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THERMAL GRADIENT IN SOLIDS IMMERSED IN PLASMA

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Abstract – The thermal profile determination in samples immersed in plasma has been determined indirectly through the hardness values converted in temperature accord to the calibration graphic (Fig .1a). Observing the micrographs of the figure 2(a,b) one realizes which there is a Zone Affected by Bombardment (ZAB) in the samples treated by plasma. So the thermal profile of the samples are represented in the temperature x depth graphic (Fig. 2c,d).

Samples of steel AISI M35, with dimensions 9,5 mm in diameter and 3 mm in height were quenched at temperature of 1230 ^{o}C in resistive furnace. In order to obtain the calibration curve of hardness vs. tempering temperature, figure 1a, six samples quenched were tempered in resistive furnace for temperature between 500 and 750 ^{o}C. In order to study the plasma heating other quenched samples were treated in 500 °C in hollow cathode configuration, during 90 min for pressure of 4 and 10 mbar. The plasma equipment utilized in the tempering consists in a hermetically closed chamber where there are inside it two electrodes connected to a source supply DC, a gas injection and vacuum system (Fig. 1b). The microstructural characterization was accomplished in cross section of samples through electronic and optical microscopy. The microhardness measurements were obtained on the surface and in the depth of samples profile.

The surface exposed at plasma presents a layer which here it was denominated ZAB (Zone Affected by Bombardment) which is formed during the plasma treatment. Comparing to the regions exposed at plasma of the two samples, due to size and the number of precipited present, it is possible to see which the heating temperature of samples treated in hollow cathode configuration at pressure in 4 mbar has been larger than at pressure in 10 mbar. Since microstructure of that surface region has suffered modifications due to particles impact that originate thermal picks, they modify together the microstructure in that region capable to create a surface layer different from the other regions of sample [1,2], becoming necessary to utilize the equation 1 in that region. However, according to the microstructural characteristics presented in ZAB, the temperature reached in that region at 4 mbar has been extremely high exceeding 1000 °C, since is possible observe through SEM it has appeared a continuous film of carbides in the contour grain which only occurs at extremely high temperatures

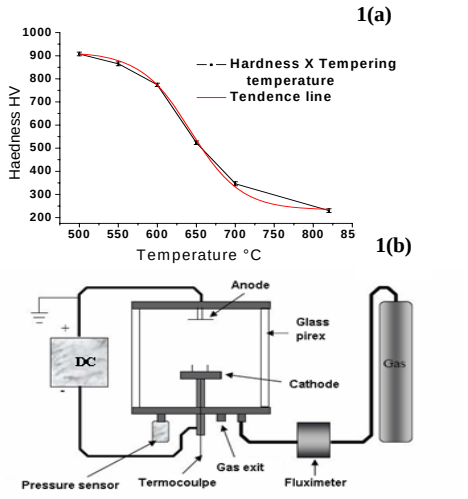

Figure 1: the calibration graphic **of** hardness values converted in temperature according to **b)** The plasma equipment utilized in the tempering process

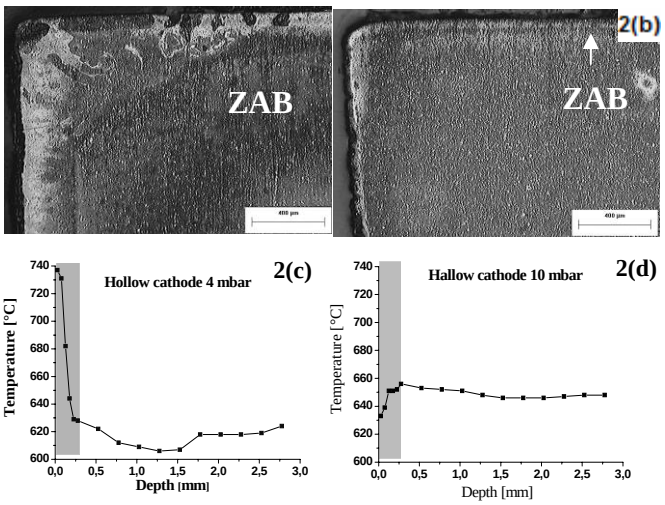

Figure 2: Zone Affected by Bombardment, **a)** sample at pressure of 4 mbar **b)** sample at pressure of 10 mbar; Graphic hardness values converted in temperature, **c)** sample at pressure of 4 mbar, **d)** sample at pressure of 10 mbar.

[1] C. Alves Jr, V. Hajek, C.A. dos Santos, Mat. Sci. Eng. A, 348 (2003) 84-89.

[2] N.K.A.M. Galv˜ao, B.L.S. Costa, M.W.D. Mendes, R.A. de Brito, C.F. Souza Jr., C. Alves Jr, Journal of Materials Processing, Technology, 200/1 (2008) 115 -119