STANDARD INCLUSION RATING

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 in 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 SC-77CE B&W

Procedures

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 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 Initial Patterns option allowed us to specify the necessary processing information (Figure 2). For each sample, we specified a field pattern, an focusing selection 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 clicked 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.

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" button was triggered. It took less than 10 minutes for Clemex CIR to process the current analysis for two samples.

Clemex CIR then selected the Result option from the Workplace window. A map of each category of inclusion appeared on the Image window of the currently selected sample (Figure 3). 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 (Figures 4 and 5). If dust

or a polishing scratch remaining from the preparation process was detected as an inclusion, it can be removed from the results by vallidatin process.

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.
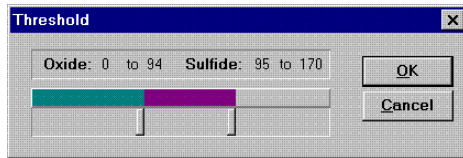

Figure 1: According to its gray level, the Threshold defines whether an object is detected or not and whether it is a sulfide or an oxide.
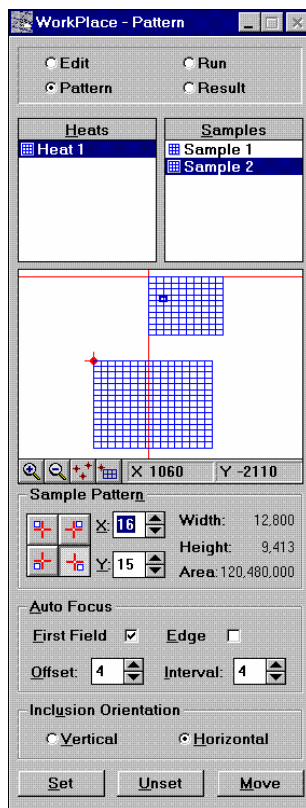

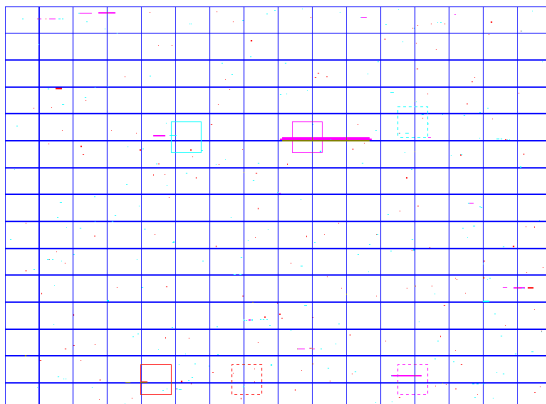Figure 2: Pattern option permits specifying necessary processing information

Figure 3: Map of inclusions and worst fields (thin and heavy) from sample 2.
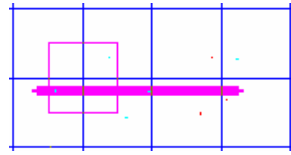
Figure 4: Zoom of the worst field of alumina (thin) from the map inclusions of the sample 2.
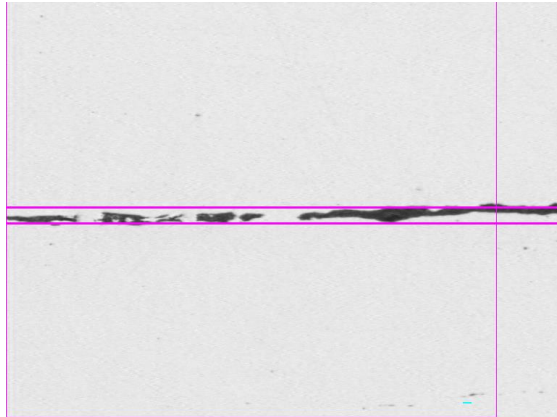
Figure 5: When double-click on the worst field, the stage moves back to the corresponding position on the corresponding sample and shows the detected inclusions.

Results

It is able to access the results expressed in a specific and standardized way. We had the choice of ASTM E45 A, ASTM E45 C, ASTM E45 D, ASTM E45 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).

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Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm²)	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

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Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm²)	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 T	0.5 H	1.0 T	1.0 H	1.5 T	1.5 H	2.0 T	2.0 H	2.5 T	2.5 H	3.0 T	3.0 H	3.5 T	3.5 H	4.0 T	4.0 H	4.5 T	4.5 H
Sample 1	A	2	1	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
	C	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
Sample 2	A	15	1	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
	C	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
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
	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
	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
	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

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Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm²)	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

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Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm²)	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%

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Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm²)	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**

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Heat 1 - Informations

Heat 1 - DIN K

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

Sample ID	K0 S	K0 O	K1 S	K1 O	K2 S	K2 O	K3 S	K3 O	K4 S	K4 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

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Heat 1 - Informations

Sample ID	Width (mm)	Height (mm)	Area (mm²)	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 Rating	Oxide O Length	Silicate S Rating	Silicate S Length
Sample 1	3	447	0	0
Sample 2	16	2045	0	0