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EVALUATION OF IONIC NITRIDING IN TRAVELLERS OF THE TEXTILE INDUSTRY

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ABSTRACT

The textile industry uses modern machines that transport the threads at high speeds. This fact causes accelerated wear in the metallic components, committing the quality of the final product. These metallic components are known as "travellers". In this work the travellers were treated in a plasma reactor at 400 ºC, 450 ºC and 500 ºC for 2h. The pressures used were 1 and 2 mbar and the composition of the gaseous mixture was 20% N_2 and 80% H_2. The nitreded travellers were characterized by optical microscopy, microhardness and later its performing was accompanied in the textile industry. The travellers treated at 400 ºC, 2 mbar and 2 h presented larger uniformity of the nitreded layer and the threads transported for these components showed excellent characteristics.

1. INTRODUCTION

Currently, the textile industry has developed several processes to obtain threads with high quality and consequently the increase of its production. These processes vary in function of the raw material used and the final application of the thread.
The industrial production has been increased with the creating of faster machines. However, all the investments don't guarantee the quality of the thread.
The wiring system is called "ring spinning" and this machine has a metallic component called "traveller" [1]. This component reaches high velocities and for this reason suffers accelerated wear. The increase of the speed in the "spinning" accelerates the wear an the travellers, reduces its useful life and also increases the costs with maintenance. Thus, new researches have been developed looking for a construction or modification of these travellers, increasing the wear strength.
The wear occurs in the travellers due the sliding of the metal-metal and metal-fibers surfaces, which move to high speeds, at high tensile, during a long time and with little contact area [2-3].
Some solutions were proposed seeking the increase in the useful life of the travellers, for example, the processes of treatment of the surfaces, which has been getting good results in the industry. The ionic nitriding is a thermochemical process versatile, since it possess several processes parameters (voltage, current, temperature, pressure, atmosphere and time) that can be varied, allowing to modify the surface properties of the material, as hardness, wear strength, corrosion strength and thermal strength [4]. These properties are obtained at low temperatures of treatment, avoiding possible distortions in the piece, phase transformations and growing of grains in the material.

2. MATERIALS AND METHODS

The travellers were nitreded in a conventional way, seeking to determinate the better conditions to obtain the required properties. It was used five samples (travellers) that were treated at different temperatures (400, 450 and 500 °C). Figure 1 shows a diagram of the process. The following conditions were used: time - 2 h; pressures - 1 and 2 mbar; composition of the gaseous mixture - 20% N_2 and 80% H_2; voltage - 500 – 690 V and current - 0,16 – 0,21 mA. Another configuration was also used and this technique is called "cathodic cage". The treatments with the second configuration were accomplished at the same temperature and time, however, using pressure about 2,8 mbar and gaseous composition of 80% N_2 and 20% H_2. Voltage, current, pressure and cathode temperature are measured and controlled in the panel.
Before to initiates the process of plasma nitriding, the samples were cleaned during 10 min in an ultrasonic cleaning equipment, using acetone as a cleaning agent to separate the fat due to the handling.

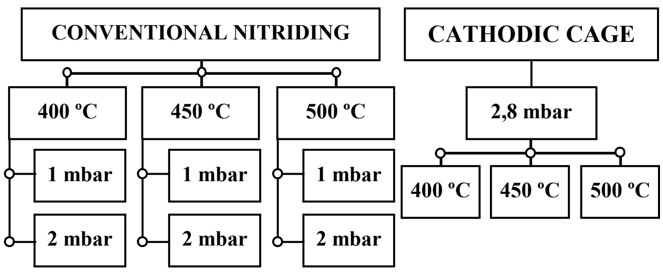

Figure 1 – Diagram of process in the travellers nitriding.

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The position of the travellers in the sample holder was determined starting from several nitridings, seeking the appropriate position with the better area of the plasma's performance. After these tests, it was observed that samples should be put lying in the sample holder, according to the Figure 2.

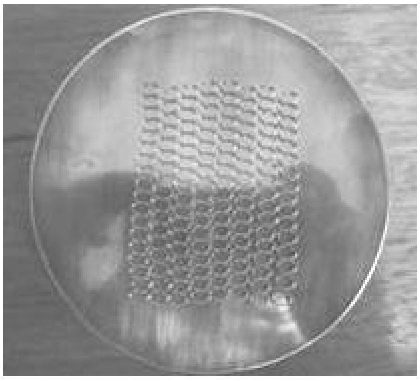


Figure 2 – Organization of the travellers in the sample holder.

A schematic of the plasma reactor is shown in Figure 3. It consists of a stainless steel cylinder closed in the extremities by two stainless steel flanges and two electrodes. The cathode, in the bottom functions as the sample holder. The sample is placed in the sample holder. The reactor is closed and pumped until the pressure reaches 2,8 mbar. The electrodes are polarized and the gaseous mixture is introduced in the reactor chamber. The mixture is ionized and the temperature is raised up to the treatment temperature (400, 450 and 500 °C). After 2h, the power is turned off. After cooling, the samples are retreated the chamber.

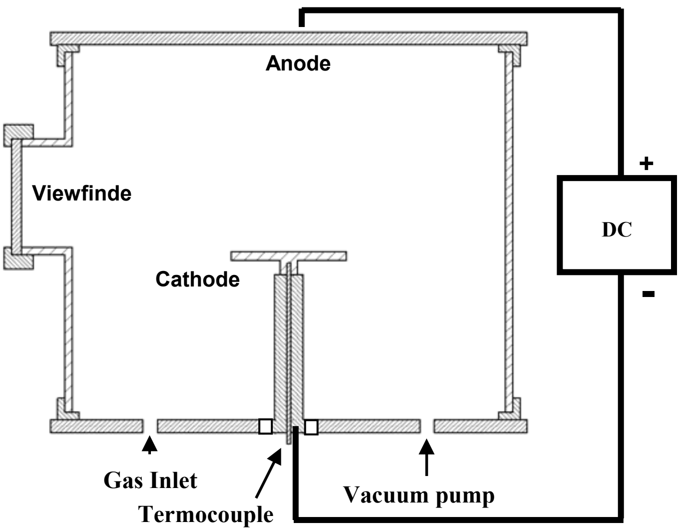
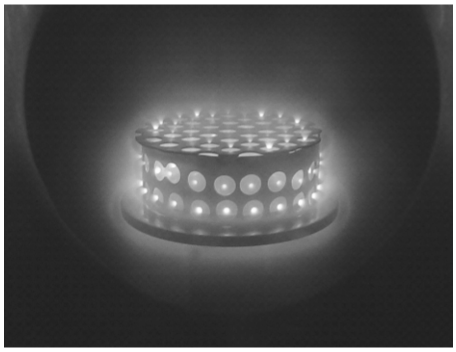


Figure 3 - Schematic of the plasma reactor.

In the configuration known as "cathodic cage", developed of Labplasma/UFRN [5-6], the travellers are involved in a metallic cage, which operates as a cathode. The travellers were placed on the insulating disk of alumina, staying, therefore, in flotation potential. Thus, the energy that heats up the samples is from the cage by radiation. Figure 4 (a) and (b) shows the travellers being treated by both nitriding methods used.

(a)



(b)

Figure 4 - (a) Traveller treated by the conventional nitriding process and (b) treated by the cathodic cage

After both treatments, the samples were characterized by optical microscopy (*OLYMPUS BX 60M*), microhardness (*PANAMBRA - PANTEC HVS 1000*) and XRD (in a Shimadzu Diffractometer, using Cu K-α radiation, with 2θ varying between 10 and 80º and scattering velocity of 2°.min-1).

3. RESULTS AND DISCUSSION

Figure 5 shows that both the techniques of plasma nitriding produced uniform layers, mainly in the external part of the traveller. The developing of the nitreded layer is determined, basically by the temperature, time and potential of the nitriding. The appropriate layer to sliding systems should have good uniformity in the thickness, absence of flaws and detachment.

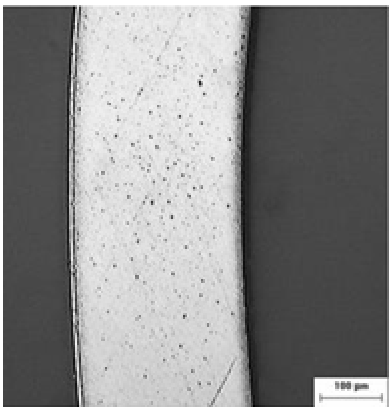
Usually, uniform layers are formed in the ionic nitriding, but the formation of these layers depends of the treatment parameters. In this case, varying the temperature, layers with different characteristics are obtained. The travellers showed in Figure 5 (a) and (b) present uniform plenty layers.

The Table 1 shows the medium values of the layer thickness of the travellers and the deviation pattern. It was observed that the rate of growth of the layers was larger in sample (a), in the conventional technique, followed by the sample (b), in cathodic cage, both in the same conditions of temperature and pressure.

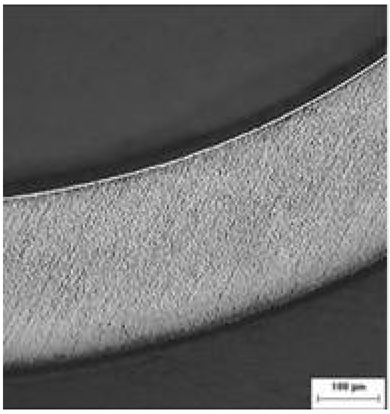
Table 1 - Thickness and deviation pattern of nitreded layers

Sample (a)	Sample (b)	Sample (c)	Sample (d)	Sample (e)
5.18μ ± 0.57	6.27μ ± 0.67	4.86μ ± 0.45	4.65μ ± 0.43	5.9μ ± 0.54

O.B.S.: The medium value of five samples was used.



(a)



(b)

Figure 5 – Micrographics of the nitreded layers. Sample nitreded by the conventional technique: (a) at 400 ºC, 20% H_2 and 80% N_2; and nitreded by cathodic cage: (b) at 400 ºC, 20% N_2 and 80% H_2.

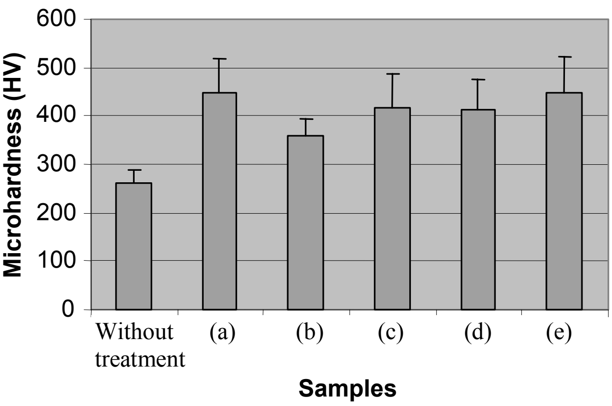


Figure 6 – Superficial hardness of the travellers and deviation pattern.

Figure 6 shows an increase in the hardness of the layers in function of the temperature. Both the techniques of plasma nitriding used (conventional nitriding and cathodic cage) showed that the nitreded layer didn't vary significantly, although the thickness and morphology of this layer are affected by the temperature. In this work it was looked for to find a condition where was possible to obtain a larger hardness added to a low variation of roughness of the travellers.

XRD patterns are showed in Figures 7 (a), (b) and (c). It can be noted that the travellers without treatment presented peaks relatives to Fe and Fe associated to Ni, besides Cr. The XRD patterns are analogous in both the techniques, presenting in both of cases peaks relatives to ε - Fe_3N, however, in the cathodic cage configuration were observed peaks relatives to γ' - Fe_4N.

After the nitriding the samples were guided for the industry (COTEMINAS S.A. - Companhia de Tecidos Norte de Minas), located in the state of RNorte/Brazil, to evaluate its performing. These travellers were placed in the “spinning” and its performing was accompanied during 23 days.

The threads transported for the travellers nitreded in plasma presented good characteristics compared to that transported for travellers without treatment. The pilosity (H) and the rupture of the threads were smaller due the smaller superficial wear, once a larger wear means increase in the pilosity of the threads (Figure 8).

Figure 8 (a) shows that the values of pilosity were smaller in threads transported for nitreded travellers until almost the 20th day of accompaniment. This fact indicates that the useful life of the travellers can be increased by the plasma nitriding process.

Figure 8 (b) shows the measures of rupture strength, where can be observed that, in spite of the travellers nitreded have presented less rupture strength than that without treatment, the first one presented larger uniformity of the measures. Thereby, they can be considered better than the travellers without treatment. The nitreded travellers presented smaller oscillation in the values compared with those without treatment.

4. CONCLUSIONS

The travellers treated in following conditions (at 400 °C, during 2 h) showed excellent results such as superficial hardness of approximately 450 HV in the nitreded layer and 250 HV in the sample core. The obtained nitreded layer was uniform and without flows. The nitriding process of travellers is viable, and the threads transported for these components presented good characteristics as compared with the travellers without treatment. These results motivate the studies related with the useful life of components of the industry submitted to thermal treatments.

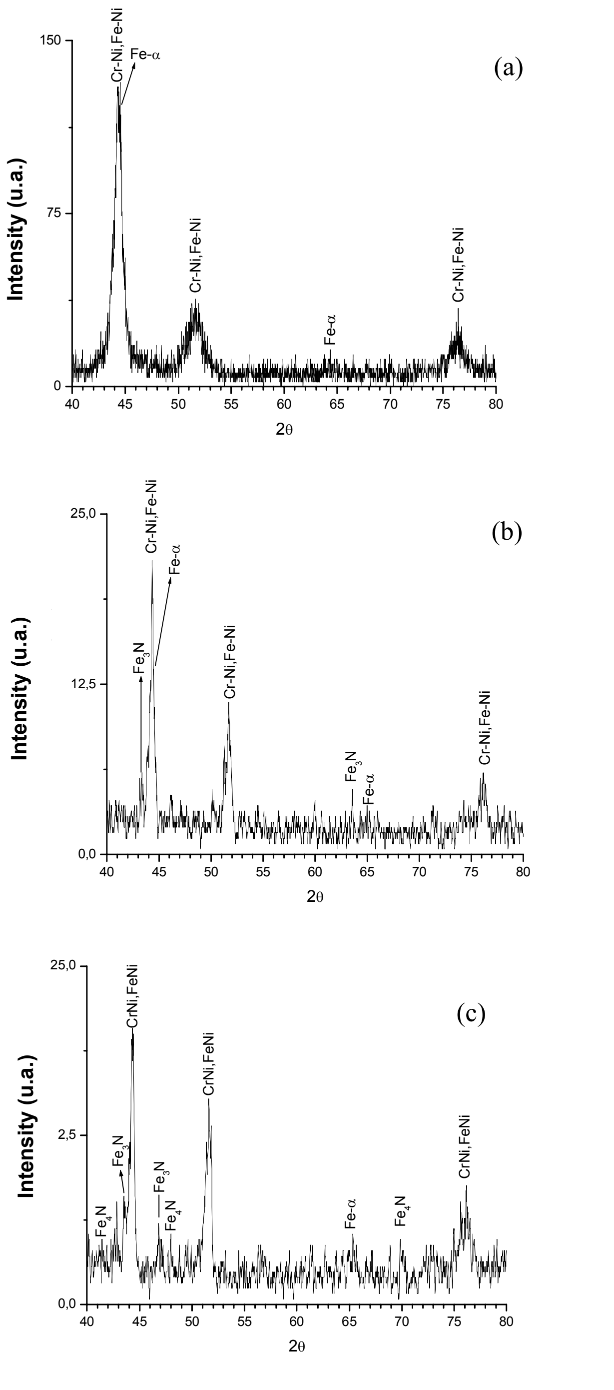


Figure 7 – XRD patterns of the samples: Without treatment (a), by conventional nitriding at 450 ºC (b) and by cathodic cage (c).

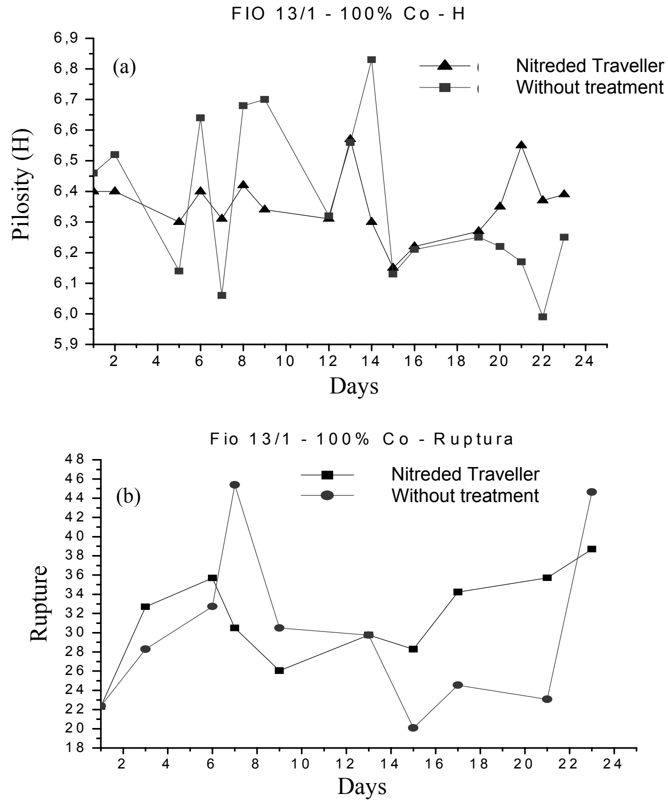


Figure 8 – Accompaniment of the threads 13/1 - 100% CO (FIL. ZINSER-351 - MAQ. 36) using traveller C2 hd T Super Speed (R+F) Nº 3. (a) Pilosity and (b) rupture of the thread.

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