SURFACE PROPERTIES OF PLASMA NITRIDED TEMPERED STEEL

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1. Introduction

Plasma nitriding, known also as ion nitriding is a kind of thermochemical surface treatment. Plasma nitriding provides an industrially important technique for modifying the surface layers of steels to improve their surface hardness and wear resistance. [1-3]. The process enriches the steel surface with nitrogen to enhance its mechanical and tribological properties. The nitrided layer resulting from this thermochemical process comprises two sublayers: an outer compound layer and an underlying diffusion zone (layer). The compound layer is often composed of ε-Fe₂₋₃N and γ′-Fe₄N nitrides [1, 2].

2. Experimental procedure

Laboratory plasma nitriding equipment was built by own plan in the Department (Fig 1). The chamber of the equipment is a glass bell, which is perfectly suited to observe the plasma.

Plasma nitriding treatments were performed in DC plasma (Table 1). After completing the process, samples were slowly cooled in the chamber to temperatures below 100°C to minimize surface oxidation.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>p (mbar)</td>
<td>3</td>
</tr>
<tr>
<td>T (°C)</td>
<td>490</td>
</tr>
<tr>
<td>t (hour)</td>
<td>4</td>
</tr>
<tr>
<td>gas [H₂-N₂] (%)</td>
<td>50-50</td>
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</tbody>
</table>

Tab.1. Parameters of plasma nitriding

The material used in this study was C45 type steel. The samples (Ø20×8 mm) were cut from a round steel which made by different type of plasma nitriding: DCPN (direct current plasma nitriding), ASPN (active screen plasma nitriding), ASPN+bias (active screen plasma nitriding with bias) [2]. The bias is a second voltage on the samples, which is 11% of the screen’s voltage.

After the nitriding, all surfaces of the samples were examined by using binocular stereomicroscope. The cross sections of each sample was polished in a clamping and chemically etched in 2% Nital.

3. Results and discussion

Edge effect shows different color from the center of the specimens which treated by DCPN process or using bias, in contrast, ASPN process (Fig. 2). At the ASPN process the glow discharge didn’t occur on the surface, samples was heated by the radiation from the screen which causes higher homogeneity of the temperature [5].

Comparison the compound layer of the samples revealed that the different type of nitriding cause different thickness layer (Table 2) on the surface (Fig. 3).
Fig. 2. Samples surfaces after plasma nitriding: 1. DCPN, 2. ASPN, 3. ASPN+bias

<table>
<thead>
<tr>
<th>Thickness (µm)</th>
<th>DCPN</th>
<th>ASPN</th>
<th>ASPN+bias</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>9.2</td>
<td>4</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Tabl. 2. Thickness of the nitrided layer

Fig. 3. Nitrided layer that etched in 2% Nital

As the hardness values (Fig. 4.) and the thickness values show, the ASPN process has lower quality, but the surface is more homogeneous compared to the other two.

4. Remarks

- The edge effect was observed on the surface of the different type of plasma nitriding samples.
- ASPN process has more homogenous surface, but the layer thickness and the hardness is lower than the other processes.

Acknowledgements

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References