

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 μ m/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 validatin 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.

reshold										
0 to 94	Sulfide: 95 to 170	<u>O</u> K								
		<u>C</u> ancel								
	0 to 94	0 to 94 Sulfide : 95 to 170								

🗱 WorkPlace - Patt	ern 📃 🗐 🗙
© Edit © Pattern	C Run C Result
<u>H</u> eats ⊞ Heat 1	Samples Sample 1 Sample 2
Q ++* ★ 11 Sample Pattern ++* ★ <	Width: 12,800 Height: 9,413 Area: 120,480,000
Auto Focus Eirst Field ☑ Offset: 4 🚔	Edge 🗖 Interval: 4 🗬
⊂Incl <u>u</u> sion Orientati C <u>V</u> ertical	
<u>S</u> et <u>U</u> n:	set <u>M</u> ove

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).

Organization: User:		Clemex Technologies Myriam Savard				oratory 10/97 1:13 PM	,	
Heat 1 - Informations	6							
Sample ID	Width (mm)	Heigh	nt (mm)	Area (n	nm²)	Calibration	a. A	Magnification
Sample 1 Sample 2	8.00 12.80		6.28 9.41		50.20 1.04 20.48 1.04			
Heat 1 - ASTM E45-9	7 A							
Sample ID	Sulf	ide A Heavy	Alu Thin	mina B Heavy	Silic	ate C Heavy	Glob	ular D Heavy
Sample 1 0.5 Sample 2 0.5		0.5 0.5	2.0 2.0	0.0 2.5	0.0 0.0	0.0 0.0	0.5 1.0	0.0 0.5



Organizatio User:	on:	Clem Myria	ex Te Im Sa	echnol ward	ogies					nent: Time:			orator 0/97	y 1:13 F	РМ		_		
Heat 1 - Informat	ions—											_	_	_	_	_			
Sample ID Width (mm)			Height (mm)				Area (mm²)			Calibration				Magnification					
Sample 1 Sample 2		8.00			28 41		50.20 120.48		1.043 1.043				100x 100x						
		2									5								
leat 1 - ASTM E																	4.0		4.5
Sample ID	Туре	т	0.5 H	т	1.0 H	т	1.5 H	т	2.0 H	т	2.5 H	т	3.0 H	т	3.5 H	т	4.0 H	т	4.5 H
Sample 1	ABCD	2 3 0 23	1 0 0	00000	0 0 0	0 1 0 0	0000	0 1 0 0	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	
Sample 2	ABCD	15 5 0 109	1 0 0 3	0 6 0 3	0 1 0	0 3 0 0	0 1 0	0 2 0 0	0 1 0 0	0000	0 2 0 0	0000	0000	00000	0000	0000	0000	0000	
Average	ABCD	8.5 4.0 0.0 66.0	1.0 0.0 0.0 1.5	0.0 3.0 0.0 1.5	0.0 0.5 0.0 0.0	0.0 2.0 0.0 0.0	0.0 0.5 0.0 0.0	0.0 1.5 0.0 0.0	0.0 0.5 0.0 0.0	0.0 0.0 0.0 0.0	0.0 1.0 0.0 0.0	0.0 0.0 0.0 0.0	0. 0. 0.						
Organizati User:	Organization: Clemex Technologies User: Myriam Savard				nent: Time:			orator	y 1:13 F	PM									

Sample ID	Width	(mm)	Height (mm) 6.28 9.41		Area (mm²) 50.20 120.48		Cali	bration	Magnification		
Sample 1 Sample 2		8.00 12.80					1.043 1.043		100x 100x		
Heat 1 - ASTM E4	5-97 E										
Туре	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	
B Thin B Heavy D Heavy	- 3	10	4 1 0	3 1 0	0 2 0	000	000	000	000	000	
SAM Rating	Alu	mina B:	81	GI	obular D:	11					
		lemex Tecl lyriam Sava			Department: Date & Time:		Laboratory 12/10/97 1:13 PM				
Heat 1 - Informati											
Sample ID	Width	n (mm)	Height		Are	a (mm²)	Cal	ibration	Magn	ification	
Sample 1 Sample 2		8.00 12.80		6.28 9.41	50.20 120.48			1.043 1.043		100) 100)	
1											
Heat 1 - JIS G 055	55									tores -	
Sample ID	5		Sulfide A1		Alumina			te A2		obular C	
Heat 1 - JIS G 055 Sample ID Sample 1 Sample 2	55		Sulfide A1 0.0020% 0.0042%		Alumina 0.005 0.026	9%	0.0	te A2 000% 000%		obular 0 0.0019% 0.0042%	



User:	on:	Clemex Technologies Myriam Savard			Depar Date 8	tment: Time:	Laborati 12/10/97	ory 7 1:13 PM		
Heat 1 - Informati						-				
Sample ID	W	dth (mm)	He	ight (mm)		Area (mm²)		Calibration	Ma	gnification
Sample 1 Sample 2		8.00 12.80	8.00 6.28 12.80 9.41			50.20 120.48		1.043 1.043		100x 100x
Heat 1 - DIN M										
Sample ID			SS		OA		os		OG	
Sample 1 Sample 2		1 2			5 7		-		4 4	
Average			1.5		6.0				4.0	
Organizatio User:	on:	Clemex Te Myriam Sa		s		tment: & Time:	Laborat 12/10/9	tory 7 1:13 PM		
Sample ID		dth (mm)	He	ight (mm)		Area (mm²)		Calibration	M	agnification
		dth (mm) 8.00 12.80	He	ight (mm) 6.28 9.41		Area (mm²) 50.20 120.48		Calibration 1.043 1.043	M	100
Sample 1		8.00	He	6.28		50.20 120.48		1.043	M	agnification 100; 100;
Sample ID Sample 1 Sample 2		8.00	He	6.28	3	50.20	iber 5	1.043	Ма 7	100
Sample ID Sample 1 Sample 2 Heat 1 - DIN K—	Wi Type SS	8.00 12.80	1	6.28 9.41 2 0	3	50.20 120.48 Rating Num 4	5 0	1.043 1.043 6 0	7	100: 100: 8 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID	Туре	8.00 12.80	1	6.28 9.41 2	3	50.20 120.48 Rating Num 4	5	1.043 1.043 6	7	100:100:
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID	Wi Type SS OA	8.00 12.80 0 4 0	1 2 1	6.28 9.41 2 0 1	3 0 1	50.20 120.48 Rating Num 4 0 0	5 0 1	1.043 1.043 6 0 0	7	100: 100: 8 0 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID	Wi Type SS OA OS OG SS	8.00 12.80 0 4 0 5 11	1 2 1 0 6	6.28 9.41 2 0 1 0 0 1	3 0 1 0 1	50.20 120.48 Rating Num 4 0 0 0 1 0	5 0 1 0 0	1.043 1.043 6 0 0 0 0 0 0	7 0 0 0 0 0	100 100 8 8 0 0 0 0 0 0 0 0 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID Sample 1	Wi Type SS OA OS OG	8.00 12.80 0 4 0 5	1 2 1 0	6.28 9.41 2 0 1 0 0	3 0 1 0	50.20 120.48 Rating Num 4 0 0 0 1	5 0 1 0 0	1.043 1.043 6 0 0 0 0	7 0 0 0 0	100 100 8 0 0 0 0 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID Sample 1 Sample 2	Wi Type SS OA OS OG SS OG OG	8.00 12.80 0 4 0 5 5 11 1 0 49 K0	1 2 1 0 6 3 3 0 24	6.28 9.41 2 0 1 0 0 1 4 0 5	3 0 1 0 1 0 2 0 3	50.20 120.48 Rating Num 4 0 0 0 1 0 3 0 3 8 K2	5 0 1 0 0 3 0 0	1.043 1.043 6 0 0 0 0 0 0 0 0 1 0 0 0 8 8	7 0 0 0 0 0 0 0 0 0	100: 100: 100: 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID Sample 2 Sample ID	Wi Type SS OA OS OG SS OG SS OG SS OG SS	8.00 12.80 0 4 0 5 5 11 1 0 49 K0 0	1 2 1 0 6 3 3 0 24 S	6.28 9.41 2 0 1 0 0 1 4 0 5 5 K1 0	3 0 1 0 1 0 2 0 3 3	50.20 120.48 Rating Num 4 0 0 0 1 1 0 3 0 3 8 8 2 0	5 01 0 0 3 0 0 5	1.043 1.043 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	100 100 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID Sample 1 Sample 2	Wi Type SS OA OS OG SS OG OG	8.00 12.80 0 4 0 5 5 11 1 0 49 K0	1 2 1 0 6 3 3 0 24	6.28 9.41 2 0 1 0 0 1 4 0 5	3 0 1 0 1 0 2 0 3	50.20 120.48 Rating Num 4 0 0 0 1 0 3 0 3 8 K2	5 0 1 0 0 3 0 0	1.043 1.043 6 0 0 0 0 0 0 0 0 1 0 0 0 8 8	7 0 0 0 0 0 0 0 0 0	100 100 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Sample ID Sample 1 Sample 2 Heat 1 - DIN K Sample ID Sample 1 Sample 1 Sample ID Sample 1	Type SS OA OS OG SS OA OS OG SS OA OS OG	8.00 12.80 0 4 0 5 11 1 0 49 K0 0 5.1	1 2 1 0 6 3 3 0 24 S	6.28 9.41 2 0 1 0 0 1 4 0 5 K1 0 4.9	3 0 1 0 1 0 2 0 3 3 5 0.0	50.20 120.48 Rating Num 4 0 0 0 0 1 0 3 0 3 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5 0 1 0 0 3 0 0 0 5 0.0	1.043 1.043 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	100 100 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0



Organization: User:		Clemex Technologies Myriam Savard		Department: Date & Time:	Laboratory 12/10/97 1:13 PM	
Heat 1 - Informations		2 A 199.5			2.000 To 27	
Sample ID	Width (mm)	Heigh	nt (mm)	Area (mm ²)	Calibration	Magnification
Sample 1 Sample 2	8.00 12.80	6.28 9.41		50.20 120.48	1.043 1.043	100x 100x
Heat 1 - ASTM E45-9						
Sample ID	Rating	de O Length	Rating	cate S Length		
Sample 1 Sample 2	3 16	447 2045	0	0		