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INFLUENCE OF ELECTROLYTIC PLASMA NITRIDING ON PHASIC COMPOSITION OF 40CR10 AND OLC 55 STEELS

The X-ray diffraction researches allowed the identification of the phases present in the structure of steels 40Cr10 and OLC 55, treated thermally and thermal-chemically in electrolytic plasma and the calculation of concentration of the structural phases identified.

***Key words**: electrolytic plasma, steels, nitration, X-ray diffraction.*

1. Introduction

The analysis of the phasic composition of the steels 40Cr10 and OLC 55, treated thermally and thermal-chemically in electrolytic plasma allows the establishing of a correlation between the technological parameters of the processing methods and the physical-mechanical properties obtained in the end.

The experimental determinations were effectuated by X-ray diffraction, the analysis of diffraction diagrams allowing the identification of phases present in the structure of each sample and the calculation of the plane spacing d_{hkl} and the phase concentration.

2. Experimental procedure

The experimental researches were effectuated by cylindrical samples □15 x 50 mm, from the steels 40Cr10 and OLC 55, processed thermally by anodic heating in watery electrolytes according to the conditions presented in table 1.

Table 1

Technological parameters of thermal and thermal-chemical treatment in electrolytic plasma

No. crt.	Steel type	Sample	Thermal and thermal-chemical treatment applied	Technological parameters of thermal processing
1	40Cr10	3B	nitration + tempering + bluing	$T_{\text{înc}}$ = 650ºC; t_{inc} = 6 min T_{rev} = 350ºC; t_{rev} = 1 h
2		3D	nitration + tempering	$T_{\text{înc}}$ = 700ºC; $t_{\text{înc}}$ = 6 min
3		3HH	nitration + tempering + bluing	$T_{\text{înc}}$ = 750ºC; t_{inc} = 6 min T_{rev} = 350ºC; t_{rev} = 1 h
4		3A	nitration + tempering	$T_{\text{înc}}$ = 650ºC; t_{inc} = 6 min T_{aust} = 750ºC
5	OLC 55	4V	nitration + tempering + bluing	$T_{\text{înc}}$ = 650ºC; t_{inc} = 6 min T_{rev} = 350ºC; t_{rev} = 1 h
6		4DD	nitration + tempering	$T_{\text{înc}}$ = 700ºC; $t_{\text{înc}}$ = 6 min
7		4MM	nitration + tempering + bluing	$T_{\text{înc}}$ = 750ºC; t_{inc} = 6 min T_{rev} = 350ºC; t_{rev} = 1 h
8		4Y	nitration + tempering	$T_{\text{înc}}$ = 650ºC; t_{inc} = 6 min T_{aust} = 750ºC

The diffraction diagrams were obtained by the device DRON 2, using radiations MoK_{α} and FeK_{α}. The interval analysed is comprised between: 2θ = 15º…40º

3. Experimental results

In figures 1…8 we present the diffraction diagrams obtained.

On the diffraction diagrams we identify the peaks of high intensity specific to phases and diffraction planes:

- austenite: (111); (200); (220); (311);
- martensite: (110); (200); (211);

- nitrides: Fe_3N

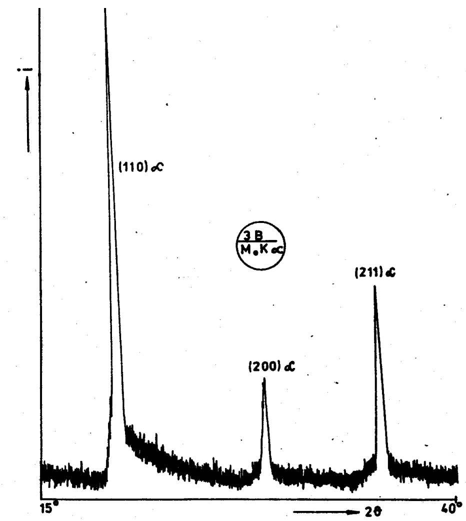

Fig. 1. Diffraction diagram of steel 40Cr10 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 3B

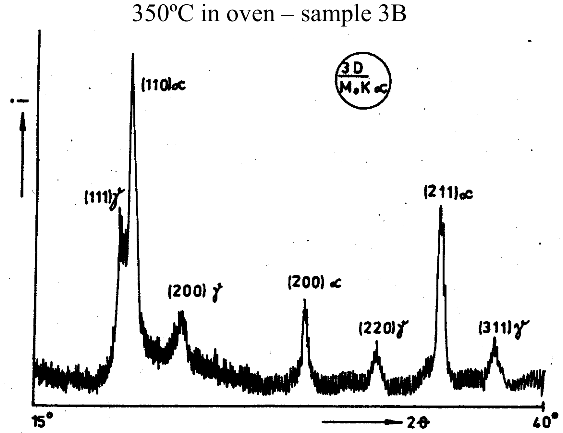

Fig. 2. Diffraction diagram of steel 40Cr10 nitrated and tempered in electrolytic plasma – sample 3D

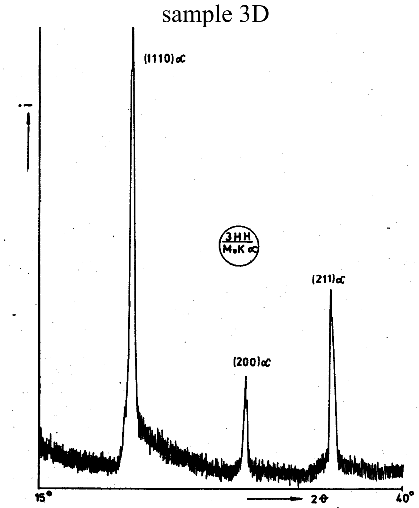

Fig. 3. Diffraction diagram of steel 40Cr10 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 3HH

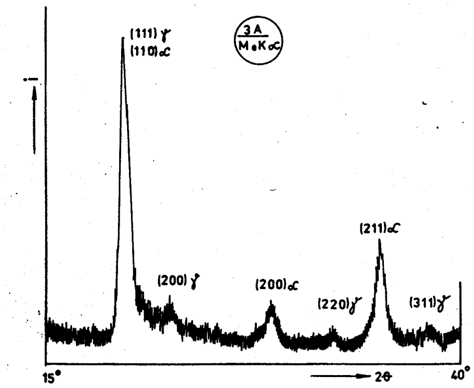

Fig. 4. Diffraction diagram of steel 40Cr10 nitrated and tempered in electrolytic plasma –sample 3A

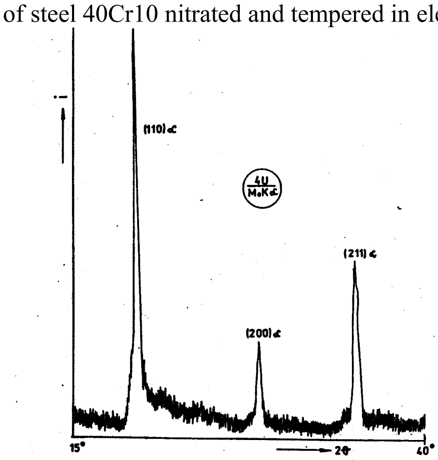

Fig. 5. Diffraction diagram of steel OLC 55 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 4V

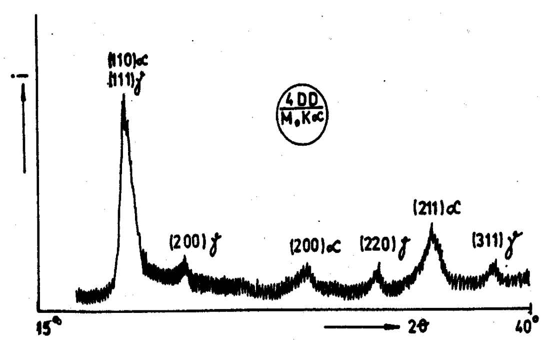

Fig. 6. Diffraction diagram of steel OLC 55 nitrated and tempered in electrolytic plasma –*sample 4DD*

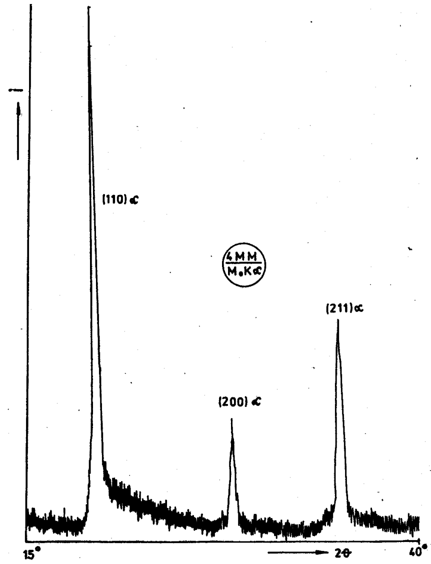

Fig. 7. Diffraction diagram of steel OLC 55 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 4MM

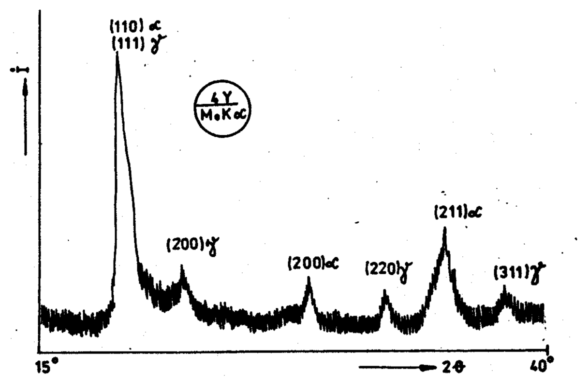

Fig. 8. Diffraction diagram of steel OLC 55 nitrated and tempered in electrolytic plasma – sample 4Y

Table 2

Plane spacing and phase nature presented in the structure of steel 40Cr10 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 3B

d_{hkl}	Phase	(h k l)
2,053	α	110
1,4378	α	200
1,1646	α	211

Table 3

Plane spacing and phase nature presented in the structure of steel 40Cr10 nitrated and tempered in electrolytic plasma – sample 3D

d_{hkl}	Phase	(h k l)
2,076	γ	111
2,024	α	110
1,8161	γ	200
1,4364	α	200
1,2857	γ	220
1,1763	α	211
1,0929	γ	311

Table 4

Plane spacing and phase nature presented in the structure of steel 40Cr10 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 3HH

d_{hkl}	Phase	(h k l)
2,024	α	110
1,4328	α	200
1,1692	α	211

Table 5

Plane spacing and phase nature presented in the structure of steel 40Cr10 nitrated and tempered in electrolytic plasma – sample 3A

d_{hkl}	Phase	(h k l)
2,076	α+γ	110□+111□
2,024	α	110
1,8161	γ	200
1,4364	α	200
1,2857	γ	220
1,1763	α	211
1,0929	γ	311

Table 6

Plane spacing and phase nature presented in the structure of steel OLC 55 nitrated and tempered in electrolytic plasma and subsequently blued at 350ºC in oven – sample 4V

d_{hkl}	Phase	(h k l)
2,0510	α	110
1,4369	α	200
1,1716	α	211

Table 7

Plane spacing and phase nature presented in the structure of steel OLC 55 nitrated and tempered in electrolytic plasma – sample 4DD

d_{hkl}	Phase	(h k l)
2,0680	α+γ	110□+111□
1,8161	α	200
1,4364	α	200
1,2800	γ	220
1,1777	α	211
1,0908	γ	311

Table 8

Plane spacing and phase nature presented in the structure of steel OLC 55 nitrated and tempered in electrolytic plasma and subsequently blued at 350°C in oven – sample 4MM

d_{hkl}	Phase	(h k l)
2,0580	α	110
1,4443	α	200
1,1739	α	211

Table 9

Plane spacing and phase nature presented in the structure of steel OLC 55 nitrated and tempered in electrolytic plasma – sample 4Y

d_{hkl}	Phase	(h k l)
2,0686	$\alpha+\gamma$	$110_{\alpha}+111_{\gamma}$
1,8278	α	200
1,4400	α	200
1,2800	γ	220
1,1787	α	211
1,0904	γ	311

As for the concentration of the phases present in the structure of the samples investigated, we determined the values presented below table 10.

Table 10

Technological parameters for thermal and thermal-chemical treatment in electrolytic plasma

Sample	v_{α}, [%]	v_{γ}, [%]	v_N, [%]
3B	100	-	-
3D	78,30	21,70	-
3HH	100	-	-
3A	65,80	8,30	25,90
4V	100	-	-
4DD	70,30	12,40	17,40
4MM	100	-	-
4Y	64,70	14,10	21,20

4. Conclusions

1. The Roentgen structural investigations effectuated pointed out the nature of phases present in the structure of the two steels processed thermally n electrolytic plasma: nitrogen-based martensite (nitromartensite); residual austenite and chemical compounds (nitrites).
2. The structural phases identified correspond to the thermal-chemical treatment applied, their concentration being dependent on the two main technological parameters: temperature and diffusion time.
3. Thus, in the improving steels 40Cr10 and OLC 55 nitrated, we notice a reduction of the nitride quantity once with the increase of the diffusion temperature.
4. The application of bluing in oven after nitration and tempering in electrolytic plasma has as effect the complete transformation of the residual austenite in cubic martensite.

REFERENCES

1. Baciu, Maria, Contributions on the structural and property changes of thermally and thermochemically treated steels in electrolytic plasma (in Romanian), PhD thesis, „Gh.Asachi” Technical University from Iaşi, 1999.

2. Belkin, P.N, Ignat'kov, D.A., Pasinkovskÿ, E.A., Azotirovanie v elektrolitnoj plazma, Kolloquium Eigen-sspannungen und Oberflächen-verfestigung, p.265, 1982.

3. Belkin, P.N., Pasinkvoskÿ, E.A. Termičeskaâ i himiko - termičeskaâ obrabotka stalej pri nagreve v rastvorah elektrolitov, Metallovedenie i termičeskaâ obrabotka metallov, nr.5, pag.12-17, 1989.

4. Duradži, V.N., Parsadanian, A.S., Nagrev, metallov v elektrolitnoi plazme (lb. rusă), Ed. Stiinca, Kišinev, 1988.

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