OLYMPUS

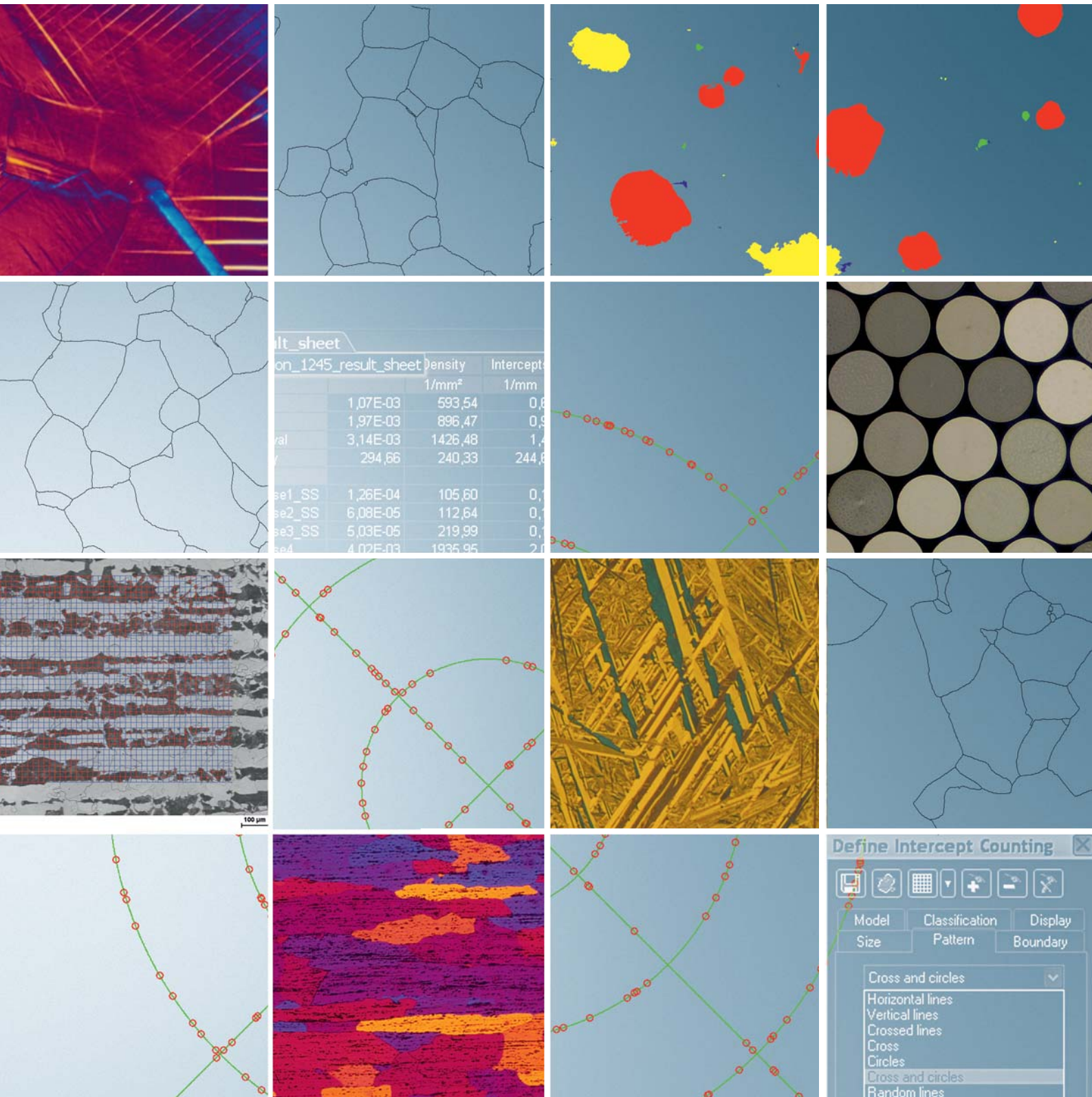
Your Vision, Our Future

Software for Materials Science Microscopy

Stream

Extensions

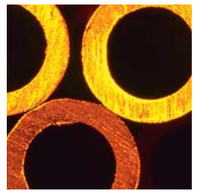
Extensions for digital metallography



STREAM EXTENSIONS

Streamlining workflows for specific microscopy applications in industrial metallography

Using intuitive workflow-oriented interfaces based on workflows from typical everyday lab routines, the Stream Extensions are integrated seamlessly into the Olympus Stream software series. At the click of an icon, the most complex image analysis tasks are executed quickly, precisely and in compliance with most common international and national standards. With a significant reduction in processing time for repeating tasks, the materials scientist can concentrate on using their time and knowledge for the correct interpretation of resulting data rather than on acquiring measurements.



Your Vision, Our Future

Olympus is dedicated to producing digital imaging solutions to support all levels of materials science. Therefore, it has developed a comprehensive range of dedicated Materials Extensions to make the most of any manufacturing or research applications.

The image on the left shows a handling plant for steel slabs in a steel mill.

Stream Extensions

A **Step by step**
Optimised workflow


Image acquisition


Measurements


Results

Report

B **Full compliance**
With common industry standards


ISO


ASTM


DIN


JIS

EVERYBODY IS AN EXPERT

The Materials Extensions for Olympus Stream support the user in their work, making them an expert right from the start, without extensive training or know-how. The workflow-oriented process guides the user step by step through image measurement or analysis processes, right through to the result. No mistakes, no worries, just reproducible results.

Workflow

A The user-friendly, workflow-oriented structure of the Olympus Stream Extensions utilises large icons with self-explanatory captions to seamlessly guide the user through the entire analysis process. Each Materials Extension has its own workflow, situated on the left-hand side of the GUI. The user is guided precisely through the whole process via the self-explanatory captions on the icons.

Settings

Defining the correct settings is, without a doubt, one of most crucial tasks to perform before evaluating an image. For each of the Materials Extension options, the user can easily define specific settings in one simple step at the beginning of the workflow, eliminating the need to search for any hard-to-find settings or menus. These settings are used for each of the images analysed, allowing the user to tailor the process parameters to each individual sample and task. Once the parameters have been defined, the resulting data is just a few clicks away.

Ease of use

With the Materials Extensions, routine work can be performed with only a few clicks of the mouse, eliminating the often tedious set-up process. This straightforward approach makes the user feel more comfortable using the software, as only the necessary functions are displayed.

Usable for all

The workflow-oriented process of each of the Materials Extensions guarantees that even users with minimal experience in imaging techniques or knowledge of microscopy and materials science can handle the software with ease. Each of the extensions is quick and easy to learn or, alternatively, they can be taught by a trained advisor – depending on the users' existing knowledge.

Standards-compliant

B All of the Materials Extensions comply with common industry standards. If one method is described by several standards, the preferred one can be easily selected from a comprehensive list. In addition to performing the measurements to the tolerances set by the chosen standard, each Materials Extension will also detail the analysed data in spreadsheets, diagrams or reports as required by the standard.

Seamless integration of Microsoft Office

C The Materials Extensions integrate seamlessly into Microsoft Office, enabling the user to perform complex calculations. Results can be transferred easily to Excel for further analysis and report generation. Stream also supports the use of Word templates to make repeat documentation tasks efficient and professionally styled. Additionally, images can be inserted directly into PowerPoint, allowing users to continue working with familiar programmes. As a result, the Materials Extensions facilitate a comfortable familiarity, right from the beginning.

C **Comfortable integration**
With the Microsoft Office suite


Word


Excel


PowerPoint

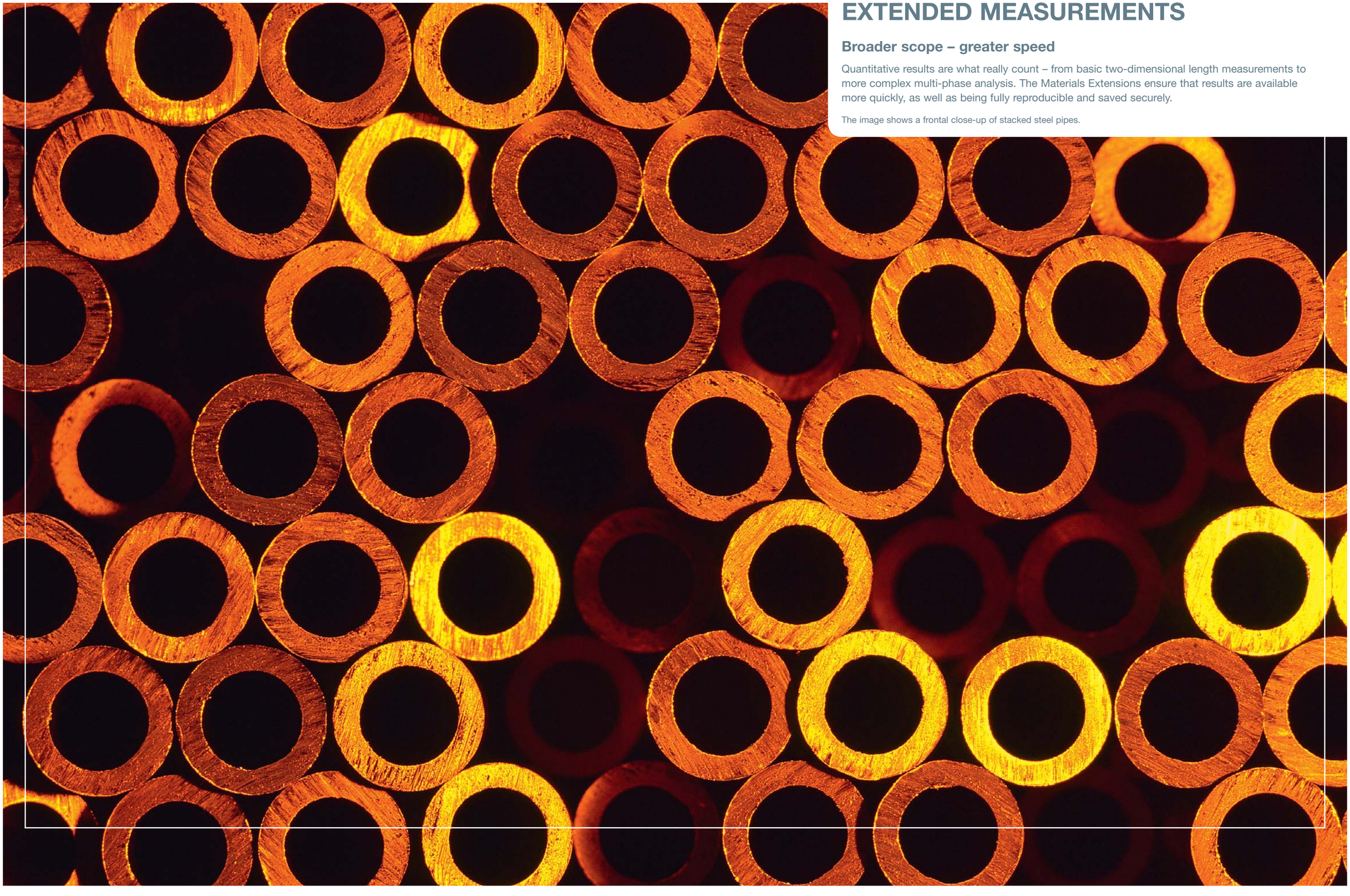

PDF

EXTENDED MEASUREMENTS

Broader scope – greater speed

Quantitative results are what really count – from basic two-dimensional length measurements to more complex multi-phase analysis. The Materials Extensions ensure that results are available more quickly, as well as being fully reproducible and saved securely.

The image shows a frontal close-up of stacked steel pipes.

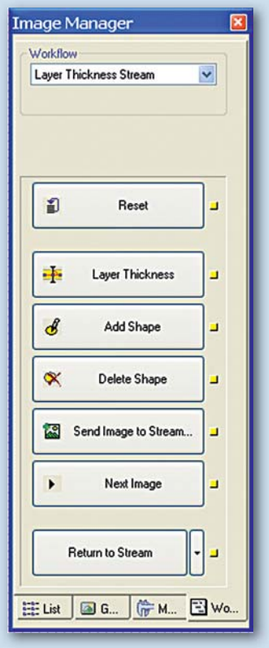


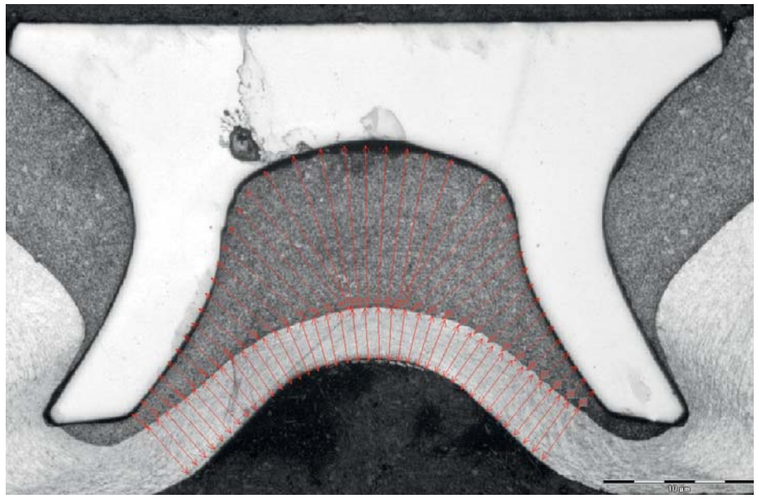
A **Setting**

Defining the contours of arbitrary surfaces via a single dialogue box

B **Workflow**

Determining the thickness of single or multiple layers of cross-sectioned samples





LAYER THICKNESS MEASUREMENT

The layer thickness measurement extension is designed to determine the thickness of single or multiple layers of cross-sectioned samples. The layer thicknesses are measured either perpendicularly to neutral fibres or using the shortest distance. This means that during evaluation, the contours of arbitrarily shaped surfaces are tracked. Furthermore, the integrated neutral fibre method ensures that highly complex layer geometries can be measured and described as an orientation line throughout the course of the entire layer.

Settings

A The settings dialogue box is opened by simply clicking on the “Layer Thickness” icon, initiating the set-up process. This will prompt the user to define the neutral fibre as well as the contours of arbitrarily shaped surfaces of single or multiple layers using upper and lower boundaries. Layer boundaries can be specified using line segments, polygons, freehand polygons, curves or particle boundaries. The user can then decide if the measurement should run manually or automatically and determine the number of counts. All settings can be saved and easily recalled, making frequently recurring experiments fast, convenient and efficient to perform. Several measurement modes are available, including the shortest distance and perpendicular measurements.

Execution

B After the layer structure and measurement methods have been defined, the measuring process itself can be initiated by clicking on the “Automated Measurement” icon in the settings dialogue box. The measurement results are displayed on-screen and evaluation begins automatically. Further shapes can be added or deleted to existing or new images using the “Add Shape” and “Delete Shape” icons.

Results

All layer thickness measurements are listed automatically in a spreadsheet, together with a range of statistical parameters such as number of counts, maximum and minimum values, mean values, ranges, as well as standard and third standard deviations. The sheet lists the results of each layer as well as the combined results. A detailed evaluation checks whether or not the measurement values are within the preset, user-defined tolerance range, and automatically marks it in the sheet.

MICROHARDNESS MEASUREMENT
(VICKERS, KNOOP)

C The Micro Hardness Measurement Extension allows interactive measurement of the indentation made by a microhardness tester, using Vickers or Knoop indenters. Hardness is calculated based on a thorough evaluation of the indent diagonals. The resulting data can be displayed in tables and/or diagrams.

Settings

D The settings function requires the user to insert all the testing parameters, including load, indenter face angle, time, descent and indentation speed. Furthermore, data such as user name, sample name and comments can also be added.

Execution

E Once all of the data has been inserted, the user must choose either the Vickers or Knoop method. While measuring each image, the results are automatically transferred to the results spreadsheet.

Results

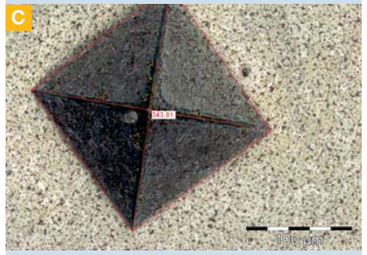
The measurement results can be displayed as either tables and/or diagrams, as specified by the user. In conjunction with the test parameters (load, indenter type, penetration speed), the hardness value is automatically calculated. For each image analysed, the range of measurements is listed along with the corresponding hardness value. If required, statistical data can also be added onto the same sheet.

Standard spreadsheet listing results of microhardness measurement

MHT Knoop Knoop [2]

	A	B	C	D	E	F
	AB_002_09					
	Sample name:	01_DCD_0_A_23				
	Date:	25.05.2009				
	Descent speed [um/s]:	100,00				
	Indentation speed [um/s]:	100,00				
	Load/Time:	10,000 [kgf] / 10,000 [s]				
	Image name	First diagonal nm	Second diagonal nm	Center point x nm	Center point y nm	HK
1	01_DCD_0_A_231	230514,23	232454,22	138066,24	138128,17	2677,80
2	01_DCD_0_A_232	229116,68	231861,87	137291,20	137928,12	2710,57
3	01_DCD_0_A_233	230068,48	231148,24	137416,36	137680,58	2688,19
4	01_DCD_0_A_234	231856,32	231937,39	137656,75	137665,15	2646,89
5	01_DCD_0_A_235	229704,73	232305,17	137544,61	138268,52	2696,71
6	01_DCD_0_A_236	231631,60	231861,87	137205,49	137617,58	2652,03
7	01_DCD_0_A_237	232386,52	232777,87	137503,59	138261,93	2634,83
8	01_DCD_0_A_238					
9	Statistics					
10	Count	7	7	7	7	7
11	Mean	230754,08	232049,52	137526,32	137935,72	2672,43
12	Minimum	229116,68	231148,24	137205,49	137617,58	2634,83
13	Maximum	232386,52	232777,87	138066,24	138268,52	2710,57
14	Standard Deviation	1221,99	525,19	282,75	286,87	28,30

C



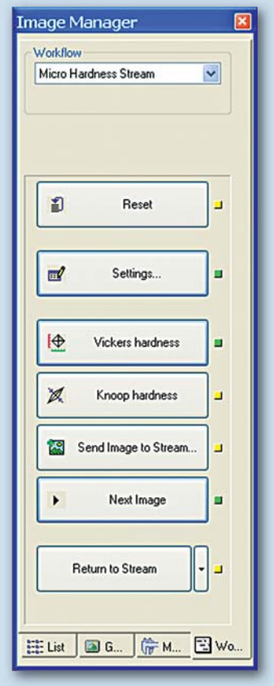
Microhardness measurement using the Vickers method

D **Setting**

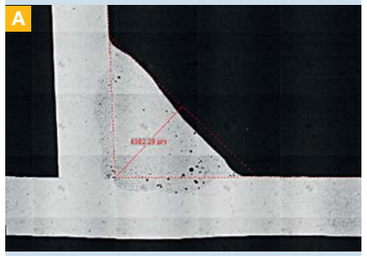
Defining the necessary data via a single dialogue box

E **Workflow**

Hardness measurements based on evaluation of indent diagonals



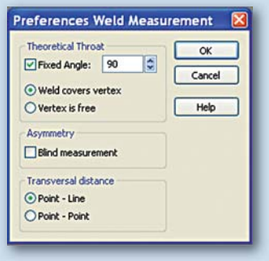
A



Theoretical throat (A measure) measurement

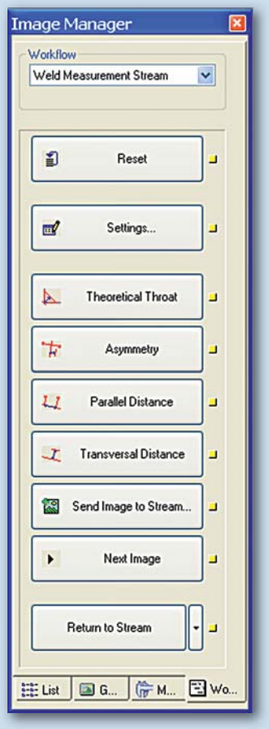
B Settings

Definition of parameters



C Workflow

Interactive welds measurement in accordance with standards



WELD MEASUREMENT

A The software has been designed specifically for the interactive measurement of welds in accordance with established procedures. Users can accurately measure microscopic images of weld cross-sections and display the data in a clear, tabulated format. It guides the user through the entire process in a way that minimises measurement errors. Furthermore, it supports the user in the construction of the helper lines required for obtaining the correct measurement results with ease. Four different methods are supported: theoretical throat (A-measure), asymmetry distance, parallel distance along a line between two arbitrary points, and transverse distance to a given line.

Settings

B The settings toolbar enables users to set parameters in accordance with the sample and method of choice for the weld measurement. For example, users can change the theoretical throat angle to a vertex-free or a weld cover vertex, and choose the measurement method for the transversal distance.

Execution

C By simply clicking on the appropriate icon, the user is guided through the entire weld measuring process, right through to the execution of the desired measurement. As such, if the user clicks the “Theoretical Throat” icon, two lines are automatically displayed with an angle as defined in the settings. Using the mouse, the user can easily overlap the two lines with the brackets of the sample and move the third line (which is automatically perpendicular to the angle bisector) to the deepest point of the fillet weld. Other measurements are designed in the same way, to minimise the number of required mouse clicks.

Results

For easy viewing, the measurement results are displayed directly as an overlay to the image and the dataset is automatically transferred into a spreadsheet.

Standard spreadsheet listing results of weld measurement

Results_Weld

	Theoretical Throat	Asymmetry	Parallel Distance	Transversal ...
1	µm	µm	µm	µm
2	510,33	9,56	786,07	218,76
3	523,41	15,11	769,09	222,78
4	592,24	9,56	785,14	220,05
5	654,10	41,10	785,14	213,38

INTERACTIVE PHASE COUNT

(ASTM E562)

The Interactive Phase Count Materials Extension evaluates the phase proportion absolutely and as a percentage value by systematic manual counting in accordance with ASTM E562. Phase weights of 1 or ½ are interactively assigned to user-defined grid points. The square grid is adjustable with variable density and the results are clearly displayed in a spreadsheet.

Settings

D E Initially, the user must define the range of sequentially spaced grid points by the number of grid points in the x-axis. This grid is then systematically placed as an overlay onto the image.

Execution

F By clicking on the “Count Full” icon, the user defines all of the grid points that are within the phase of interest. Next, all grid points which are located on the boundary of the phase need to be defined by clicking on the “Count Half” icon. For statistical measurements to be obtained over several images, simply click the “Next Image” icon and follow the same procedure as before.

Results – compliant with ASTM E562

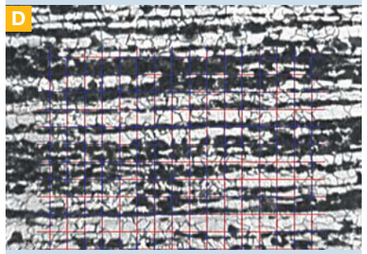
The results spreadsheet displays the area fraction of each single image as well as the mean area fraction of the image series. For further statistical analysis, the results are easily transferable to Excel.

Standard results spreadsheet of an interactive phase count including statistical parameters

Results Point Count ASTM E 562

	Image	Area fraction	Number of images	Mean area fraction	Standard deviation	95% CI	Relative Accuracy
1		%	8	% 21,03	% 14,80	% 18,81	% 88,64
2	DP_234_34_SP_239	33,60					
3	DP_234_34_SP_235	26,64					
4	DP_234_34_SP_236	18,80					
5	DP_234_34_SP_237	3,04					

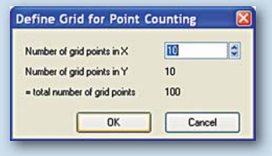
D



The sequentially spaced grid points are user-definable

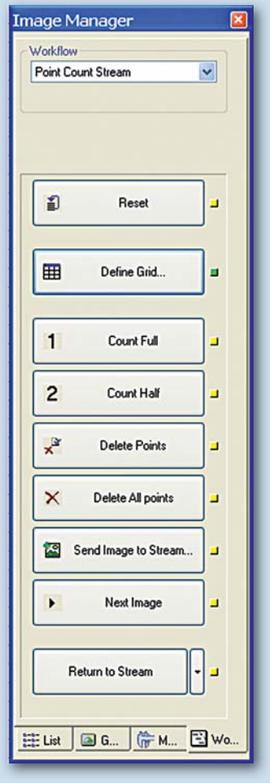
E Settings

Definition of grid points



F Interactive Phase Count

Evaluation of absolute and percentage phase values



METALLOGRAPHY

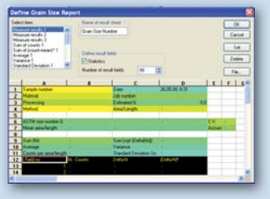
Bringing precision to key tasks

As an extremely in-depth field, metallography requires a number of precise techniques to accurately image and evaluate the microstructure of a specimen. As such, there is often a requirement for two or more distinct technologies to be combined into one instrument, without compromising on quality.

The image shows stacks of steel bars in a steel factory.

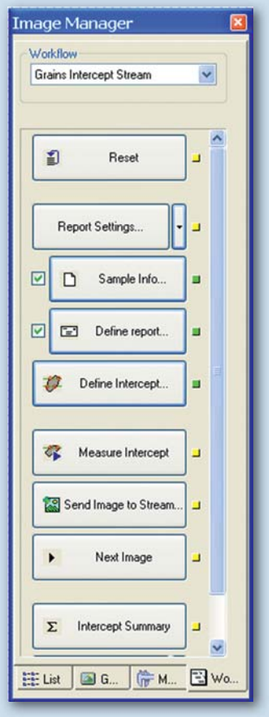
A **Settings**

Definition of report data and settings of the intercept counting



B **Workflow**

Analysis and documentation of grain sizes in accordance with ASTM E112



C

Horizontal, vertical, diagonal or circular measurement lines and combinations thereof are supported

GRAIN SIZING INTERCEPT
(ASTM E112)

The Grain Size Intercept Extension for Olympus Stream allows users to analyse and document grain size according to the intercept measurement method described in the ASTM E112 standard. The resulting data can then be displayed either as a spreadsheet or in a graphical format.

Settings

A By clicking on the “Report Setting” icon, the user must firstly define the report layout and input general data such as sample number, information about the material, the operator, job number and estimated grain size. This data is then inserted into the report file automatically. In the “Define Intercept Counting” dialogue box, the user will be prompted to define the intercept settings for grain counting. For instance, it is possible to define the size of the pattern as well as to select between different patterns, including horizontal and vertical lines, as well as crosses and circles. Furthermore, the combination of both random lines and cycloids is also supported. Various boundary settings, such as light or dark borders, can be user-defined, depending on the individual grain phases.

Execution

B **C** Once the settings have been specified, the results are produced via just one simple click on the “Measure Intercept” icon. When analysing a series of images, the user can simply click the “Next Image” icon, and start the process again. Each resulting dataset is automatically displayed in the results spreadsheet. When the “Intercept Summary” icon is selected, a detailed final report is generated.

Results – compliant with DIN 50601, JIS G 0552, ASTM E112

The results spreadsheet will list the number of cross circles and the total length for each image analysed. The ASTM E112-compliant report shows all the data the user added in the settings toolbar, the method used, the number of intercepts found in each individual image and the calculated g-value along with a range of other statistical data.

Results spreadsheet of a cross-circle grain sizing intercept measurement

Grain Size Number_Result_Sheet

	A	B	C	D	E	F
1	Sample number:		Date:	26.05.09, 8:44		
2	Material:		Job number:			
3	Processing:		Estimated G:	0,0		
4	Method:	cross-circle	Length [µm]	5041,52		
5						
6	ASTM size number G	9,0	+-	0,19	C.V.	0,07
7	Mean intercept distance [µm]	14,1	+-	0,96	Accuracy [%]	6,4
8						
9	Sum (Ni)	2151,0	Sum (sqrt (Delta(Ni)))	3269,5		
10	Average	358,50	Variance	653,90		
11	n/l [1/µm]	0,0711	Standard Deviation So	25,57		
12	i Field no.	Ni no. of intercepts	Delta-N	(Delta-N)²		
13	1	333,0	25,5	650,3		
14	2	328,0	30,5	930,3		
15	3	364,0	-5,5	30,3		
16	4	353,0	5,5	30,3		
17	5	392,0	-33,5	1122,3		
18	6	381,0	-22,5	506,3		

GRAIN SIZING PLANIMETRIC
(ASTM E112)

The Grain Sizing Planimetric Materials Extension contains functions for determining and documenting grain size according to the planimetric procedure. Due to integrated task automation, it is easy to define fixed task sequences for frequently recurring analysis experiments. Grain sizing planimetry evaluates grain size distribution in accordance with the ASTM, DIN and JIS standards. The Grain Sizing Planimetric Materials Extension also supports user-defined protocols.

Settings

The settings are divided into three easy-to-use parts: general settings, report settings and the separator definition, making specific settings easily accessible. The general settings provide the basic parameters, such as measurement area or the sandwich threshold. In report settings, the user is prompted to enter header data, which enables the automatic completion of reports to be compliant with predefined standards. It can also arrange the spreadsheet in accordance with individual specifications. The separator definition dialogue box enables the grain boundary detection settings to be adjusted and tested as required.

Execution

D **E** Once all of the settings have been defined, the measurement can be executed with a simple click on the “Detect Grains” icon. A series of images can also be analysed automatically, using the previously defined settings. Each of the images is analysed individually and the results are subsequently accumulated in the last step of the workflow. Finally, a report detailing the results is created automatically.

Results – compliant with DIN 50601, JIS G 0552, ASTM E112

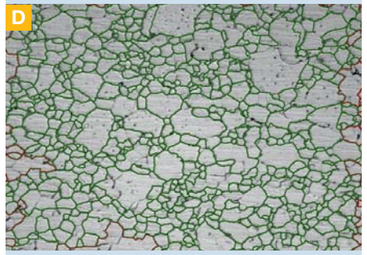
F For each image, a grain size frequency distribution diagram is generated. Furthermore, a detailed measurement report for each image will be entered into a planimetric sheet, followed by an in-depth analysis of the different areas of the individually detected grains. Providing additional flexibility means that the user is able to summarise and accumulate the results in a single sheet.

Results spreadsheet of a grain sizing planimetric measurement

Planimetric Result Sheet

A	Average values	GGDN09	GGDN10	GGDN11	GGDN12	GGDN13	GGDN14
Image Pos. X [µm]		0,00	0,00	0,00	0,00	0,00	0,00
Image Pos. Y [µm]		0,00	0,00	0,00	0,00	0,00	0,00
Total area [µm²]	59952,01	9992,00	9992,00	9992,00	9992,00	9992,00	9992,00
Number of inner grains	371,00	3,00	8,00	73,00	105,00	75,00	107,00
Area of inner grains [µm²]	26283,50	1978,23	1718,29	6071,77	5571,22	6092,75	6851,23
Number of border grains	180,00	11,00	12,00	33,00	40,00	47,00	37,00
Area of border grains [µm²]	31668,51	8013,77	8273,71	3920,23	4420,78	3899,25	3140,77
Class number of grain		2	2	2	2	2	2
G number elongated 1	9,87	7,37	8,79	10,45	11,21	10,55	10,88
G number elongated 2	10,23	7,86	9,67	10,75	11,29	10,72	11,07
Elongation number	0,96	0,94	0,91	0,97	0,99	0,98	0,98
G number single grain	10,05	7,61	9,23	10,60	11,25	10,63	10,98
Dual grain 1	9,04	6,95	7,92	9,14	10,32	9,78	10,14
Dual grain 2	11,33	8,11	10,21	12,38	12,75	12,07	12,43
G number sandwich 1	0,00						
G number sandwich 2	0,00						
Sandwich width [µm]	0,00						
Grain size 1,0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 1,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 2,0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 2,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 3,0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 3,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 4,0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 4,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 5,0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 5,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 6,0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Grain size 6,5	8,96E-05	0,00	0,00	22,24	0,00	0,00	0,00

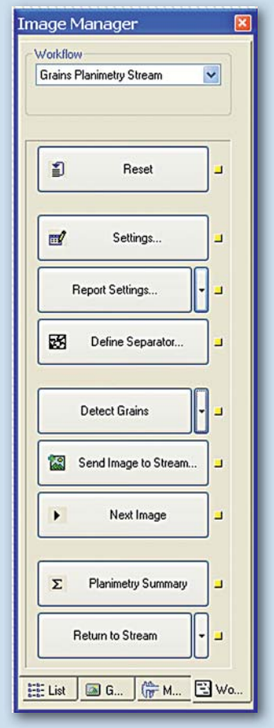
D



A high-performance algorithm for reconstruction of grain boundaries is included

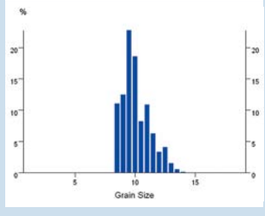
E **Workflow**

Results spreadsheet of a grain sizing planimetric measurement



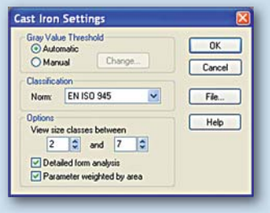
F **Grain size**

Frequency distribution



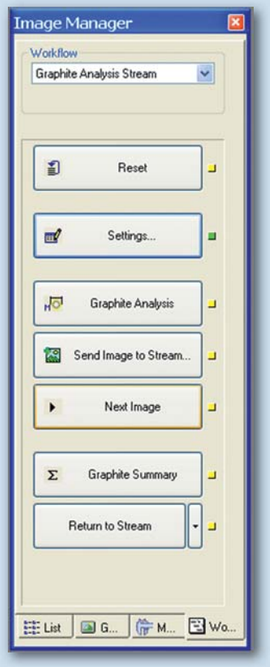
A Settings

The necessary data are defined in a seperate dialogue box



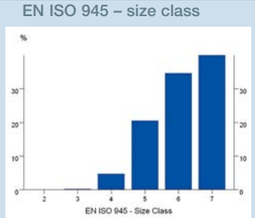
B Workflow

Analysing cast iron in accordance with international standards



C Graphite results diagram

EN ISO 945 – size class



CAST IRON

(EN ISO 945, ASTM E247, VDG)

As an extension for the evaluation of spherical graphite, the Cast Iron Materials Extension consists of two parts: the cast iron graphite analysis offers a fast, accurate and automated classification of spherical graphite, whereas the cast iron ferrite/pearlite analysis accurately calculates the ferrite/pearlite ratio in accordance with accepted standards.

Graphite Analysis

The Cast Iron (graphite analysis) Extension automatically extracts the classification parameters from images of spherical graphite and evaluates them with respect to sample shape and size. With the ability to analyse nodular, dendritic and flake graphite, each particle can be sorted into a size class, determined on the basis of the particle parameter. The results of this are displayed as spreadsheets and diagrams along with shape distribution results. The resulting data is classified in accordance with various national and international standards such as VDG, EN ISO 945 and ASTM, which are integrated into the software, along with any other norms that are specified by the user.

Settings

A The user initially needs to define the settings for the graphite analysis, which is initiated simply by clicking on the “Settings” icon. To detect the nodular graphite, users can decide between automatic or manual threshold determination. The desired standard can be selected from a list of available classifications. Users are required to enter the minimum and maximum size classes for inclusions that are desirable in the results spreadsheet. Furthermore, statistical calculations can be defined by the shape of the nodular graphite particles. It is also possible to exclude very small particles which are not relevant for the measurement from the analysis.

Execution

B The next step is to click on the “Graphite Analysis” icon, which will commence the analysis process and automatically generate a spreadsheet of the resulting data. Further images can be analysed in the same way and each individual measurement result will be added to an overall results spreadsheet. To perform the graphite analysis for all of the images, the user simply needs to click on the “Graphite Summary” icon. A diagram detailing the graphite size distribution is created along with a report, which is in accordance with the standards defined in the settings.

Results – compliant with EN ISO 945, ASTM E247 and JIS G 5502

C The measurement report includes the image name, calculated nodularity, area (%) and the number of detected particles, in accordance with the defined standards. For the nodularity and the area, the Cast Iron Materials Extension also calculates the average values, displaying them in a detailed and easy-to-read list. The correct size classification is calculated by weighting the size classes, and usability is increased by the ability to select a different standard or range of size classes without the need to repeat the complete analysis procedure.

Results spreadsheet of a graphite analysis

Graphite Analysis [EN ISO 945]_b

	Form	Statistics	Count	Image	Form	Size	Nodularity	Area Frac.	Size 2	Size 3	Size 4	Size 5	Size 6	Size 7
		%	1/mm²				%	%	max.1000µm	max.500µm	max.250µm	max.120µm	max.60µm	max.30µm
	I	50,6	269,7	FAIC10	I,VI(45%)	5	9,04	7,2	0	1	25	109	184	212
1	II	0,4	6,8	FAIC20	VI	5	40,22	7,4	0	0	0	6	7	9
2	III	7,3	156,4	FAIC30	IV	5	44,19	8,1	0	0	0	9	5	9
3	IV	19,4	25,6	FAIC50	I	5	3,75	7,9	0	1	7	34	50	54
4	V	1,3	36,2	FAIC60	I	5	3,05	7,0	0	0	11	30	55	51
5	VI	21,0	9,4	FAIC100	I	5	2,98	5,7	0	0	7	30	67	89
6														
7	Nodules	22,3	45,6											
8	All	100,0	504,0											

Ferrite/pearlite analysis

Following the graphite analysis, the Cast Iron Extension also enables quick and easy determination of the ferrite/pearlite ratio in a variety of samples. With two different techniques available to determine the graphite content of the material, the user has the flexibility to choose the one that is most suited to their application.

Settings

Both techniques are available by selecting the “Graphite Fraction” icon. The first method requires the user to input the graphite content, if available from other measurements. The second technique uses the graphite content measured from the analysis of spherical graphite. Before the analysis begins, the user must select accurate thresholds so that the lighter coloured ferrite components are easily identifiable from the darker graphite/pearlite phase.

Execution

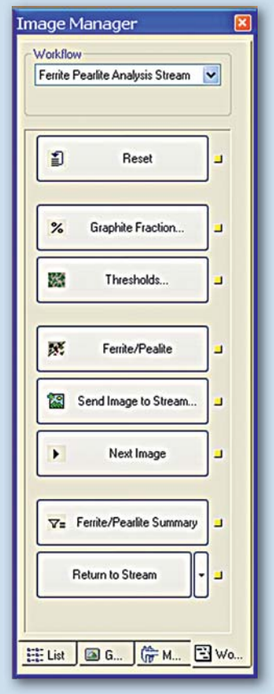
D **F** Ferrite/pearlite analysis is initiated with a simple click of the “Ferrite/Pearlite” icon. The ratio is then automatically determined and transferred into the results spreadsheet. As with the spherical graphite, measurements can be accumulated for multiple samples and subsequently reported in a single datasheet. To analyse any further images, the user simply needs to click on the “Next Image” icon.

Results

E The report sheet lists the image names and the percentage of ferrite and pearlite present. A summary is automatically generated at the end of the analysis, which includes the average values of all the measurements, along with an optional diagram of the information.

D Workflow

Determination of ferrite/pearlite ratio in samples



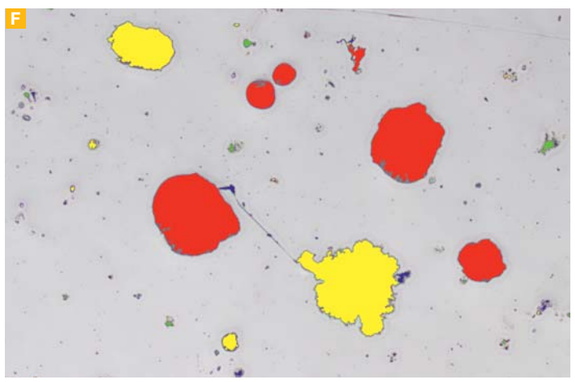
E Results

Ferrite/pearlite ratio

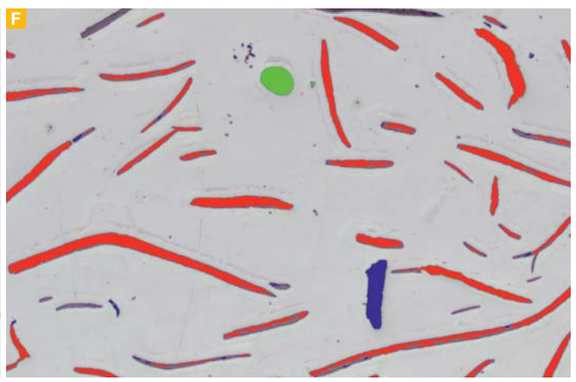
Ferrite_Pearlite Result

	Image	Ferrite	Pearlite
		%	%
	Average	12,03	87,97
1	Ferrit_Perlit_	9,88	90,12
2	Ferrit_Perlit_	11,89	88,11
3	Ferrit_Perlit_	14,30	85,70

F



F



A

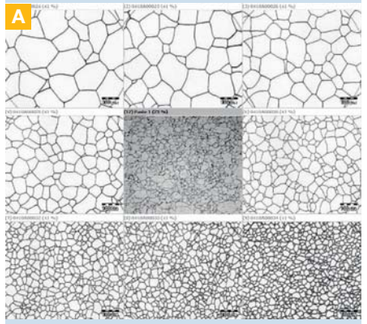


Chart comparison screen

CHART COMPARISON

The Chart Comparison Materials Extension makes accurate scaling for unambiguous size comparisons a simple process. It comes with the ASTM E112 charts as standard and additional charts are available as a further extension to this programme. Users can also define their own charts and integrate them into the chart pick lists.

Settings

A The user can decide whether to use an 8x or 3x comparison screen. For most situations, an 8x comparison is preferable due to the ability to compare the image with 8 references simultaneously. However, the 3x comparison offers the advantage of a larger display size. In the “Chart Manager” tab, users can select predefined reference charts, use their own or import them from external sources.

Execution

B The selected charts will be automatically loaded and, in the case of the 8x comparison, the first 8 reference images of the chart are loaded on-screen. The matching reference image is then automatically transferred to the navigator table and is subsequently included in the results spreadsheet.

Results

The image data from the matching reference images is transferred into a results spreadsheet, along with the results of each image in the series. The data that is transferred is dependent upon the reference sheet that was previously selected.

Charts

C Grain size, ASTM E112
Reference images of the standard ASTM E112 for micrographic determination of the ferritic or austenitic grain size of steels and ferrous materials.

D Grain size, DIN 50601
This extension chart provides reference images of the standard DIN 50601 for micrographic determination of the ferritic or austenitic grain size of steels and ferrous materials

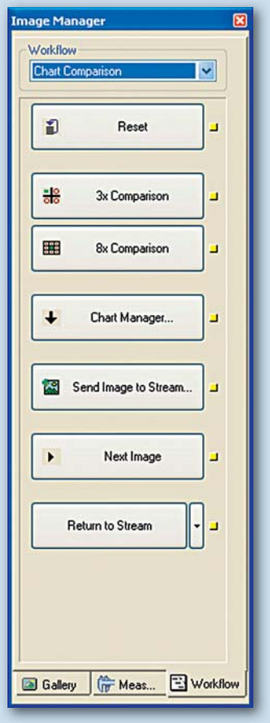
E Grain size, ISO 643
This extension chart provides reference images of the standard ISO 643 for the micrographic determination of the apparent grain size.

F Inclusion Rating, DIN 50602
This extension chart provides reference images of the standard DIN 50602 for the microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions.

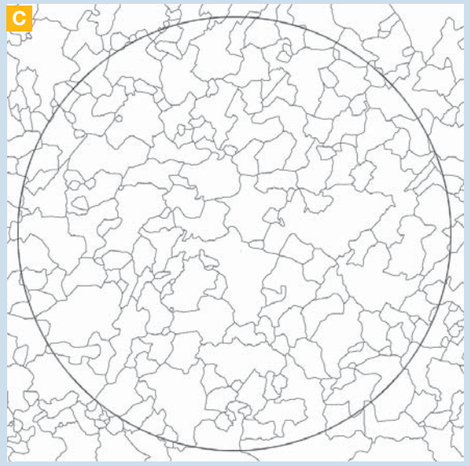
G Graphite in cast iron, DIN EN ISO 945
This extension chart provides reference images of the standard DIN EN ISO 945 for the designation of microstructures within graphite.

B **Workflow**

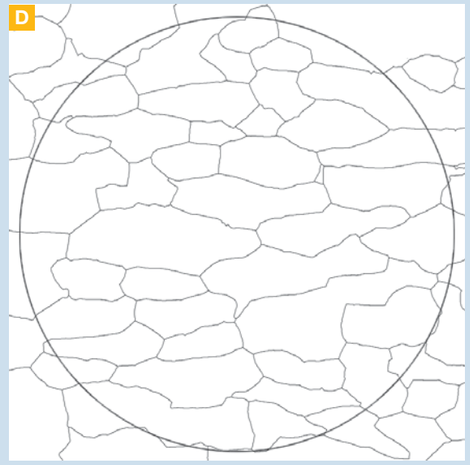
Chart comparison



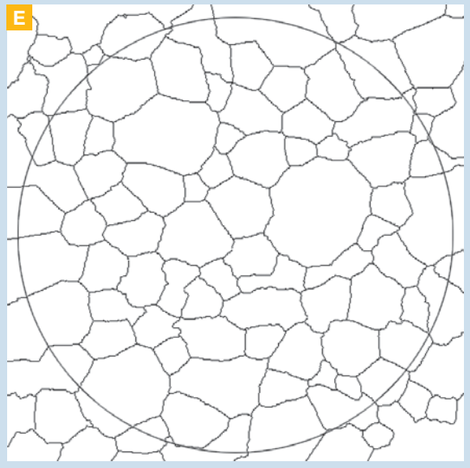
C



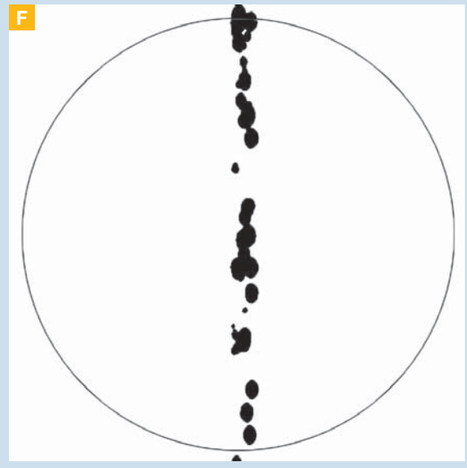
D



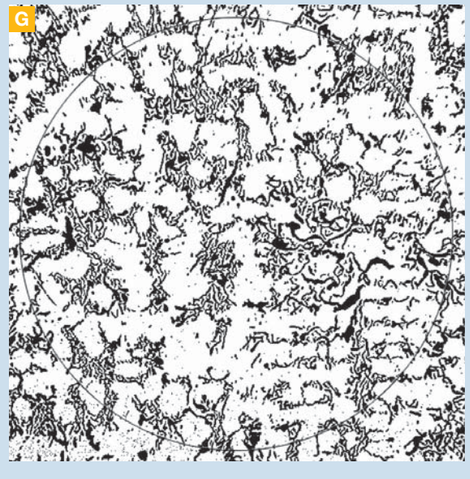
E



F



G



Example images

C Standard ASTM E112

D Standard DIN 50601

E Standard ISO 643 (version 2003)

F Standard DIN 50602

G Standard DIN EN ISO 945

ADVANCED METALLOGRAPHY

Pushing metallography to its limits

Advanced metallography requires equipment that is able to perform highly sophisticated, in-depth analysis. For example, analysis of non-metallic inclusions or the measurement of decarburisation depths requires an advanced approach to digital image analysis in order to ensure precise data is obtained. Several Materials Extensions to the Olympus Stream software are available to solve such tasks in accordance with international and national standards.

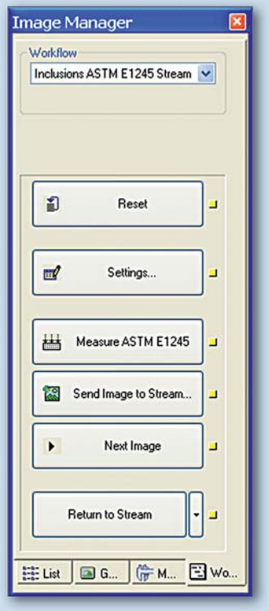
The image shows stacked bars of steel in a steel mill.

A Settings

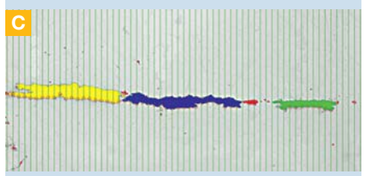
Definition of threshold values

B Workflow

Standardised evaluation of inclusions and second phases



C



"Virtual" interception lines are used to evaluate the inclusions or second phases

INCLUSION RATING
(ASTM E1245)

The Inclusion Rating ASTM E1245 Materials Extension enables users to evaluate inclusions or second phases with automatic image analysis in accordance with the ASTM E1245 standard. It effectively determines area fraction, particles per unit area and intercepts per unit length, using a particle-based method. Multiple images can easily be accumulated and the specific values for each are clearly displayed in a spreadsheet format.

Settings

A The user must define suitable threshold values to ensure accurate separation of sulphides and oxides, and state whether the interception lines are vertical or horizontal.

Execution

B Once the settings have been entered, the measurement is automatically performed with a simple click of the "Measure ASTM E1245" icon. The results are automatically inserted into the results spreadsheet and evaluation of the next image commences with a click on the "Next Image" icon.

Results

C The results spreadsheet includes measurement parameters such as ratio, density and segments for each of the measured images, as well as a range of statistical data for all of the measurement results. The spreadsheet is therefore divided into two parts: the upper part details the statistical data for the three measurement parameters, with their averages; the lower part presents the values of the three measurement parameters for each of the measured images.

Results spreadsheet of non-metallic inclusion rating evaluation using ASTM E1245, Method A

Inclusion_1245_result_sheet

		Fraction	Density	Intercepts
			1/mm²	1/mm
	Average	0,01	33348,76	10,70
	Standard Deviation	0,02	61585,48	15,32
	95% Confidence Interval	0,01	47338,79	11,77
	% Relative Accuracy	84,21	141,95	109,99
1	NE1_SS109	0,01	1935,95	3,15
2	NE2_SS212	4,38E-03	1513,56	2,75
3	NE3_SS184	0,05	178019,21	48,37
4	NE1_SS334	0,02	90681,56	20,38
5	NE2_SS801	4,85E-03	908,14	2,43
6	NE3_SS733	4,85E-03	908,14	2,43
7	NE1_SS158	3,63E-03	696,94	2,05
8	NE2_SS935	0,02	19975,46	9,57
9	NE3_SS997	0,01	5499,85	5,20

INCLUSION COUNTING
(ASTM E45, DIN 50602)

The Inclusion Counting Worst Field Materials Extension analyses images to accurately determine non-metallic inclusion ratings in compliance with ASTM E45, Method A, and DIN 50602, Method M. Automatically created reports will fully document the results.

Settings

D The initial step is to define the settings which will be used to determine inclusions. The user needs to define the elongation, which is the threshold level that is used to distinguish between the different inclusion types, such as globular oxide (D) and alumina (B) vs. sulphide (A) and silicate (C). Furthermore the user must also define the grey scale threshold that distinguishes between sulphide (A) vs. oxide types, including silicate (C), alumina (B) and globular oxide (D).

Execution

E Selecting the "Measure ASTM E45" icon initiates automatic analysis of the image and the evaluated data is transferred to a spreadsheet, where it is listed according to the selected standard.

Results

F The Inclusion Counting Worst Field Materials Extension automatically creates a report which contains all relevant measurement results for the standards in question. Users are also able to have the results of the non-metallic inclusion inspection evaluated according to two different standards simultaneously, while an individual report will be created for each.

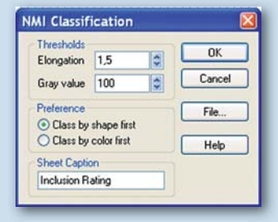
Report of an inclusions counting worst field analysis using DIN 50602, Method M

TP_QM_14_10_09_543.owb

		SS	OA	OS	OG	Sample No.	Material	Processing	Job number
1									
2	(Average)	5,00	0,00	4,00	8,00				
3	1	5,00	-	4,00	8,00	5771	steel		
4	2	5,00	-	4,00	8,00	5772	steel		
5	3	5,00	-	4,00	8,00	5773	steel		
6	4	5,00	-	4,00	8,00	5774	steel		
7	5	5,00	-	4,00	8,00	5775	steel		

D Settings

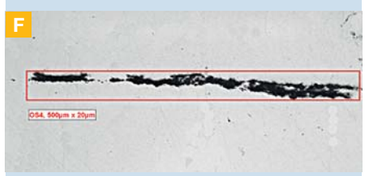
Options for ASTM E45, Method A, and DIN 50602, Method M available



E Workflow

Standardised evaluation of inclusions and second phases

F



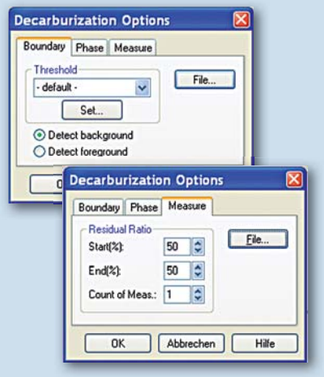
Determination of non-metallic inclusion ratings

A

Determination of the residual decarburisation ratio at various depths

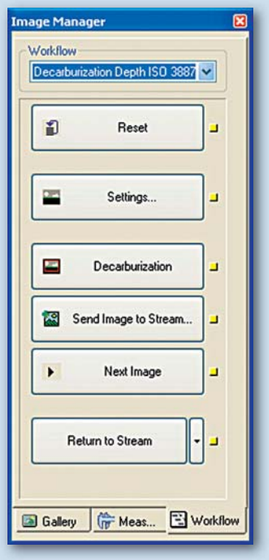
B **Setting**

Definition of the necessary data



C **Workflow**

Calculating the depth profile of decarburisation



DECARBURISATION DEPTH

(ISO 3887)

A The Decarburisation Depth Materials Extension can detect sample boundaries and calculate the profile depth. The software determines the depth of both total and partial decarburisation, according to the relative amount of free ferrite with increasing distance from the surface. The depth at one or more given degrees of decarburisation can be entered directly into the results spreadsheet.

Settings

B To accurately measure the total and partial decarburisation based on the relative amount of free ferrite, a number of settings are required. The user is initially prompted to define the boundary of the steel sample, followed by the areas in the steel that belong to the carbon-deficient phase. Finally, the user is able to define at which residual ratios the decarburisation depth should be determined by setting a start and end residual ratio, along with the number of measurements.

Execution

C Based on these settings, the Decarburisation Depth Materials Extension uses the cross-section of the steel to determine the residual decarburisation ratio at various depths. Therefore the user simply has to click the “Decarburisation” icon to begin the analysis. The residual decarburisation ratio is calibrated in such a way that it has a value of 100% on the sample surface and 0% at the depth where the decarburisation ends. From this data, the software automatically calculates the decarburisation depth at the predetermined residual ratios.

Results

All of the calculated decarburisation depths will be displayed in a clear and easy-to-read table. In the image overlay, at least two lines will be drawn: a white line to demarcate what the system has detected to be the steel sample boundary and a blue line to represent each of the residual ratios specified by the user. The mean distance between these two lines is calculated as the corresponding decarburisation depth.

BANDING

(ASTM E1268)

The Banding Materials Extension features the characterisation and measurement of banded or oriented microstructures, such as carbide banding in steel in compliance with ASTM E1268 standards.

Settings

D In the initial step, all of the experimental parameters need to be defined by the user in the self-explanatory settings window. These include defining the measurement line spacing, as well as the boundary width of the measurement frame and thresholds.

Execution

E F Once these settings have been finalised, the resulting data is generated by clicking on the “Banding” icon. This produces a detailed report of the banding characterisation, degree of orientation, band spacing and free path spacing.

Results – compliant with ASTM E1268

The software accurately assesses the degree of banding or orientation of the microstructure, in accordance with ASTM E1268. Directly measured from the image, the number of feature interceptions, with the test lines either parallel or perpendicular to the deformation, is used to calculate the anisotropy index and the degree of orientation. A series of measurements on multiple images can be obtained and the data is listed in an overall results spreadsheet, which details average results as well as individual values.

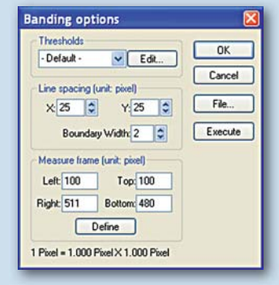
Banding results spreadsheet in accordance with ASTM E1268

Banding Results*

		Average	Standard Deviation	95% C.I.	Banding
1					
2	NL (_|_) [1/mm]	14,77	8,25	10,25	0,00
3	NL (| |) [1/mm]	7,00			0,00
4	Anisotropy Index	2,11			1,23
5	Degree of Orientation	0,41			0,13
6	Spacing Center to Center	67,73			26620087,34
7	Phase Fraction [%]	41,00			42,80
8					

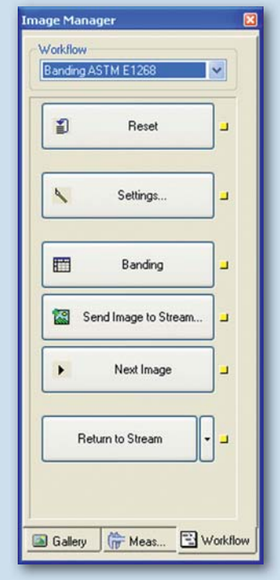
D **Settings**

Definition of requested parameters

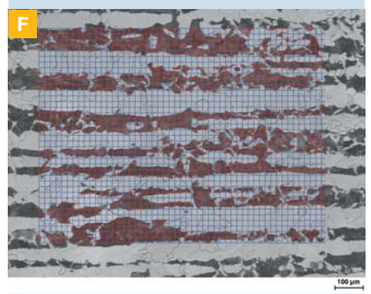


E **Workflow**

Standardised characterisation and measurement of banded or oriented microstructures

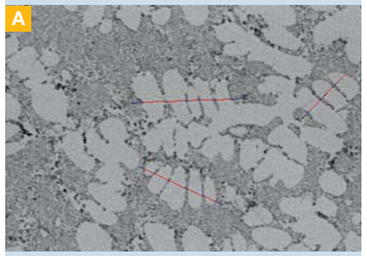


F



Determination of carbide banding in steel

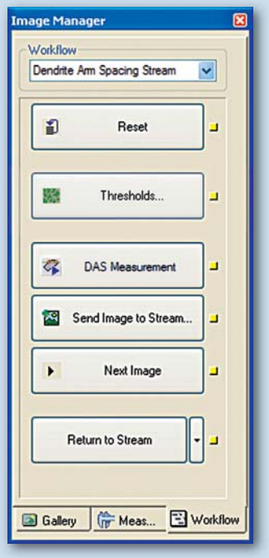
A



Analysing the fineness of dendrite structures found in aluminium alloys

B **Workflow**

Dendrite arm spacing measurement



DENDRITE ARM SPACING

The Dendrite Arm Spacing Materials Extension examines the gaps between neighbouring dendrite arms. Enabling interactive determination of the average dendrite arm spacing, this software can detect dendrite arms automatically using the preset thresholds. The measurement results are subsequently summarised into an easy-to-read spreadsheet format.

Settings

A The user must initially set appropriate threshold values for the dendrite arm spacing measurements. During the course of the measurements, users are required to define intercept lines within the structure while measuring the dendrite arm spacing value. The intercept lines should be located on areas that are typical of the whole structure, and each one should intercept a number of neighbouring dendrite arms.

Execution

B The system accurately calculates the corresponding measured distance from each intercept line when the user clicks the “DAS measurement” icon. The system immediately assesses each intercept line and processes the length of the measured distance, the number of dendrites and the dendrite arm spacing value, placing them in the results spreadsheet before the next intercept definition begins.

Results

The measurement results for all of the considered intercept lines can be found in the results spreadsheet, which contains a range of data including: length of the measured space, dendrite count, resulting dendrite arm spacing values of each intercept line, and the total value (the measurement’s end result). This value is calculated as the quotient of the entire length of the measured distances and the entire count of dissected dendrites. It describes the level of detail in the dendritic structure image.

Results spreadsheet of dendrite arm spacing measurement

DAS Results

	DAS Measurement	Measured distance	Dendrite count	DAS
1		µm		µm
2	Total	3230,18	30	107,67
3	1	483,90	7	69,13
4	2	1386,35	3	462,12
5	3	893,04	13	68,70
6	4	466,89	7	66,70

Specifications

Extended measurements

	Layer thickness measurement ST-MOD-LTM	**Microhardness measurement** ST-MOD-MHT
Description	Measures the thickness of single or multiple layers	Measures the indentation print and calculates the hardness
Supported standards	n/a	Vickers, Knoop
Measurement types	Perpendicular to neutral fibres, shortest distance (curve types: line, polygon, interpolated polygon, automatic detection)	Diagonal interactive measurement, multiple indentation print measurement
Report/output	Spreadsheet (single measurement point values), statistics (max, min, mean, standard deviation), image with overlay (measurement lines)	Spreadsheet (diagonal length, centre point: x/y coordinates, hardness value, statistics: max, min, mean, standard deviation)

	Weld measurement ST-MOD-WM	**Point count, ASTM E562** ST-MOD-E562
Description	Measures welds	Determines volume fractions by systematic manual point count
Supported standards	n/a	ASTM E562
Measurement types	Theoretical throat, asymmetric distance, parallel distance along a line between two arbitrary points, transversal distance to a given line	Interactive counting of full and half phase portions on a point grid (number of grid points in x is user definable, number of grid points automatically defined in accordance with ASTM E562)
Report/output	Spreadsheet, image with overlay (measurement lines, measurement results)	Speadsheet (area fraction in %, mean area fraction in % [for measurements on more than one image])

Metallography

	Grain sizing intercept, ASTM E112 ST-MOD-GS-IN	**Grain sizing planimetry, ASTM E112**
Description	Analyses the grain size (intercept method)	Analyses the grain size (planimetry method)
Supported standards	ASTM E112, DIN 50601, JIS G 0552	ASTM E112, DIN 50601, JIS G 0552
Measurement types	Automatic measurement (cross pattern, circle pattern)	Automatic measurement (manual definition of separator and sandwich threshold)
Report/output	Spreadsheet (g-value, mean intercept distance, C.V., accuracy [%], statistics: average, variance, standard deviation)	Spreadsheet (g-value: elongated, single grain, sandwich, elongation number, dual grain, percent of grains/class), chart (grain frequency distribution), image with overlay (detected grain boundaries)

	Cast iron (graphite and pearlite/ferrite), EN ISO 945 ST-MOD-CI	**Chart comparison and chart E112** ST-MOD-CC-E112
Description	Classifies spherical graphite and determines the ferrite/pearlite ratio	Displays and sizes comparison charts in accordance with the microscopic sample images to be compared. Includes comparison chart for the determination of the ferritic or austenitic grain size of steel and ferrous materials.
Supported Standards	EN ISO 945, ASTM E247, JIS G 5502	ASTM E112 (for optional standards, see charts)
Measurement types	Automatic measurement (grey scale threshold setting automatic or manual)	3 or 8 reference images
Report/Output	Spreadsheet (Graphite: form, size, nodularity, area fraction [%], size class distribution; ferrite/pearlite: ferrite [%], pearlite [%]), chart (graphite: graphite size class distribution), image with overlay (detected graphite contents; different form classes appear in different colours)	Spreadsheet (value of the matching reference image)

Specifications

Comparison charts

Chart, ASTM E112	Comparison chart for the determination of the ferritic or austenitic grain size of steel and ferrous materials
included in ST-MOD-CC-E112	(included in the extension chart comparison)
Chart, DIN 50601	Comparison chart for the determination of the ferritic or austenitic grain size of steel and ferrous materials
ST-C-50601	(requires extension chart comparison)
Chart, DIN 50602	Comparison chart for the assessment of the content of non-metallic inclusions
ST-C-50602	(requires extension chart comparison)
Chart, ISO 643:2003	Comparison chart for the determination of the apparent ferritic or austenitic grain size in steels
ST-C-643	(requires extension chart comparison)

Advanced metallography

	Inclusion, ASTM E1245 ST-MOD-E1245	**Inclusion worst field, ASTM E45** ST-MOD-INC-WF
Description	Automatically determines the inclusion or second-phase constituent content of metals	Determines the inclusion content of steel
Supported Standards	ASTM E1245	ASTM E45 (Method A), DIN 50602 (Method M)
Measurement types	Automatic measurement (horizontal or vertical interception line orientation, interactive grey scale threshold setting)	Automatic measurement (defined by elongation threshold, interactive grey scale threshold setting)
Report/output	Spreadsheet (density [1/mm^2], intercepts [1/mm], statistics: average, standard deviation, 95% confidence interval, % relative accuracy)	Spreadsheet

	Decarburisation, ISO 3887 ST-MOD-DEC	**Banding, ASTM E1268** ST-MOD-E1268
Description	Determines the depth of decarburisation	Assesses the degree of banding or orientation of microstructures
Supported standards	ISO 3887	ASTM E1268
Measurement types	Automatic measurement (defined by start residual ratio [%], end residual ratio, number of measurements)	Automatic measurement (interactive grey scale threshold setting, grid definition: line spacing x, line spacing y, boundary width)
Report/output	Spreadsheet (decarburisation depth [mm] at the predefined residual ratios), image with overlay (detected sample boundary, lines at the predefined defined residual ratios)	Spreadsheet (feature interceptions [1/mm], anisotropy index, degree of orientation, spacing centre to centre [µm], phase fraction [%], spacing edge to edge [µm], statistics: average, standard deviation, 95% confidence level)

	Dendrite arm spacing ST-MOD-DAS
Description	Examines the gaps between neighbouring dendrite arms
Supported standards	n/a
Measurement types	Automatic measurement (interactive grey scale threshold setting)
Report/output	Spreadsheet (dendrite count, dendrite arm spacing [µm]), image with overlay (detected dendrite arm boundaries)

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