STUDIES AND RESEARCH FOR DETERMINATION OF RETAINED AUSTENITE

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Abstract. *This paper has as fundamental purpose the theoretic and practical presentation and explanation of the way to determine the retained austenite content. Is presented the chosen experimental method and technique – the estimation method of the residual austenite content using the DRON 3 diffractometer. The used procedure: after processing and indexing the difractogrames was determined the residual austenite content following the pairs of iron lines: α (110) and γ (111) and α (211) and γ (311), reaching the conclusion that the samples investigated by X-ray diffraction contain residual austenite between 2,8 % minimum calculated value and 4,9% maximum calculated value..*

Keywords: *retained austenite, X-ray diffraction*

1. INTRODUCTION

For the fulfillment of the goals for this paper were made studies on: the documentation on the retained austenite content determination method; the documentation of the testing procedure according to normative; quality assurance of test.

Among the most common applications of the X-ray diffraction analysis phase is steel, that the determination of retained austenite.

Quantitative determination of residual austenite content in the heat-treated steels by X-ray diffraction is a reliable means of controlling the properties of steel and its quality.

The functional role of retained austenite is complex because it can have both positive and negative effects on the properties and performance steels.

A too high content of retained austenite can decrease the elasticity of the steel, the hardness reduction, reduced life, dimensional instability etc[1-5].

Experiment

Diffractometer analysis of retained austenite has two aspects: highlighting retained austenite (qualitative analysis) and determining the percentage of retained austenite (quantitative analysis).

The existence of retained austenite (Feγ) in the steel after quenching, diffraction will lead to a diffraction pattern containing the diffraction lines specific to austenite[6-7].

Qualitative analysis of retained austenite is thought to be complete when the diffraction pattern characteristic lines appear Feγ after quantitative analysis can begin.

The amount of retained austenite (% RA) is calculated according to the formula:

$$\%AR = \frac{R_\alpha I_\gamma}{R_\alpha I_\gamma + R_\gamma I_\alpha} \bullet 100\% \qquad (1)$$

where the repeatability factors lines (110) and α (111) and Iα and Iγ is determined by automatic scanning detector profiles of the two lines.

Calculation of the percentage of austenite in the case of using MoKα radiation and a line (211) and Feα (311) Feγ is carried out using :

$$\%AR = \frac{I_\gamma}{I_\gamma + 3{,}38 I_\alpha} \bullet 100\% \qquad (2)$$

Analyzes related phases of this study were performed with DRON 3 diffractometer with Cu tube (λ_{Cu} = 1.541 A)[8-9]

Results and Discussion

In figure 1 is show the diffractrogram image for sample 1 obtain on DRON 3 diffractometer (figure.1).

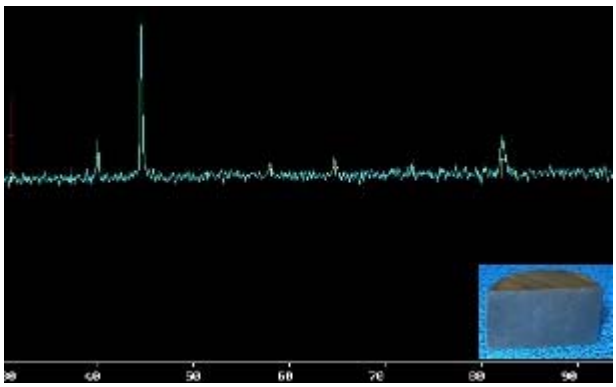

Figure 1. The diffractogram image for sample 1.

The figure 2 and 3 is representations of sample 1 phases.

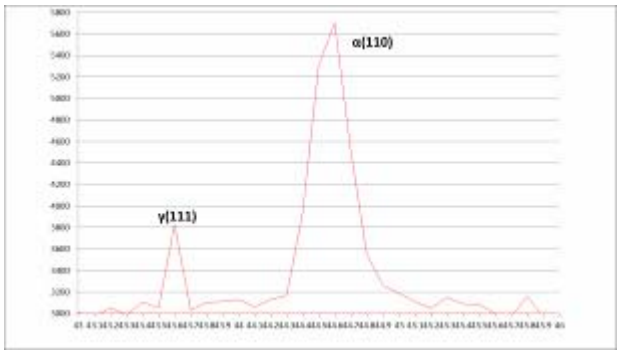

Figure 2. Graphical representation of sample 1 phases γ (111) and α (110)

Figure 3. Graphical representation of sample 1 phases γ (311) and α (211)

Calculation of residual austenite for sample 1 is show in equation 3 and 4.

$$AR\%(\gamma(111);\alpha(110)) = \frac{I_\gamma}{I_\gamma + 3.38 \bullet I_\alpha} \bullet 100 \quad (3)$$

$$= \frac{1.44}{1.44 + 3.38 \bullet 13.2} \bullet 100 = 3.12\%$$

$$AR\%(\gamma(311);\alpha(211)) = \frac{I_\gamma}{I_\gamma + 3.38 \bullet I_\alpha} \bullet 100 \quad (4)$$

$$= \frac{0.6}{0.6 + 3.38 \bullet 5.95} \bullet 100 = 2.95\%$$

Results obtained for indexing and calculation of residual austeniteare shown in in Table 1.

Table 1. Results

No.	Phase	2 theta	d	hkl	cps
1	gama	43.63	2.079	111	1440
2	alpha	44.68	2.033	110	13200
3	gama	82.25	1.176	211	600
4	alpha	90.65	1.087	311	5950
	AR %	UR(95%)			
1	3.12	2.1			
2					
3	2.95	1.9			
4					

In the table 2 is shown the chemical composition obtained by the spectrometer SPECTROMAXx to ensure quality results.

Table 2. Chemical composition for sample 1

No.	C %	Si %	Mn %	Cr %
	0.74	0.24	0.30	1.43
No.	Ni %	Cu%	Fe %	
	0.14	1.43	96.7	

In figure 4 is show the diffractrogram image for sample 1 obtain on DRON 3 diffractometer (figure.4).

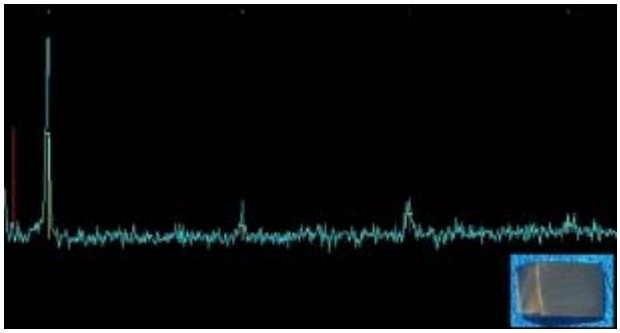

Figure 4. The diffractogram image for sample 2

The figure 5 and 6 is representations of sample 2 phases.

Figure 5. Graphical representation of sample 2 phases γ (111) and α (110)

Figure 6. Graphical representation of sample 2 phases γ (311) and α (211)

Calculation of residual austenite for sample 1 is show in equation 5 and 6.

$$AR\%(\gamma(111);\alpha(110)) = \frac{I_\gamma}{I_\gamma + 3.38 \bullet I_\alpha} \bullet 100 \quad (5)$$

$$= \frac{3.5}{3.5 + 3.38 \bullet 24.5} \bullet 100 = 4.05\%$$

$$AR\%(\gamma(311);\alpha(211)) = \frac{I_\gamma}{I_\gamma + 3.38 \bullet I_\alpha} \bullet 100 \quad (6)$$

$$= \frac{0.625}{0.625 + 3.38 \bullet 4.125} \bullet 100 = 4.29\%$$

Results obtained for indexing and calculation of residual austeniteare shown in Table 3.

Table 3. Results

No.	Phase	2 theta	d	hkl	cps
1	gama	43.67	2.09	111	3500
2	alpha	44.63	2.031	110	24500
3	gama	82.27	1.174	211	625
4	alpha	90.63	1.083	311	4125
	AR %	UR(95%)			
1	4.05	1.7			
2					
3	4.29	1.2			
4					

In the table 4 is shown the chemical composition obtained by the spectrometer SPECTROMAXx to ensure quality results.

Table 4. Chemical composition for sample 2

No.	C %	Si %	Mn %	Cr %
	1.40	0.36	0.22	1.44
No.	Ni %	Cu%	Fe %	
	0.11	0.18	96.12	

In figure 7 is show the diffractrogram image for sample 3 obtain on DRON 3 diffractometer (figure.7)

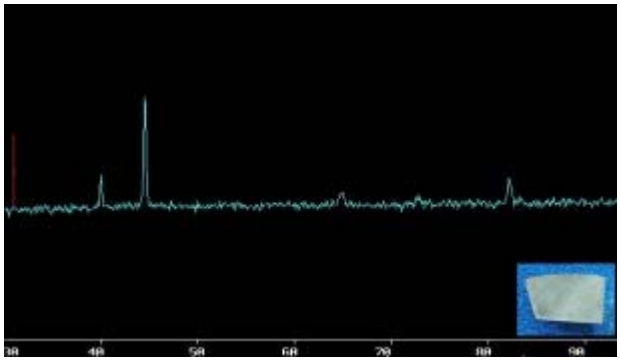

Figure 7. The diffractogram image for sample 3

The figure 8 and 9 is representations of sample 2 phases.

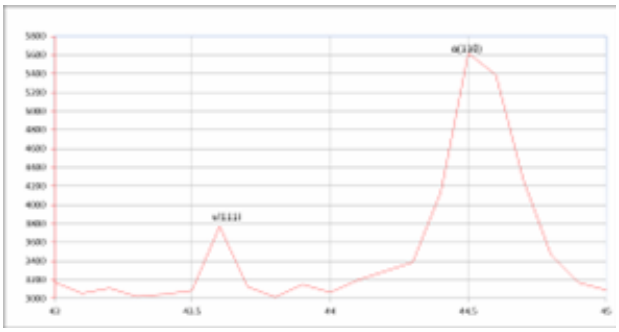

Figure 8. Graphical representation of sample 3 phases γ (111) and α (110)

Figure 9. Graphical representation of sample 3 phases γ (311) and α (211)

Calculation of residual austenite for sample 1 is show in equation 7 and 8

$$AR\%(\gamma(111);\alpha(110)) = \frac{I_\gamma}{I_\gamma + 3.38 \bullet I_\alpha} \bullet 100 \quad (7)$$

$$= \frac{2}{2 + 3.38 \bullet 20.25} \bullet 100 = 2.83\%$$

$$AR\%(\gamma(311);\alpha(211)) = \frac{I_\gamma}{I_\gamma + 3.38 \bullet I_\alpha} \bullet 100 \quad (8)$$
$$= \frac{0.38}{0.38 + 3.38 \bullet 3.9} \bullet 100 = 2.8\%$$

Results obtained for indexing and calculation of residual austeniteare shown in Table 5

Table 5. Results

No.	Phase	2 theta	d	hkl	cps
1	gama	43.61	2.072	111	2000
2	alpha	44.58	2.036	110	20250
3	gama	82.21	1.178	211	380
4	alpha	90.67	1.089	311	3900

	AR %	UR(95%)
1	2.83	1.5
2		
3	2.80	1.9
4		

In the table 6 is shown the chemical composition obtained by the spectrometer SPECTROMAXx to ensure quality results

Table 6. Chemical composition for sample 3

No.	C %	Si %	Mn %	Cr %
	1.40	0.36	0.22	1.44
No.	Ni %	Cu%	Fe %	
	0.11	1.18	96.1	

2. Conclusions

In this sense, to estimate residual austenite content using more mathematical models which is particularly complex. In this paper we used the mathematical model developed by AJC Wilson based on kinematic theory of X-ray diffraction pattern suitable for X-ray diffraction specialists of average, but has the advantage of great intuitive. The model that is implemented properly difractometriei radiation technique X. Table 7 provides an overview of the results obtained for the three samples of unknown steel by the method set forth above.

Table 7. Table content of retained austenite in the samples

No	Phase	AR %	UR (95%)
Sample 1	gama	3.12	2.1
	alpha		
	gama	2.95	1.9
	alpha		
Sample 2	gama	4.05	1.7
	alpha		
	gama	4.29	1.2
	alpha		
Sample 3	gama	2.83	1.5
	alpha		
	gama	2.80	1.9
	alpha		

Analyzing raw and processed diffraction data and calculation results, it is found that the results are relevant. To obtain more accurate results required the use of more efficient devices, allowing better fit the parameters of the experiment.

3. REFERENCES

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