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STUDIES AND RESEARCHES REGARDING THE QUALITY OF THE SURFACES OF THE PIECES PROTECTED DURING IONIC NITRIDING

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ABSTRACT

The technology regarding the application of thermo-chemical treatment of ionic nitriding is continuously being improved. At the same time, a vast researching programme took place referring to the local protection through special isolating coats of the metallic surfaces against plasma nitriding. That's why is necessary to make an analysis of the influence of the pellicle of the dyes elaborated for the local protection against the quality of metal pieces on which these were applied in order to isolate them during the process of ionic nitriding.

1. INTRODUCTION

As a result of the physic-chemical phenomenons which proceed during the ionic nitriding process, the pieces suffer not only dimensional but also qualitative modifications (regarding roughness).
The modifications in quality of metallic surfaces during plasma nitriding result from the cathode spraying or from the possible transition of glow discharges in electric arcs which take place during this process. These modifications also depend on the material, shape and dimensions of the piece, [1].
It is very important to be acquainted with the influence of the technological parameters (temperature, pressure, time, discharging voltage) and of the electrical ones (current densities, coefficients of secondary electronic emission current drops, intensities of the discharging currents, absorbed powers and energies) of ionic nitriding on the variations of the values of the roughness which appear on the surfaces of the pieces used in the process. These aspects need to be known for a proper bordering of the dimensions of the pieces among the tolerance fields prescribed for the good working of the metallic products among the various subunits they belong to.
The special documentation from Romania and from abroad offer limited and general information on account of the problems concerning the modifications in quality of metallic surfaces during ionic nitriding. This poor information is a result of the limited interest manifested in this field of chemical treatments and even absent when we refer to the influence of the pellicles of special dyes on metallic surfaces protected during the process of plasma nitriding.
The following lines present the running of the experiments and also the results concerning the way the V-1 and V-2 special dyes elaborated for the protection against ionic nitriding influence or not the cause of possible modifications on the surfaces on which they are applied.

The dyes used in the process are made of copper lamina powder dispersed in carbon tetrachloride or in polystyrene lacquer (the polystyrene was dissolved in carbon tetrachloride), mixed with magnesium oxide. [2, 3, 4]

2. EXPERIMENTAL ATTEMPTS AND RESULTS

Using an INI-30 installation, the experimental researches required the running of eight cycles of ionic nitriding: EXP1 … EXP.8, at two different temperature scales (500°C and 550°C) and four temporal regimes (5h, 10h, 15h and 20h), under a pressure of 2,5 torr, and the work atmosphere 25%N2 / 75%H2. The samples prepared for the experiments were elaborated from steel: 39MoAlCr15, in the shape of Φ60x10mm disks. All the pieces had a threaded punctured hole (M6) in the center, with a view to being assembled into the single fixing post charging device using a threaded rod (M6). At the beginning, the samples were improved at 28…30 HRC, and after mechanic working, all their surfaces have been ground. At the end, the pieces were ungreased, half of them having been protected with a 0,45 mm film of V-1 and V-2 dyes. The film was made through double brushing with intermediary drying period (cca.10min.)
Figure 1 renders the ionic nitriding plant INI-30 (fig.1a) and the mounting the devices and the apparatus used during the experiments (fig.1b).

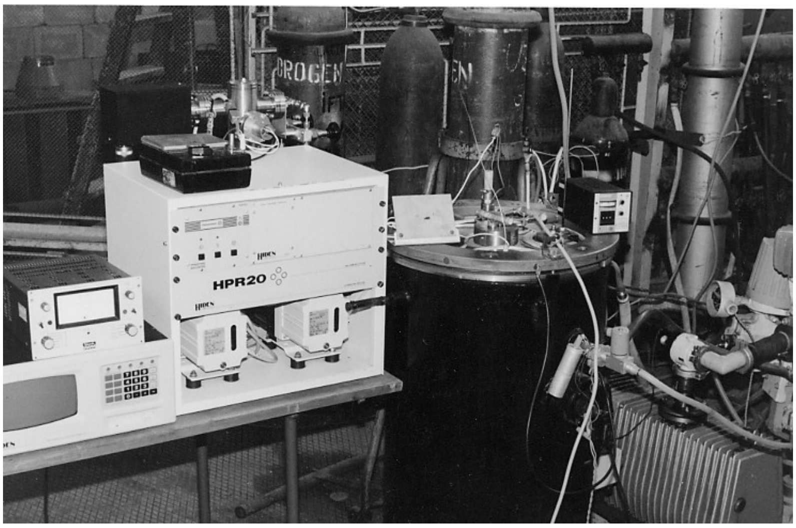


FIGURE 1a. THE IONIC NITRIDING PLANT INI-30.

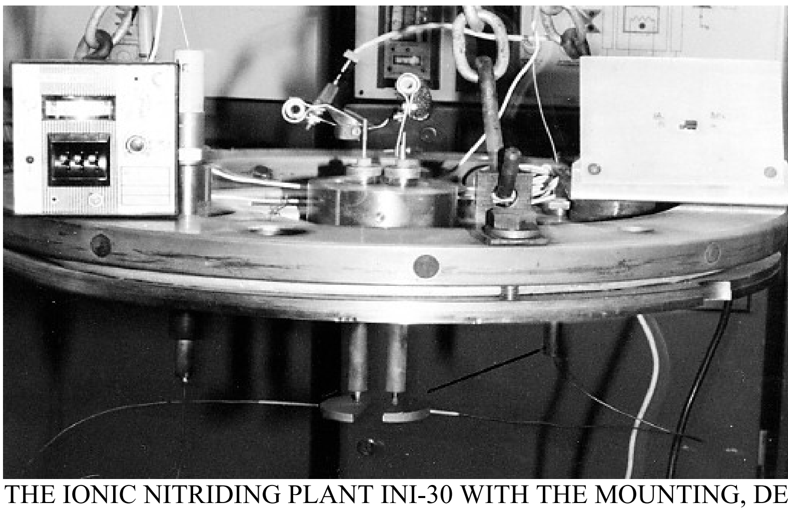
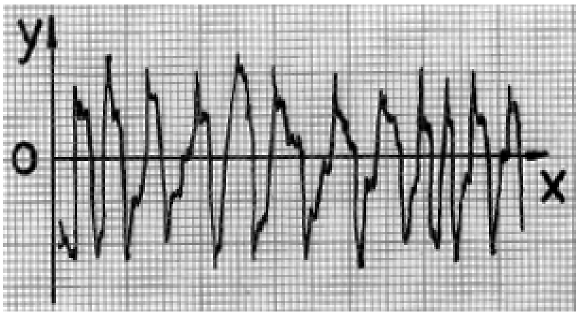
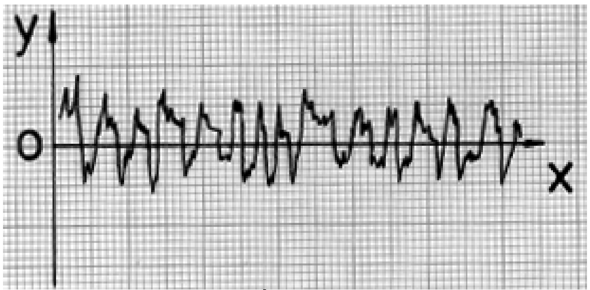


FIGURE 1b. THE IONIC NITRIDING PLANT INI-30 WITH THE MOUNTING, DEVICES AND APPARATUS USED AS PARTS OF THE EXPERIMENTS.

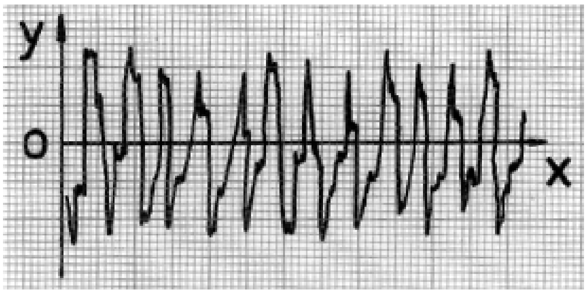
The roughness resulted from the grinding of the pieces (no matter what the quality of the steel was), were determined through the method of tangibility using the instrument for measuring the microgeometry of the surfaces Kalibibri VEI-201, associated with a profilograph.
The measurements for roughness were made before and after the process in plasma, and there were recorded both Ra values-arithmetic mean deviation of the profile directly on the profilometer and Ry values-the maximum height of the profile on the diaphragms of the profiles recorded by the poligraph (in accordance with SR ISO 4287-1:1993, STAS 5730/4-1987).
It should be mentioned that at the end of the process the pellicles of paint were completely and carefully removed through energetic drying and ungreasing.
Table 1 shows the results which represent the arithmetic mean of four successive measurements and figure 2 presents the most representative profilograms of two of the unprotected and protected surfaces during the process of ionic nitriding.



a.



b.



c.

FIGURE 2 a,b,c. THE MOST REPRESENTATIVE PROFILOGRAMS.

There are some general aspects that should be mentioned regarding these measurements:

- The roughness (after protection and ionic nitriding) kept their values of Ra_p and Ry_p very closed to Ra_m and Ry_m (before plasma nitriding).
- The extremely law increments of the roughness of protected samples in comparison with the unprotected ones result from the possible traces of submicroscopic copper booklets which accidentally remained on the metallic surfaces we're talking about. So, the roughness values Rap and Ry pwere not influenced by the applied thermo-temporal regimes.

- After ionic nitriding, the values of roughness Ram and Rym improved with 17…21% for Ram and with maximum 28% for Ry m compared with their values measured before the process. The positive effect manifested at the same time with the increase of temperature and duration of plasma nitriding and the explanation for the decrease of the roughness was the grinding of the irregularities of surfaces due to cathode pulverization, to ionic bombardment and to possible adherence of very small particles of material that got into the roughness' cavities.

TABLE 1. THE VALUES OF THE MEASUREMENTS OF ROUGHNESS FOR UNPROTECTED AND PROTECTED SAMPLES, (EXP1…EXP8) BEFORE AND AFTER IONIC NITRIDING

Ionic nitriding regime		Unprotected samples					Protected samples		
		Number of sample	Ra_m, [μm]		Ry_m, [μm]		Number of sample	Ra_p, [μm] after ionic nitriding	Ry_p, [μm] after ionic nitriding
T, [°C]	t, [h]		before	after	before	after			
			ionic nitriding		ionic nitriding				
500	5	P39 / 42 m1	1,85	0,33	0,32	1,86	P39 / 42 p1	0,26	1,98
	10	P39 / 42 m2		0,34		1,86	P39 / 42 p2	0,23	1,86
	15	P39 / 42 m3		0,36		1,89	P39 / 42 p3	0,28	1,73
	25	P39 / 42 m4		0,33		1,88	P39 / 42 p4	0,26	1,54
550	5	P39 / 42 m5	1,63	0,31	0,29	1,66	P39 / 42 p5	0,24	0,74
	10	P39 / 42 m6		0,30		1,65	P39 / 42 p6	0,25	0,59
	15	P39 / 42 m7		0,33		1,68	P39 / 42 p7	0,27	0,52
	25	P39 / 42 m8		0,32		1,64	P39 / 42 p8	0,21	0,48

3. CONCLUSIONS

During the process of plasma nitriding, local protection of the surfaces of pieces made of 39MoAlCr15 steel, realized through films of V-1 and V-2 dye, proved (on terms imposed by the experiments that proceeded) that they eliminate the possibilities of modification in quality of the surfaces on which tese are applied. The films of dye preserve very well the values of the roughness whom they protect against ionic nitriding.

Due to the fact that research on physical models is characterised by certain significant drawbacks, such as a long research period, a significant amount of intellectual work and the impossibility of including the economical factors, the present-day trend in the management of the technological processes is characterised by a the usage on a wider scale of the mathematical models.

These reproduce the researched process by means of certain operational relations and provide optimal real-time actuation conditions, reducing the costs in comparison to the usage of physical models.

Experiment has always been a means of acquiring knowledge about the surrounding environment, being the criteria for verifying hypotheses and theories. The choice of the experiment strategy and its completion have long been considered dependent on the experimenter's experience and intuition, mathematics being used only to process the data.

Suggestive graphical representations of the factorial experimental programme of the Ra objective function are presented in figure 3,4,5 and 6. [5]

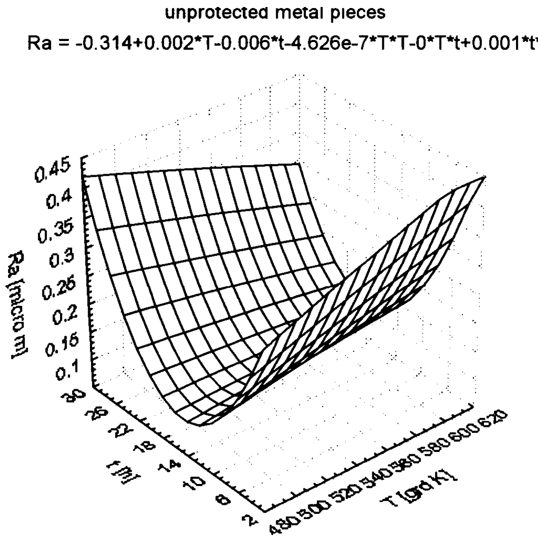


FIGURE 3. THE EVOLUTION OF THE MINIMUM R_a PARAMETER FOR UNPROTECTED METAL PIECES.

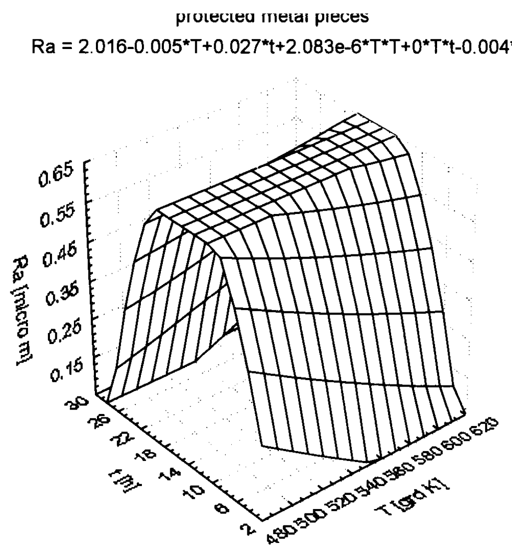


FIGURE 4. THE EVOLUTION OF THE MAXIMUM R_a PARAMETER FOR PROTECTED METAL PIECES.

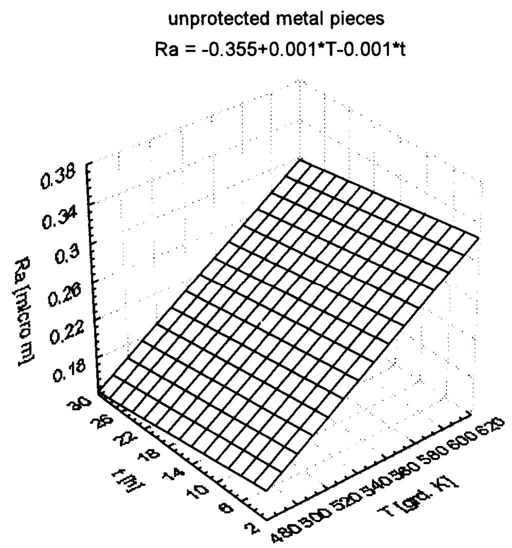


FIGURE 5. THE EVOLUTION OF THE MINIMUM AND MAXIMUM R_a PARAMETER FOR UNPROTECTED METAL PIECES.

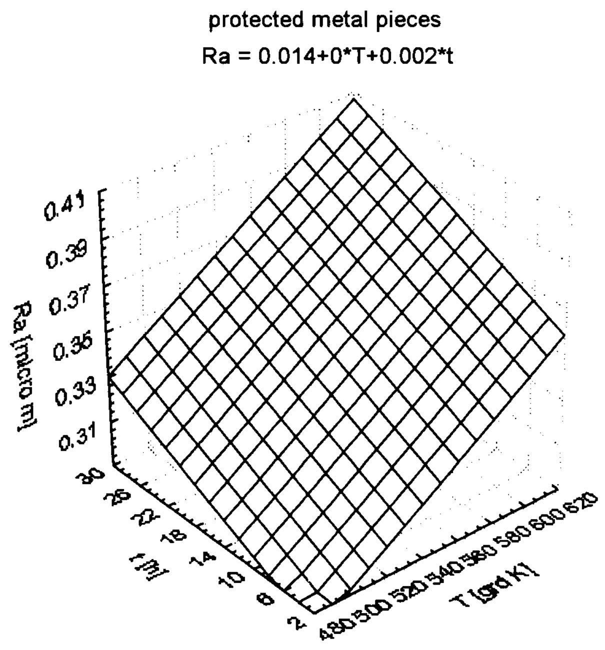


FIGURE 6. THE EVOLUTION OF THE MINIMUM AND MAXIMUM R_a PARAMETER FOR PROTECTED METAL PIECES.

The increasing volume of experimental research has brought into the spot light the issue of experiment's efficiency. The emergence of the electronic computers have made it possible to complete new experimentation schemes meant to slightly improve the research efficiency. [5] In fact the factorial experiment planning strategy ascertains that the experimental plans are optimal with respect to the proportion number of measurements/precision of the estimations on the values of the objective function, performed by means of the explicated factorial model. [5]

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