# UNIFORMITY IMPROVEMENT OF PIII TREATMENT IN BATCH PROCESSING MODE APLIED TO AISI 304 USING A HOT FILAMENT BELT

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## 1. Introduction

Nowadays, several studies are being conducted to obtain surface modifications in stainless steel using PIII technique [1]. However, for applications requiring high qualification and reproducibility of the final product, this process is encountering difficulties. In industrial line of production, it is common to use a batch process mode to solve the problem of reproducibility and treatment of large quantities of work-pieces. In this work, a study of effectiveness of using PIII in batch processing mode was carried out.

## 2. Experimental

The treatment pressure in this case was set around 2 Pa and PIII duration was 120 min. Pulses of 7.5 kV/40 μs were applied at 1 kHz repetition rate. The samples were subjected to a surface cleaning process (removal of oxides or impurities) before treatment by a bombardment of argon ions. Several sample holders (rectangular cross section towers) with various stainless steel AISI304 samples were distributed inside a vacuum chamber of 600 liters. The vacuum system consists of a stainless steel chamber with 600 liter, a mechanical pump E2M80 (1 atm to 1 Pa), EH250 roots pump (10 to 1 Pa), and a diffusion pump (1 Pa to $10^{-4}$ Pa). Nitrogen PIII was applied to samples by using glow discharge plasma from plasma source operated at 250 mA and 300 V. The sample holders (x 5) were positioned in cross shaped geometry, with spacing greater than 20 cm between each one of them, as shown in Fig. 1. The temperatures of the sample holders were monitored by an optical pyrometer with lowest limit of measurement set at 250 ° C. Highest temperature achieved was approximately 330 °C.

## 3. Results and Discussions

Tests were done successfully in batch treatment mode, obtaining a good distribution of temperature during the PIII process. From x-ray diffraction analysis of the samples, it was seen that there was good uniformity of implantation. In previous experiments, it was seen that the samples in the towers located closer to the filament electron source reached higher temperature than others. It is believed that the supply of electrons in the region around the hot filament generates a region of higher density of the plasma, according to the theory of load balancing, which may have contributed to a more efficient ion implantation. For this reason, a belt of hot filament surrounding the sample holders was used which allowed to treat multiple components simultaneously (batch mode) with better uniformity, shown on Fig. 2. Then, it was possible to reach temperatures above 300 ° C in most of the towers which resulted in treated layers with good thickness due to thermal diffusion [2].

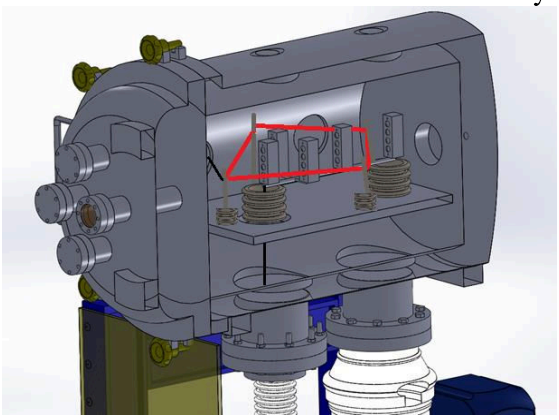

**Fig. 1.** *The hot filament (red line) was fixed surround of the samples supports.*

**Fig. 2.** *Real view inside the vacuum chamber during PIII treatment.*

## 4. References

[1]- Ueda et al.; *"Surface improvements of industrial components treated by plasma immersion ion implantation (PIII): results and prospects"*, Surface and Coatings Tech., v. 156, 71-76 (2002).

[2]- Staines, A.M.; Bell, T.; *"Technological importance of plasma-induced nitrided and carburized layers on steel"*, Thin Solid Films, 86, 201-212 (1981).

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