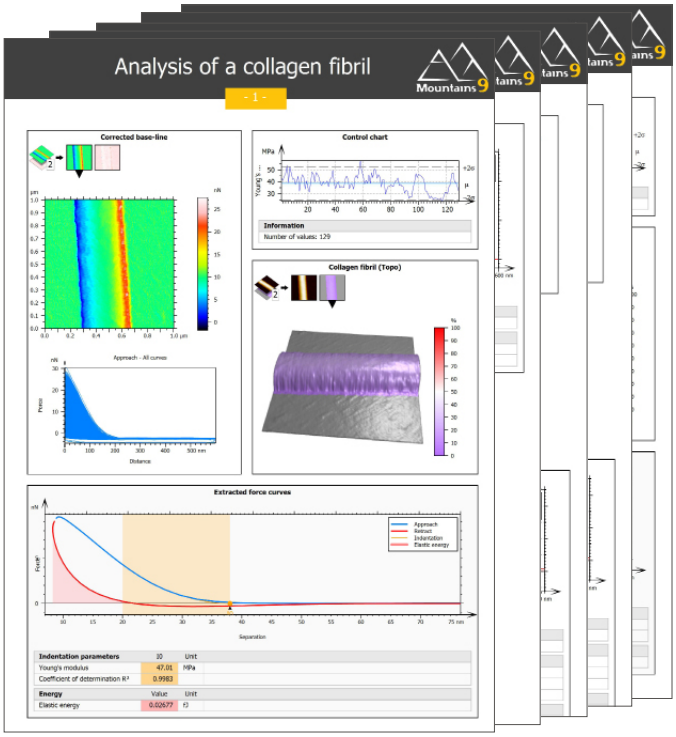
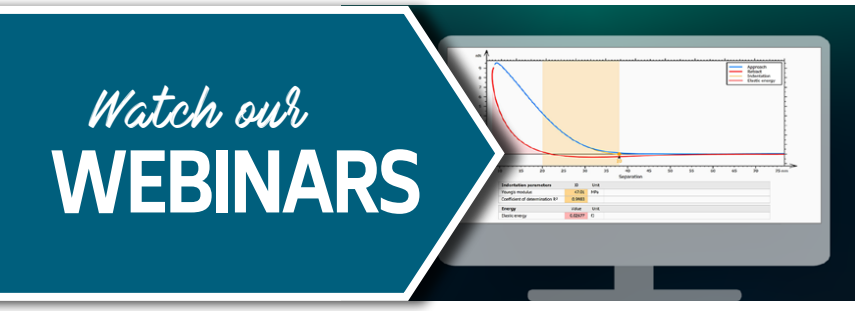
IN THIS ISSUE

STUDY STYLES, NEW TOOLS FOR FORCE SPECTROSCOPY...
THE MOUNTAINS® 9.1 RELEASE



This Fall, the Digital Surf team has been cooking up a new version of Mountains® 9. Updated features are available for users of all types of instrument technologies. Your Mountains® analysis reports are just going to keep getting better!

... Turn to page 2 ...



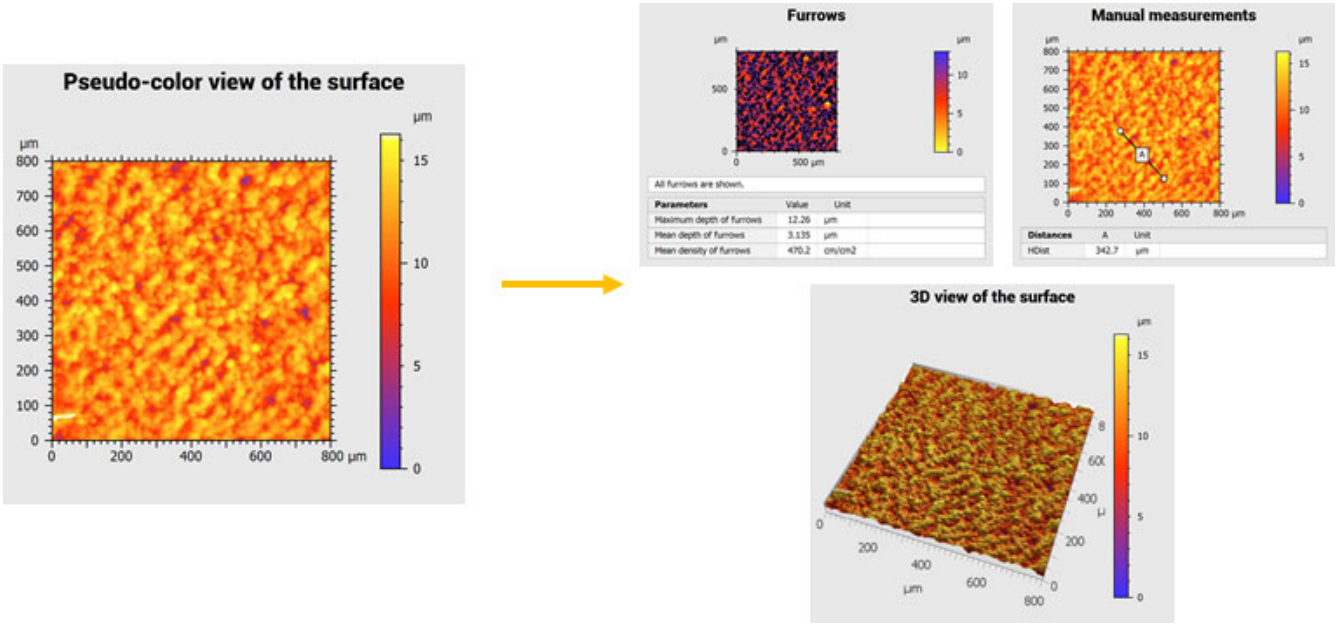
Register for our webinar

The Materials Research Society (MRS) 2021 Meeting & Exhibit will be a hybrid edition.

Come visit our booth in person on Nov 29 - Dec 2 or virtually on Dec 6-8. We're also organizing a webinar on "Analysing force spectroscopy data with Mountains® 9.1": https://bit.ly/3n7BM8F

MOUNTAINS® 9.1 WHAT'S NEW FOR MICRO & NANOSCALE ANALYSIS?

Fall is here and (finally!) the return of in-person events. What's more, a brand new release of Mountains® software is on the horizon bringing new and improved features for imaging, metrology and analysis. *Surface Newsletter* takes a look at some of the cool new features that will be on show at the **Materials Research Society Fall Exhibit** in Boston this November and available for download early December.



Above. *Quick creation and application of study styles in Mountains® 9.1.*

IT'S A QUESTION OF STYLE

Generating fantastic-looking documents for presentations is one of the features of Mountains® software most appreciated by users.

Now managing styles applied to Studies (for example Pseudo color view, 3D view, Manual measurements, Particle Analysis etc.) just got easier.

Users can create custom styles, including palette, color and axis settings, and choose whether to apply them to any further Studies or to revert to a previously saved or default style.

Styles can also be copy/pasted from Study to Study and users can even choose to apply any style to all Studies.

EXTRACT MULTIPLE (CUSTOM) REGIONS OF INTEREST

The Extract area Operator will be familiar to many Mountains® users. It now becomes the Extract Area**s** Operator, giving the ability to extract multiple areas of different shape from data of any kind: topography, images even force volume datasets.

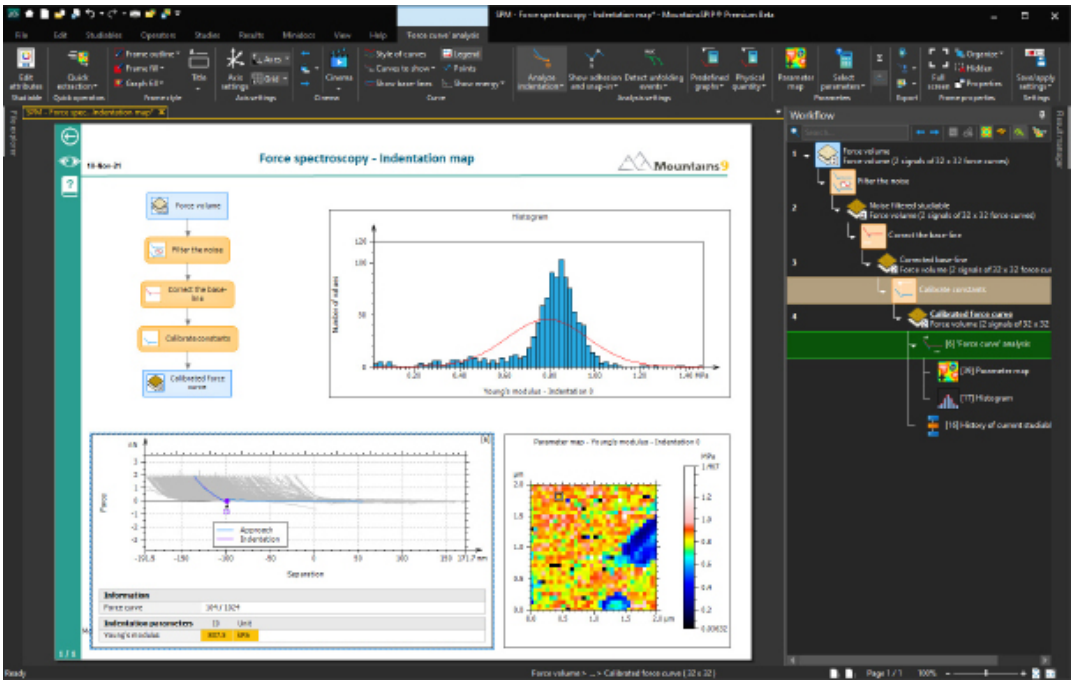
Rectangular, circular and custom areas can be combined and modified. Extracted areas can still be manipulated directly on the studiable in the document.

REVAMPED FORCE CURVE & FORCE VOLUME ANALYSIS

Big improvements await those analyzing data from force spectroscopy: force curves (force-distance curves) and force volume datasets.

Changes include an array of improved visualization options in the Force volume study as well as new tools for "cleaning up" force curve data and getting it ready for analysis (new Sort Force Curves operator).

"The focus of this release is really on helping our users focus on the parts of their data that are the



Above. *Many improvements await users working with data from force spectroscopy.*

most important to them" said Mathieu Cognard product manager for SPM applications. "A new Sort by a parameter operator enables users to sort force curves according to a parameter (Young's modulus, adhesion energy etc.) This can be useful if you're looking to isolate different materials composing a sample."

The 9.1 release also sees a lot of new features developed following user requests, including the calculation of energy parameters or enhanced baseline detection.

=> Turn to page 4 to see a user application

EVEN MORE TOOLS FOR SHELL & POINT CLOUD ANALYSIS

Shell (freeform surface) data, introduced with Mountains® 8 and Point cloud data, with version 9, continue to benefit from additional tools.

The Cloud mesh optimization tool speeds up the time to result when meshing point cloud data. A Remesh operator on Shells lets users homogenize triangle size: a useful option when working with large datasets!

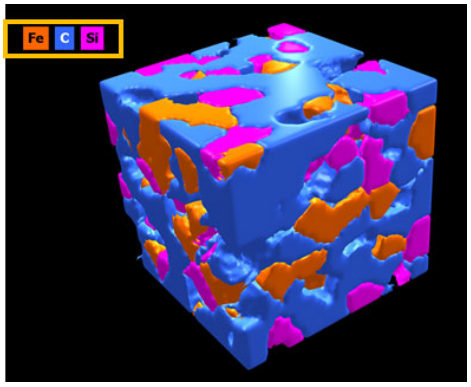
A Rotate operator further completes the available toolset for these two datatypes. Rotation can be performed manually or automatically.

MULTI-CHANNEL DATA: MANAGE COLORS & LEGENDS

Multi-channel datasets from microscopes producing multiple data channels can be effectively managed in Mountains®. This feature can now also be used to load images containing chemical data (EDS maps etc.)

New options for attributing colors and legends to different channels are made available in the 9.1 release. As always in Mountains®, dependent studies are automatically updated when a change is made.

Legends can be displayed in short or long form. This new option also applies to recently supported multi-channel cube datasets (see below).



Right. *Multi-channel cube with custom colors and legends.*

READ MORE & UPDATE

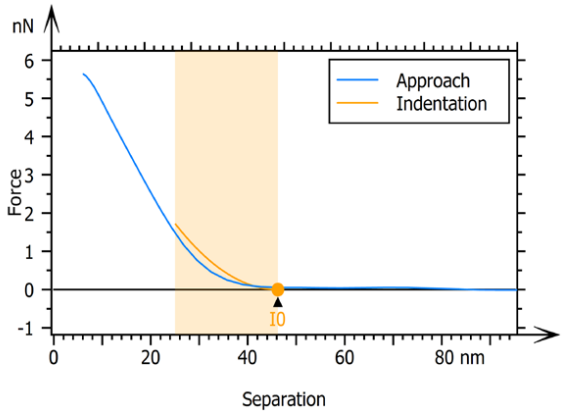
Check www.digitalsurf.com for full details of the Mountains® 9.1 release (early Dec). Access to the new version is free for users with an active **Mountains® Software Maintenance Plan**. To find out more about your Maintenance options, please contact sales@digitalsurf.com

USING NEW DEDICATED TOOLS FOR ENHANCED ANALYSIS OF FORCE CURVES

Researchers at the Structural Nanomechanics Lab at Dalhousie University in Canada have been investigating **the nanomechanical behavior of Collagen I fibrils.** Their study demonstrated that nanomechanical mapping can detect subtle changes in molecular dynamics and fibril architecture. Using data acquired by Kelsey Gsell (PhD Student in Biomedical Engineering), this article explains how Mountains® software allows fine-tuning and detailed analysis of force volume data.

Collagen is the primary protein component that provides structural integrity to mammalian tissues. It provides mechanical strength to tissues such as bone, tendon, ligament and skin. In this article, the studiable used was a force volume image of a collagen fibril from a rat tail acquired on a glass substrate. Mechanical data analysis was required to be performed on the collagen fiber only, in order to obtain meaningful results.

The raw data was therefore processed with the goal of extracting only the collagen fibril useful for the study. To do this, an initial step of indentation analysis was performed on the entire mapping (figure 1). The Sneddon model was used by fitting the force curves to an indentation depth of 25% of the zero-force height of the fibril. This ensured the influence of the underlying glass substrate on the calculated moduli was minimized.



Information			
Force curve	17005 / 65536		
Indentation parameters	I0	Unit	
Young's modulus	13934	kPa	
Coefficient of determination R^2	0.99037		

Figure 1. *Indentation analysis (Sneddon) was performed to isolate a specific region of the collagen I fibril.*

ADVANCED TOOLS FOR SORTING FORCE CURVES

The new MountainsSPIP® "Sort by a parameter" operator was then applied in order to display force curves with a Young's modulus lower than 35MPa, allowing researchers to focus their study solely on the fibril.

Statistics were generated on these specific areas of interest. The 3D view on figure 2 shows the distribution of the elastic moduli along the collagen fibril overlaid on the measured topography. Two interesting features were observed here: the fibril ends and the sharp bends exhibiting moduli lower than their surroundings.

CALCULATION OF DEFORMATION ENERGIES

MountainsSPIP® software also allows for the calculation of the deformation energies used during

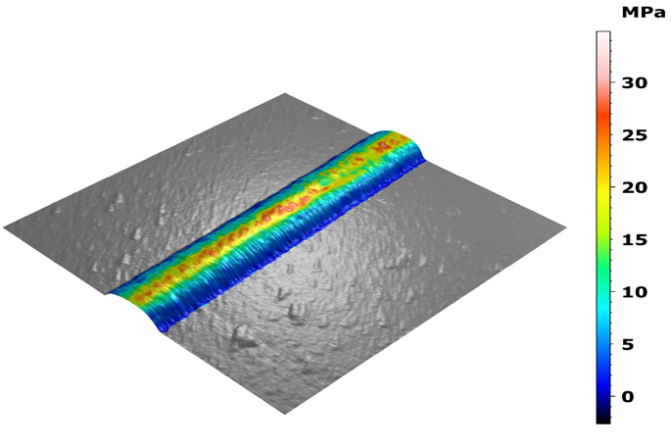
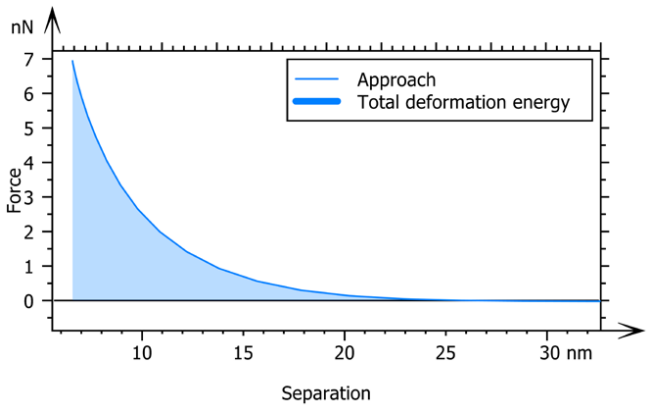


Figure 2. *Mapping of the Young's modulus overlaid on the three-dimensional topography.*



Energy	Value	Unit
Total deformation energy	0.024712	fJ
Elastic energy	0.011055	fJ
Elastic to deformation energy	44.736	%

Figure 3. *Calculation and visualization of the total deformation energy.*

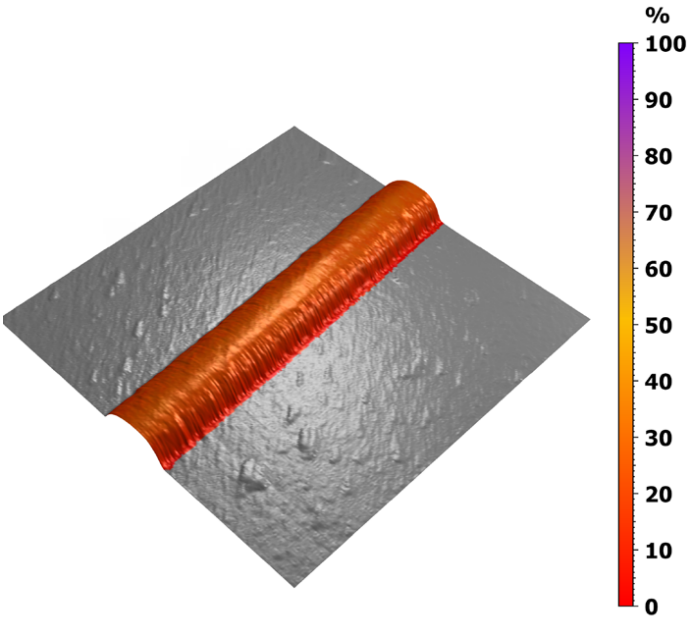


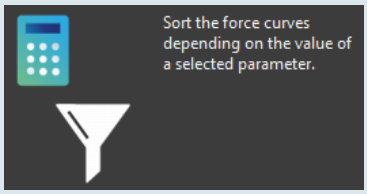
Figure 4. *Mapping of the elastic to total deformation ratio.*

the measurement. Thus, the total deformation, elastic and plastic energies were studied in order to understand the mechanical behavior of the collagen fiber under different constraints (figure 3).

SORTING FORCE CURVES USING PARAMETERS

A surface analyzed by force spectroscopy can be composed of heterogeneous elements. It is necessary to separate these components using a differentiating physical parameter (i.e. Young's modulus, adhesion energy ...)

The 'Sort by a parameter' operator allows you to select a physical parameter and to sort data accordingly. It is possible to generate a new sorted studiable as well as residual force curves.



In this case, the nanomechanical behavior was analyzed on the untreated collagen I fibril and the measurement was then performed in a buffer solution.

The 3D view in figure 4 highlights the ratio between the elastic behavior of the fibril and its total deformation. Here, a precise statistical study of the reversible deformation was made possible by the previous sorting step, highlighting the collagen fiber without taking into account the underlying substrate.

CONCLUSION

Using MountainsSPIP® software (version 9.1), it is possible to perform accurate and detailed force curve analyses. The sorting operators can be used to highlight areas of interest using precise mechanical parameters.

In this study, the mappings obtained with the software allowed the demonstration of the viscoelastic nature of the collagen fibrils at the nanoscale.

Mathieu Cognard

INSTRUMENTS AND SOFTWARE USED

BioScope Catalyst atomic force microscope from Bruker mounted on a IX71 inverted microscope from Olympus + MountainsSPIP® software.

READ MORE

Nanomechanical Mapping of Hydrated Rat Tail Tendon Collagen I Fibrils. *Samuel J. Baldwin, Andrew S. Quigley, Charlotte Clegg, and Laurent Kreplak from the Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Canada.*
In: doi.org/10.1016/j.bpj.2014.09.003

A COLLABORATION **DRIVING ROUNDNESS METROLOGY FORWARD**

Digital Surf and Taylor Hobson, world leader in surface and form metrology, have a common history dating back almost 30 years. The two companies recently completed a new round of co-developments resulting in the release of an updated version of **Metrology 4.0 software** with the manufacturer's brand new Talyrond® 500 PRO, a powerful instrument for roundness metrology. *Surface Newsletter* looks at how this latest collaboration came about and highlights the benefits for users.

WHAT IS METROLOGY 4.0 SOFTWARE?

Metrology 4.0 software made its debut in 2018 with the PGI Novus series of surface instruments. Following recent co-developments with Digital Surf, the software now also allows both measurement and analysis on the Taylor Hobson roundness instrument series.

Mountains® platform software features are seamlessly integrated into Metrology 4.0, which allows better control of the measurement process and the direct creation and export of analysis documents.

This full integration offers several clear advantages. Users working with roundness can now benefit from a fluidified and optimized workflow, with the ability to progress from measurement to reporting within the same interface, making the metrology process much simpler and more straightforward. This is particularly useful in a production context (shop floor use).

Above. *View of Metrology 4.0 software in use on the Talyrond® 500 PRO for roundness metrology*

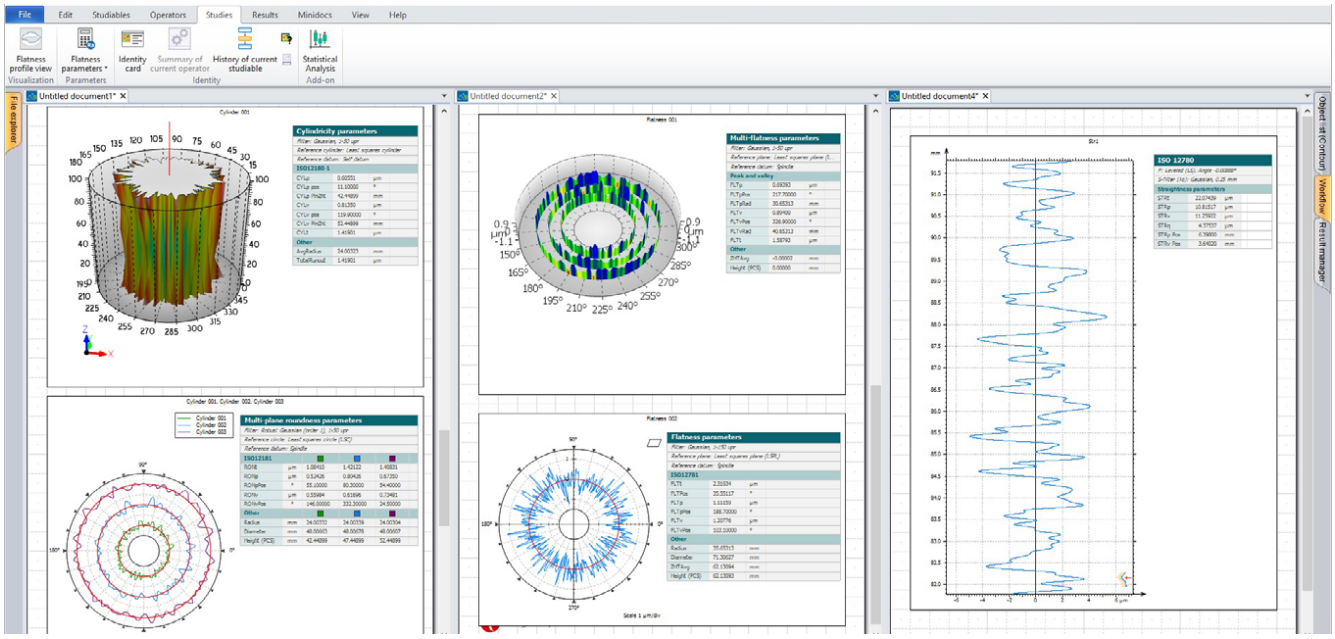
FEATURES FOR VISUALIZING AND ANALYZING ROUNDNESS

Specific features of the new version of Metrology 4.0 software include high-quality 3D visualizations of cylinders and flatness scans, ease-of-use and desktop publishing, allowing users to create personalized analysis documents showing raw measurements and analysis steps performed.

Thanks to the multi-instrument compatibility of Metrology 4.0 software, various measurement types can be represented on the same document, for example, roundness, flatness, cylindricity, surface finish and contour.

BRINGING TOGETHER THE EXPERIENCE OF INSTRUMENT & SOFTWARE EXPERTS

"Cooperation between Digital Surf and Taylor Hobson goes back almost 30 years" said François



Above. *Screenshot of Metrology 4.0 software showing analysis features for roundness metrology: cylindricity parameters, roundness parameters and flatness parameters can be displayed in a single report.*

Blateyron, director of research & metrology at Digital Surf. "Both teams understand each other. Our development department was able to build on its robust scientific knowledge to adapt to the new challenges of roundness metrology in the context of this project."

"Our combined experience in the field of precision roundness measurement and in-depth analysis software provides unique benefits." said Jon Gardiner, senior business development manager at Taylor Hobson. "Together we have produced the seamless integration of mechanical hardware and roundness metrology analysis software to deliver a world-class measurement instrument."

A PARTNERSHIP SPANNING 30 YEARS

The release of Metrology 4.0 on Taylor Hobson's roundness range is the latest collaborative episode in the Digital Surf/Taylor Hobson partnership story. The first commercial accord was signed between the two parties in 1992 when Digital Surf was still a young start-up company. The two companies have continued to grow side-by-side ever since, with the joint goal of making metrology customers' lives easier. Heavy investment in research and development, in-depth industry knowledge and a strong accent on customer support are some of the core values shared by both companies.

François Blateyron, Digital Surf

Jon Gardiner, Taylor Hobson

LEARN MORE

High precision roughness instruments
www.taylor-hobson.com/products/roundness-form/high-precision-roundness

Surface analysis software expertise
www.digitalsurf.com/about/our-company

ISO STANDARDS
WHAT IS THE GPS MATRIX?

Users of GPS (Geometrical Product Specification) standards are aware of the GPS matrix which is a convenient way of classifying standards in the various chain links of the specification-verification chain. Digital Surf's senior surface metrology expert **François Blateyron** provides further explanations.

The initial GPS matrix with six columns, defined in ISO 14638:1996, was updated in 2015 with the addition of a seventh column (see Table 1).

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Size							
Distance							
Form							
Orientation							
Location							
Run-out							
Profile surface texture							
Areal surface texture							

Table 1. *The GPS matrix, as updated in the 2015 edition of ISO 14638.*

The first three columns, A to C, refer to the "specification" prepared by the design studio and written in the technical product documentation. This should describe all the necessary details to allow the workpiece to be manufactured by a third party and yet conform to the specification. The last three columns, E to G, refer to the "verification" carried out by the metrology lab, to check that the workpiece has the required characteristics. Middle column D, the famous new seventh column, refers to conformance procedures to ensure that the actual workpiece complies to the specification.

The lines of the matrix correspond to categories of characteristics used in dimensional metrology as well as in surface metrology. Each standard developed by ISO TC213 contains an annex with the GPS matrix stating which chain links are concerned by the document.

Surface texture standards cover the last two lines. Some old standards sometimes belong to more than one column. In principle, modern standards should be limited to a single column, covering possibly several lines.

Column A contains standards describing how to write specification symbols on technical drawings, such as in ISO 1302, ISO 21920-1 or ISO 25178-1. Column B contains very important standards defining parameters such as ISO 4287, ISO 13565-2, ISO 13565-3, ISO 21920-2 or ISO 25178-2. Column C contains standards explaining how to configure the parameters; these are called specification operators. Standards such as ISO 4288, ISO 21920-3 or ISO 25178-3 belong to this column, and also standards defining filters such as the ones defined in the ISO 16610 series. Note that the two recent standards, ISO 21920 and ISO 25178 follow in their suffix the numbering of the chain link (-1 for symbols, -2 for parameters and -3 for specification operators, although the matrix now uses letters, A, B and C).

Column F (or the 6th column) contains ISO 3274, ISO 25178-6, ISO 25178-600 and the ISO 25178-6xx series describing the instrument techniques. The last column, column G, is about calibration and contains ISO 25178-70, ISO 25178-71, ISO 25178-72, ISO 25178-73, ISO 25178-700 and ISO 12179.

Column E is quite empty for surface texture. It is supposed to discuss how to calculate uncertainties, how to compare results to tolerance limits.

Column D mainly contains the ISO 14253-x series on decision rules for verifying conformity. This series is quite global and can be applied equally on dimensional or surface texture.

An interesting example is ISO 12085, the old motifs method, which covers several links of the GPS matrix. It defines the R&W parameters (chain B) and the segmentation and its limits (chain C) and gives recommendations on how to measure the profiles and how to choose spacing (chain F). This standard today would be split into several parts, each covering a single chain of the GPS matrix.

On top of all these standards are fundamental standards that apply in all cases and all chain links. For example, ISO 1 on reference temperature is a fundamental standard. The ISO 14638, that defines the GPS matrix, is itself a fundamental standard. This scheme may evolve again in a few years as TC213 recently started internal work to reorganize all existing GPS standards in a more hierarchical scheme. The GPS matrix may see a reshuffle soon.

There are also other useful matrices in GPS standards. For example, the Filtration matrix of ISO 16610 (see Table 2 below). As new standards are in preparation within this series, the matrix will likely be extended, with new columns (50 and 90) and also, in the future, it will host a new type of element with the triangle mesh data. But that is for later...

Filters: ISO 16610 Series						
General	1					
	100 (guide)					
	Profile filters			**Areal filters**		
Fundamental						
	Linear	**Robust**	**Morphological**	**Linear**	**Robust**	**Morphological**
Basic concepts	**20** Basic concepts	**30** Basic concepts	**40** Basic concepts	**60** Basic concepts		
Particular filters	**21** Gaussian	**31** Robust Gaussian	**41** Circle / segment	**61** Gaussian	**71** Robust Gaussian	**81** Sphere / Plane
	22 Spline	**32** Robust Spline	**45** Segmentation	**62** Spline		**85** Segmentation
How to filter	**28** End-effects					
Multiresolution	**29** Wavelets		**49** Scale-space	**69** Wavelets		

Table 2. *Filtration matrix of ISO 16610*

ADDITIONAL RESSOURCES

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

THE LONG-AWAITED RETURN OF IN-PERSON SHOWS

JASIS 2021

We were very pleased to be exhibiting at the 2021 edition of Jasis (Japan Analytical & Scientific Instruments Show) from November 8 to 10. Just like last year, Jasis was our first in-person event of the year, and once again this year the event was organized in a simplified format due to the current health situation.

Despite travel restrictions, over 270 companies where present on-site to showcase their latest analytical solutions and scientific instruments.

Our Japan-based technical & support engineer Damien and our interpreter Sato-san were pleased to be attending in person and to welcome visitors to our redesigned booth and to provide them with a live demo of Mountains® 9 software.

SAVE THE DATES! LOOKING FORWARD TO A BUSY 2022

We've just completed our trade show agenda for the year to come. Looking forward to meeting you in the aisles of the following exhibits & conferences:

DPG Spring Meeting
Regensburg, DE | Mar 7-10
Meeting of the Condensed Matter Section (SKM)

Forum des microscopies à sondes locales | St-Valery-sur-Somme, FR Mar 7-10
National meeting of the French-speaking community of scanning probe microscopy

Control International Trade fair
Stuttgart, DE | May 3-6
The international trade fair for quality assurance

CIRP Conference
Lyon, FR | June 8-10
Conference on Surface Integrity

Met & Props Conference
Glasgow, UK | June 27-30
International Conference on Metrology and Properties of Surfaces

Microscopy & Microanalysis
Portland, OR, USA | Aug 1-4
The annual microscopy products and services exhibit

Jasis
Tokyo, JP | Sept. 7-9
Asia's largest analytical & scientific instruments exhibition

SciX Conference
Cincinnati, KY, USA | Oct 2-7
The premier meeting for analytical chemistry and allied sciences

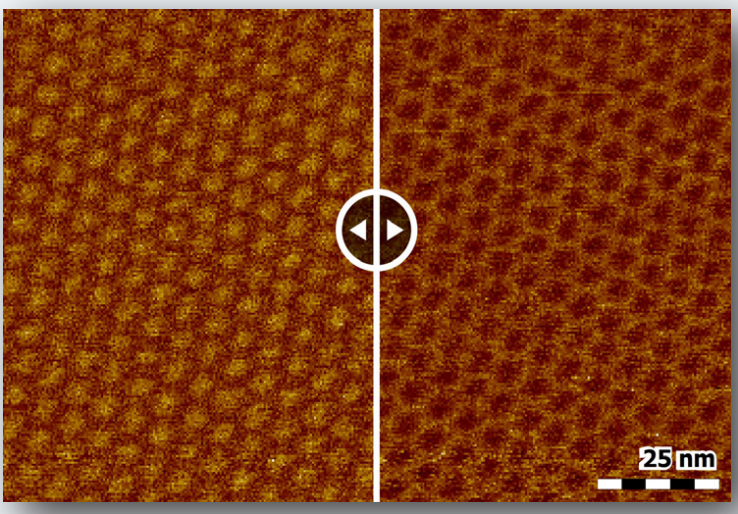
MRS Fall Meeting & Exhibit
Boston, MA, USA
Nov 28 | Dec 1
The world's foremost international scientific gathering for materials research

Laure Aubry

WHAT'S HOT ONLINE

POPULAR ON FACEBOOK

In-person events are kicking off again! Our team met up with our friends including Hirox Europe at the EPHJ tradeshow in Switzerland. It was great to see our clients and partners again. bit.ly/2YkMNtP



SEEN ON INSTAGRAM

In this amazing image obtained by the **Nanosurf** team, PFM imaging was applied to visualize the Moiré pattern of 2D materials. The Mountains® image slider feature was used to visualize the amplitude (on the left) and the phase (on the right). Wonderful to see it in action! bit.ly/3CKiNXj

Have you visited our YouTube channel recently?

Check out our channel for tutorial videos on surface analysis and SEM & SPM image analysis, with Mountains® software!

bit.ly/2U2I2za

Surface Newsletter

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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

2021 MRS Fall Meeting
November 30 - December 2, 2021 | Boston, Massachusetts
December 6 - December 8, 2021 | Virtual

DPG Spring Meeting
March 8 - 10, 2022 | Regensburg, Germany

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