MountainsMap[®] - evaluation of smartWLI data

universal package for visualization and data analysis in surface metrology

contour analysis
statistical particle analysis
geometrical measurements
ISO conform roughness analysis
3d data alignment and comparison
interfaces for customized extensions



excellent team work





smartVIS3D (scanning software) definition of scanning volume, application specific parameters and measuring macro



full automated evaluation after "start" of the scanning process flexible and interactive extension of the existing evaluation process

optimal use of resources...



smartVIS3D – data processing on the GPGPU (general purpose graphic processing unit):

image correction contrast enhancement real time 3d calculation



MountainsMap® – data processing on the CPU (central processing unit): visualization

filtering / stitching parameter calculation tolerance check logging



split processes split resources double throughput



optimized for speed and extreme resolution





modular available evaluation functions



comparison between MountainsMap[®] Imaging Topography M8P and MountainsMap[®] Premium M8P

MountainsMap [®] Imaging Topography M8P / MM 1101	MountainsMap [®] Premium M8P / MM 1102
Automotive / MM 1103	Automotive
Advanced Profile / MM 1104	Advanced Profile
Contour / MM 1105	Contour
Advanced Contour / MM 1106	Advanced Contour / MM 1106
Advanced Topography / MM 1107	Advanced Topography
Fourier & Wavelets / MM 1108	Fourier & Wavelets
Colocalization / MM 1109	Colocalization
4D Series / MM1110	4D Series
Particle Analysis / MM 1111	Particle Analysis
Statistics / MM 1112	Statistics
GBS add on honing structures / AO 1001	GBS add on honing structures / AO 1001
GBS add on statistic evaluation of cavities / AO 1002	GBS add on statistic evaluation of cavities / AO 1002
yellow – optional available modules (extra charge)	

green – integrated modules in the premium version

Imaging Topography – basic functions





document orientation:

• all studies get arranged in document form for instant printing or *.pdf export

instant macros:

- each "workflow" can be modified or extended in a graphical tree with instant actualization of all graphical representations and calculated results
- used raw data are embedded in the workflow and remain intact
- exchange of the raw data is possible to test the workflow on various different data sets / measuring objects
- saving of a document make it to a macro, which can be choose inside of the scanning software for automated evaluation

simultaneously data processing – *new in version 8*:

multiple raw data can be marked and processed parallel

batch processing:

- a saved document can be used as macro for the batch processing of unlimited raw data
- results of all raw can be saved automatically for processing in other programs (as Excel...)
- optional is the protocol printing and the export as *.pdf files possible

Imaging Topography – patching





patching:

- merges the 832 single scans of a surface together
- patching use the coordinates of motorized xy stages
- the height error of the stage can be compensated
- patching of large areas with more than 8000 x 8000 measuring points require a high end PC with 32 GB Ram

Imaging Topography – stitching





stitching:

- merges the 9 single scans of a surface together
- stitching must be used for single scans after manual positioning
- it is necessary to import the files in the correct order to each other
- a significant overlapping area is required
- stitching use the microstructures in overlapping zones to calculate the best alignment of the single scans and merge them together

Imaging Topography - visualization





2d plots 3d plots various color palettes wire plots contour lines illumination models variable gloss stereo rendering flying movies movie export

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Imaging Topography – profile extraction





Imaging Topography – 3d surface parameters



\times Selection of parameters Sa; Sal; Sbi; Parameters Sci; Sdar; List configuration Parameter configuration Sku Sdc; Sdq; 0 □ Sp □ Sv Sdr; Sds; ISO 25178 Roughness surface (S-L) No configuration □Sz ISO 25178 Sfd; Sk; Sku; Sa Sa EUR 15178N liable in the Workflow. Other areal parameters Functional parameters Smc; Smean; ASME B46.1 + Smr EUR 16145 EN Smq; Smr; + Parameter description + □ Sxp Smr1; Smr2; \sim Spatial parameters Symbol: Sp; Spar; Spk; Sal + Standard: ISO 25178 S-filter (λs) + Spq; Sr1; Sr2; □Str Family: Height parameters + □ Std Ssc: Ssk: St: \sim \sim Hybrid parameters Full name: Std; Stdi; Str; + Sdq \sim Sv; Svi; Svk; □Sdr Context: Functional parameters (Volume) Svq; Swt; Sxp; L-filter (λc) ΠVm + Sz; Vm; Vmc; + ΠVv More about this standard or family of parameters... Vmp; Vv; Vvc; Gaussian (ISO 16610-61)* 0.8 mm \sim + □ Vmp More about selecting and configuring parameters... Vvv + □ Vmc Manage end effects \sim □ Vvc + + Calculate parameters on: Functional parameters (Stratified... More Open this dialog when creating a 'Parameters table' study 🗸 □Sk □ Spk OK Cancel * Default settings

Imaging Topography – 2d surface parameters



Htp: LSRad; P3z; Pa; Pc; PD; Pda; Selection of parameters Pdc: Pda: Pfd: PH: PHSC; PHTp; Parameters Pku: PLa: PLo: PLg: Pmax: Pmr: Pp: List configuration Parameter configuration Amplitude parameters PPc; Ppm; Psk; PSm; Pt; Ptm; PTp; Q **N**Rp RV No configuration PV; PVo; Py; Pz; PzJIS; R3z; Ra; Rc; ISO 4287 Roughness profile (S-L) **R**z 150 4287 Rc + RD; Rda; Rdc; Rdg; Rfg; RH; RHSC; ISO 12780 liable in the Workflow. ISO 12181 Rt Rt Other profile parameters RHTp; Rku; RLa; RLo; RLq; Rmax; [] Ra ASME 846.1 VDA 2006 **N**Rq *Rmr*; *RONp*; *RONg*; *RONt*; *RONv*; SEP 1941 Parameter description **R**sk V Radius: Rp; Rp1max; RPc; Rpm; Rq; Rrms; Rku Symbol: C Rp1max 'S-filter (λs)' operator detected in the workflow. Standard: ISO 4287 RS: Rsk: RSm: Rt: Rtm: RTp: Rv: S-filter (λs) CRv1max Family: Amplitude parameters RV1max; RVo; Ry; Rz; Rz(n); CRz1max $\Box Rz(n)$ + Full name: Rz1max; RzJIS; STRp; STRq; STRt; Spacing parameters + STRv; tp; W3z; Wa; Wc; WD; Wda; **RSm** Context: + **Rd**q L-filter (λc) Wdc: Wdg; Wfd; WH; WHSC; WHTp; Material ratio parameters + More about this standard or family of parameters WLa: WLa; WLo; WLq; Wmax; Wmr; Rmr Gaussian (ISO 16610-21)* 0.8 mm + Rdc Rdc More about selecting and configuring paramete Wp: WPc: Wpm; Wq; Wrms; WS; + \square Rmr (Rz/4) Remove 1/2 cut-off at each end \sim Peak parameters Wsa: Wsk: WSm: Wt: Wtm: WTp: T RPc + Calculate parameters on: Open this dialog when creating a 'Parameters table' study Vo; Wy; Wz; WzJIS Total profile length (no averaging) More... OK Cancel * Default settings

Imaging Topography – area measurements



mm



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Point	Distance	Angle	Parallel lines	Rectangle	Ellipse	Custom shape	∽∽Max	Shape settings *	Select parameters *

Parallel lines	А	Unit
Distance	1.252	mm
Angles	В	Unit
Angle	50.56	0
Points	Min	Unit
Х	1.698	mm
Y	2.247	mm
	7 605	

Imaging Topography – profile measurements



Imaging Topography – wear measurement





Automotive – plots and R&W motifs ISO 12085



Information		
Filter settings	Robust Ga	ussian filter,
Parameters	Value	Unit
Rk	0.07525	μm
Rpk	0.2151	μm
Rvk	0.1813	μm
Mr1	16.23	%
Mr2	84.55	%
A1	17.45	µm²/mm
A2	14.00	µm²/mm
Rpk*	0.9226	μm
Rvk*	0.9303	μm



bs

Information				
Roughness limit A	0.5 mm			
Waviness limit B	2.5 mm			
Parameters	Value	Unit		
R	1.736	μm		
AR	0.1407	mm		
Rx	3.758	μm		
Pt	4.073	μm		

Advanced Profile – profile series and statistics



Advanced Profile – filter functions for profiles







Advanced Profile – frequency analysis



Advanced Profile – morphological envelops



Contour – planar contour evaluation of an insert gbs



2 contour lines was selected at different height levels and combined

Contour – profile evaluation of an needle tip

JS



Advanced Contour – additional functions





CAD data import and comparison deviation to form elements advanced alignment and measuring functions

Advanced Topography



μm



sample – polished surface

Advanced Topography – Sk/volume parameters gbs



μm

Parameters	Value	Unit
Vmp	2.431e-06	mm³/mm²
Vmc	6.307e-05	mm³/mm²
Vvc	7.463e-05	mm³/mm²
Vvv	1.563e-05	mm³/mm²



Information		
Filter settings	Unfiltered.	
Parameters	Value	Unit
Sk	0.1658	μm
Spk	0.04619	μm
Svk	0.1681	μm
Smr1	7.555	%
Smr2	85.46	%
Sa1	1745	µm³/mm²
Sa2	12220	µm³/mm²

Advanced Topography – texture direction





Information				
Angle	beta			
Number of bins	90			
Width of each bin	4.000000 °			
Parameters	Value	Unit		
Circular mean	56.94	0		
Mean resultant length	0.006972			
Max	180.0	0		



. 11/01

149.2 °

Third direction

Advanced Topography – fractal analysis



Information	
Method	Enclosing boxes
Darameters	Value
Farameters	Value
Fractal dimension	2.583

Advanced Topography – furrow analysis





All furrows are shown.

Parameters	Value	Unit	
Maximum depth of furrows	6.893	μm	
Mean depth of furrows	0.4727	μm	
Mean density of furrows	965.0	cm/cm2	



Advanced Topography – peak count



Fourier and Wavelets







Power spectrum density, radial

Fourier spectrum

Fourier and Wavelets





Colocalization





4D Series





		Mean	Std dev	Min	Max		
ISO 25178 - Primary							
F: None							
S-filte	er (Xs): I	Vone					
Heigh	nt para	meters					
Sq	μm	2.218	0.4282	1.790	3.056		
Ssk		0.1254	0.3059	-0.3801	0.5159		
Sku		3.209	0.6952	2.447	4.496		
Sp	μm	7.554	1.741	5.330	10.43		
Sv	μm	5.881	0.9130	4.730	7.099		
Sz	μm	13.43	2.253	11.08	17.53		
Sa	μm	1.759	0.3849	1.415	2.568		



simplifies the evaluation of multiple data with statistical analysis

Statistics





allows the statistically analysis of measuring data as well as the process monitoring for continuously measurements

GBS add on honing structures

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- structures get analyzed integral
- "rising" and "falling" structures get analyzed separate from each other
- additional is it possible to classify cross structures – important for functional behavior and oil transport

Parameters	Value	Unit
Honing Angle - Honing Structure FFT Analysis	18	0
Rising Grooves - Honing Structure FFT Analysis	16	0
Falling Grooves - Honing Structure FFTAnalysis	20	0
Rising Structures - Honing Structure FFT Analysis	26	%
Falling Structures - Honing Structure FFT Analysis	35	%
Cross Structures - Honing Structure FFT Analysis	2.0	%
Closed Structures - Honing Structure FFT Analysis	37	%



GBS add statistic evaluation of cavities

gbs





		\sim												
Number of islands	44													
Threshold	1.00	μm												
Parameters	Unit	Grain #1	Grain #2	Grain #3	Grain #4	Grain #5	Grain #6	Grain #7	Grain #8	Grain #9	Grain #10	Grain #11	Grain #12	Grain #13
Area	mm ²	0.0056	0.00515	0.00307	0.00291	0.00235	0.0017	0.00169	0.00159	0.00158	0.0013	0.00113	0.000941	0.000933
Aspect ratio		1.53	1.58	3.41	2.92	2.73	3.83	2.02	2.19	4.03	2.42	2.98	2.67	1.91
Volume	µm³	13995	20813	6088	8015	2807	2576	4531	3282	2414	2432	1116	2045	3372
Max height	μm	4.74	9.98	4.00	6.73	2.70	4.67	4.54	3.31	2.89	4.36	2.67	4.29	9.11
Height/Surface ratio	µm/mm²	847	1937	1304	2310	1148	2740	2688	2095	1831	3358	2365	4557	9767
		0	0	0	0	0	0	0	0	0	0	0	0	0



- cavities can be sorted by max. depth, area, volume
- different classifications could be used to quantify the quality of the surface

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