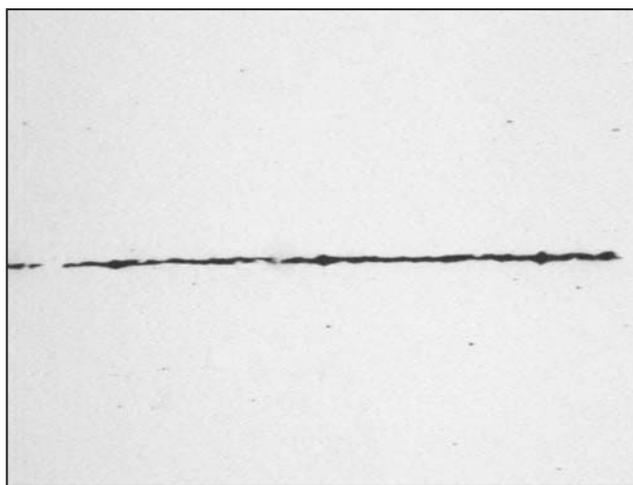


Standard Inclusion Rating

Image Analysis Report # 273



Standard Inclusion Rating Image Analysis Report # 273

Sample Description

Two samples of steel in the same mounting.

Purpose of Analysis

To demonstrate the ability of the Clemex Inclusion Rating (CIR) system to discriminate, categorize, measure and rate the inclusions found on the samples. The results have to be expressed according to ASTM E45, JIS G 0555 and DIN K standards.

Equipment Used

Image Analysis System:	Clemex CIR
Microscope:	Nikon Epiphot 200 with a 10x objective for 100x magnification
Stage:	Motorized Marzhauser EK8B-S1(100x100 mm ²) with auto focus drive
Camera:	Sony XC-77CE (768X574) B&W

Procedures¹

The analysis was performed at a magnification of 100X for a calibration factor of 1.0431 µm/pixel. This setup corresponded to the suggested user magnification.

The first step of the analysis was to adjust the light and to verify the Threshold (figure 1). According to the gray level, the Threshold defines whether an object is detected or not and if it is a sulfide or an oxide; different types of oxides are discriminated by their shape.

The next step was to define how many heats and samples were to be analyzed from the WorkPlace window under the Edit option. It is possible to analyze up to 6 heats of 6 samples each for a total of 36 samples. In the current project, 1 heat and 2 samples were logged for further analysis.

From the same window, the Pattern option allowed us to specify the necessary processing information (figure 2). For each sample, we specified a field pattern, an autofocus template and the orientation of the inclusions (for reconnection purpose). The Clemex CIR instantly indicated the corresponding area covered by the field pattern. When we were done with a sample, we keyed the "Set" button and a new analysis pattern was inserted at the current stage position. Whenever we needed to change the pattern position, we double-clicked on a field of the pattern, the stage moved to the corresponding position and the corresponding image appeared in the Image window. Note that all the pattern settings were to be loaded back into Clemex CIR during the next analysis session.

1. All figures are grouped into Appendix A.

Procedures

An analysis pattern of 10x10 fields was set for the first sample. A pattern of 16x15 fields was set for the second sample. The total analysis area for each sample was 50.20 mm² and 120.48 mm² respectively. An autofocus template was also specified for each of the patterns.

From the Run option, we specified the samples that were going to be analyzed. All newly defined samples were pre-selected by the system. The Clemex CIR started the analysis as soon as the "Start Run" button was keyed. It took less than 10 minutes for Clemex CIR to process the current analysis including the two samples.

The Results window (figure 3) appeared as soon as the analysis was complete. Clemex CIR then selected the Results option from the Workplace window. A map of each category of inclusion appeared on the Image window of the currently selected sample (figure 4). Squares of a specific color indicated the worst fields (thin and heavy) for each category. To validate the results, we double-clicked on the worst fields, the stage moved back to the corresponding position on the corresponding sample, and the detected inclusions were identified (figure 5 and 6). If dust or a polishing scratch remaining from the preparation process was detected as an inclusion, it was removed from the results by a single click.

When an inclusion covered more than one field, the Clemex CIR system rebuilt the complete inclusion from the different parts and the entire length was considered into the ratings.

Results²

From the Results window, we were able to access our results expressed in a specific and standardized way. We had the choice of ASTM E 45 A, ASTM E 45 C, ASTM E 45 D, ASTM E 45 E, JIS G 0555, DIN M and DIN K methods. From the same window, we could see the details of the rated oversize inclusions (type, length, width, and sample). The first part of the report always specified some important information about each sample.

The Clemex CIR results report was printed. We specified the name of our company, the department and the user name, and they all appeared as a header along with the date and time of the printed report. The results could also have been exported for later use. In both cases (print or export) we could have selected a specific analysis method, a combination of them or all of them. The oversize listing was not optional and would always show up.

When building a report from a text editor, we could copy and paste any image as needed. The same thing was possible with an inclusion map and the worst fields.

² The complete results are included into Appendix B.

Discussion

The Clemex CIR system has been designed precisely for this kind of analysis. It can discriminate the sulfides from the aluminas, the silicates from the globulars, and rate them according to ASTM, JIS and DIN standards.

Clemex CIR has integrated algorithms to discriminate the different types of inclusions. It will analyze the previous field by the time the stage moves to the next one. The analysis time is around 1 second per field. It also takes around 2 seconds for each autofocus. In the current analysis, the surface recommended by ASTM standard (160 mm²) was not respected because the samples were not large enough.

The usual calibration factor in the current analysis with the Clemex CIR system was 1.5 micron/pixel compared to 1.0 micron/pixel. More details could have been detected by the system but the area covered by each field would have had to have been decreased. As a result more fields would have had to be analyzed to cover the same area which would have increased the total analysis time.

Polishing scratches and dust remaining from the preparation were detected as inclusions. While they were easily removed from the results, starting with as clean a sample as possible would have decreased the validation processing time.

All the above results are reproducible.

Appendix A
Images

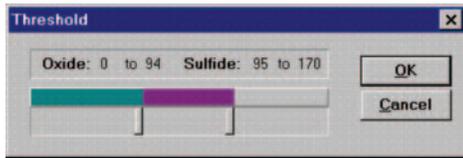


Figure 1 :
According to his gray level, the Threshold defines whether an object is detected or not and whether it is a sulfide or an oxide.

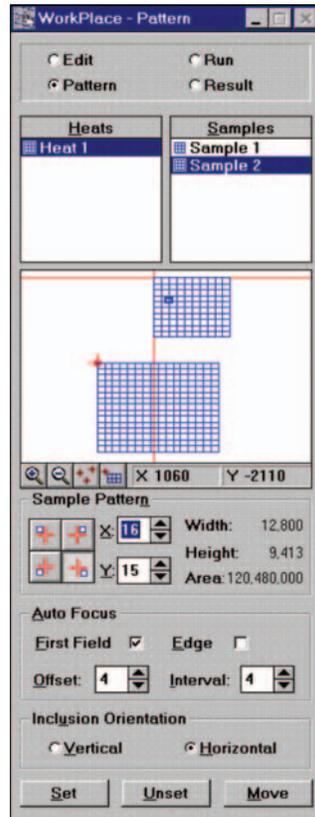


Figure 2 :
Pattern option permits specifying necessary processing information.

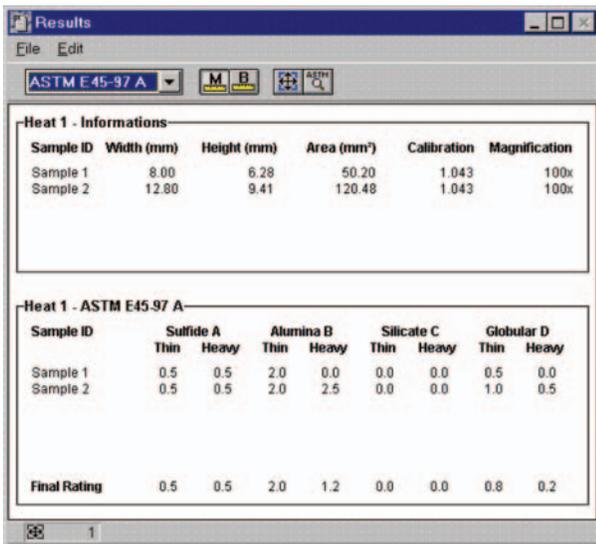


Figure 3 :
Results window that appears when the run is completed.

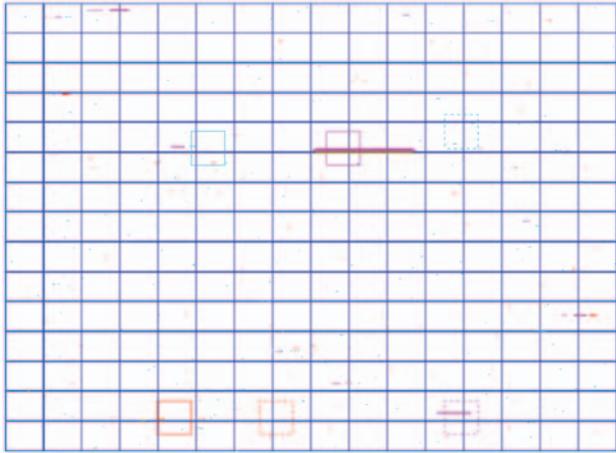


Figure 4 :
Map of inclusions and worst fields (thin and heavy)
from sample 2.

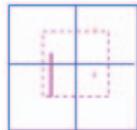


Figure 5 :
Zoom of the worst field of alumina (thin) from the
map inclusions of sample 1.

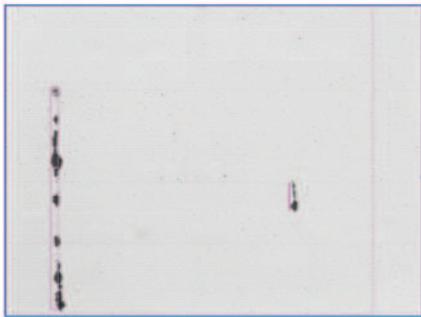


Figure 6 :
When we double-click on the worst field, the stage
moves back to the corresponding position on the
corresponding sample and shows the detected
inclusions.

Appendix B
Results

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - ASTM E45-97 A

Sample ID	Sulfide A		Alumina B		Silicate C		Globular D	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Sample 1	0.5	0.5	2.0	0.0	0.0	0.0	0.5	0.0
Sample 2	0.5	0.5	2.0	2.5	0.0	0.0	1.0	0.5
Final Rating	0.5	0.5	2.0	1.2	0.0	0.0	0.8	0.2

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - ASTM E45-97 D

Sample ID	Type	0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		
		T	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H	
Sample 1	A	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	3	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sample 2	A	15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	5	0	6	1	3	1	2	1	0	2	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	109	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average	A	8.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	4.0	0.0	3.0	0.5	2.0	0.5	1.5	0.5	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	D	66.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - ASTM E45-97 E

Type	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
B Thin	-	-	4	3	0	0	0	0	0	0
B Heavy	-	1	1	1	2	0	0	0	0	0
D Heavy	3	0	0	0	0	0	0	0	0	0
SAM Rating	Alumina B:		81	Globular D:		11				

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - JIS G 0555

Sample ID	Sulfide A1	Alumina B	Silicate A2	Globular C
Sample 1	0.0020%	0.0059%	0.0000%	0.0019%
Sample 2	0.0042%	0.0263%	0.0000%	0.0042%
Final Rating	0.0035%	0.0203%	0.0000%	0.0035%

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - DIN M

Sample ID	SS	OA	OS	OG
Sample 1	1	5	-	4
Sample 2	2	7	-	4
Average	1.5	6.0	-	4.0

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - DIN K

Sample ID	Type	Rating Number									
		0	1	2	3	4	5	6	7	8	
Sample 1	SS	4	2	0	0	0	0	0	0	0	0
	OA	0	1	1	1	0	1	0	0	0	0
	OS	0	0	0	0	0	0	0	0	0	0
	OG	5	6	0	1	1	0	0	0	0	0
Sample 2	SS	11	3	1	0	0	0	0	0	0	0
	OA	1	3	4	2	3	3	1	2	0	0
	OS	0	0	0	0	0	0	0	0	0	0
	OG	49	24	5	3	3	0	0	0	0	0

Sample ID	K0		K1		K2		K3		K4	
	S	O	S	O	S	O	S	O	S	O
Sample 1	0.4	5.1	0.2	4.9	0.0	4.2	0.0	4.0	0.0	3.0
Sample 2	1.1	46.5	0.5	44.0	0.2	41.3	0.0	39.5	0.0	37.0
Total Index	8.5	302.6	4.1	286.5	1.2	266.6	0.0	254.9	0.0	234.4
Overall	311.1		290.6		267.7		254.9		234.4	

Clemex CIR Report

Organization:	Clemex Technologies	Department:	Laboratory
User:	Myriam Savard	Date & Time:	12/10/97 1:13 PM

Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm ²)	Calibration	Magnification
Sample 1	8.00	6.28	50.20	1.043	100x
Sample 2	12.80	9.41	120.48	1.043	100x

Heat 1 - ASTM E45-97 C

Sample ID	Oxide O		Silicate S	
	Rating	Length	Rating	Length
Sample 1	3	447	0	0
Sample 2	16	2045	0	0