# PLASMA NITRIDING IN THE PRODUCTION OF SPECIAL EQUIPMENT

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**Abstract**

Technology of plasma nitriding processing a large number of machine components. In these components increases the hardness of 1200 HV and nitriding layer thickness reaches 0.6 mm. Fatigue limit in the plasma nitrided round bars increased by 60 %. Plasma nitrided parts are also corrosion resistant. Particularly oxinitriding shift has been made of the first traces of corrosion in steel 12 050 and 15 230 from 3 hours to 320 hours.

In military technology is application of plasma nitriding for example. holes artillery barrel and crankshafts aircraft piston engines.

**Keywords:** Plasma nitriding, hardness, fatigue strength, corrosion resistance.

## 1 Introduction

The bulk of the service life of components both military and civilian equipment and instruments directly related to abrasion, the occurrence of fatigue cracks and corrosion effects. All such effects are applied mainly from the surface of parts and tools. For these reasons, it is extremely important to properly affect the mechanical and other properties of the surface area.

Plasma technology are suitable methods to influence the positive properties of the exposed area. The modern and convenient site for environmental technology is plasma nitriding. This method is in all plasma technologies processed the largest volume of parts and therefore constantly updated and improved [3].

Significant advances in technology happen plasma nitriding use pulsing discharges, when the intermittent discharge in microseconds and re-established. This prevents arc discharge, vacuum chamber space can be effectively used and insulators can be very simple and reliable [1].

Furthermore, it passed by only cooled vacuum chamber to chamber and cooling the heated part with the possibility of additional internal cooling. This adjustment allows even a reduction in energy intensity, consumption of cooling water, reduce the time and nitriding chamber may also serve as tempering furnace in a vacuum or in a protective atmosphere.

Modern equipment for plasma nitriding are designed as a closed waste-free unit, which meets the highest safety and environmental requirements, including reducing requirements for degreasing without the use of chlorinated hydrocarbons [7].

Plasma nitriding technology helps in increasing the mechanical parts:

a) surface hardness and thus wear resistance

b) fatigue strength at nitrided material

c) corrosion resistance

## 2 Increasing hardness by plasma nitriding

The low alloy steel is achieved by nitriding layer of lower hardness, up to 500 HV, but the depth may be up to 1 mm. Medium and especially high-nitriding steel diffusion layers have a hardness of 1000 HV, but their depth does not exceed 0,5 mm.

Summary of hardness achieved after the plasma nitriding produced by STN are given in Table. 1. Always sufficient only high surface hardness, but it is also important priebech micro towards the core. Using short-term nitriding achieves a high surface hardness, but it smeom decline in the core material is too steep. For prolonged nitriding hardness it is indeed lower, but the transition to the micro kernel is more favorable [5]. Among the most proportious and also the most complicated parts prepared plasma nitriding they are mainly artillery caliber 100

and 152 mm. Do these artillery barrels were inserted hollow auxiliary anode being passed nitriding gas. Only in this way it is able to ensure a regular nitriding layer of the creation in its bore.

***Table 1*** *Overview hardness at the steel used in the production of special equipment*

| **Steel** | **Surface hardness** | | |
|---|---|---|---|
| | **HV 5** | **HV 10** | **HV 20** |
| **12 050** | 300 – 360 | 280 – 340 | 270 – 320 |
| **13 123** | 600 – 670 | 570 – 650 | 530 – 630 |
| **14 331** | 650 – 750 | 630 – 720 | 620 – 900 |
| **15 230** | 850 – 1000 | 830 – 900 | 800 – 900 |
| **16 420** | 600 – 700 | 580 – 660 | 580 – 650 |
| **17 023** | 900 - 1100 | 850 - 1050 | 830 - 1000 |

## 3 Increase fatigue strength

Fatigue fractures often occur in dynamically loaded components. These quarries are based on the place where the greatest amount of concentrated stressed components, it is most common on the surface. These quarries are based on the place where the greatest amount of concentrated stressed components, it is most common on the surface [6]. Nitrided layer as a means to increase the fatigue strength is recommended for the first part stressed alternately bending as torsion.

***Table 2*** *Verification of the fatigue strength for steels with various surface finishes*

| **Type of modification** | **Fatigue strength [MPa] for steel** | | |
|---|---|---|---|
| | **15 230** | **15 330** | **16 420** |
| **Without modification** | 460 | 520 | 450 |
| **Plasma nitriding** | 600 | 820 | 630 |
| **Gas nitriding** | 540 | 760 | 600 |
| **Cementation** | 580 | 550 | - |

The results of endurance tests on the test steels transferred 15 230, 15 330, 16 420 were made on the University of Defense and are shown in Table 2.

The manufacture of crankshafts 4 and 6 cylinder piston aircraft engines in the aviation repair sheds Trenčín used steel 15 330. In this case-hardened steel was found fatigue strength 520 MPa after nitriding in the gas was increased to 760 MPa and a plasma nitriding shift occurred up to 820 MPa, an increase of 70%.

Increasing the fatigue properties is attributed to the high yield strength nitrided layer plasma, and especially favorable effect of the internal pressure tensions in nitriding layer [8].

## 4 Effect on corrosion resistance

Nitriding the corrosion is performed over a wide temperature range, the deciding factor is the type of steel. The time required by nitriding a few minutes to 1-2 hours.

The formed layer has good resistance to corrosion and pressure seawater, humid atmosphere, heated steam, and weak alkalis. In a humid environment it had happened a few years and below the water layer up to several months [2].

For these reasons, the tests were carried Condensation chamber potentiostatic measurement in most steels used in special technology, for example. 11523, 12060, 13242, 14331, 15220, 16532, 17023, and OCHN3 MFA. Tests confirmed that the plasma nitriding according to CSN had a positive impact on increasing corrosion resistance [4].

Excellent results were achieved in steel 12050 and 15230 in the salt chamber. Samples were prepared oxinitridácie technology and brand name ,,Plasox``. This procedure was invented especially for unalloyed and low alloyed steels to achieve both improved wear resistance as well as high resistance to corrosion. In this procedure, the surface of the steel nitrided in a special way so as to form a white layer the surface of a thickness of 15 – 20 μm. Subsequently, the white layer oxinitrided by water vapour. In addition to hardness and corrosion resistance, give the surface a decorative black color, suitable, for example. for weapons. The results are shown in Table 3.

***Table 3*** *Test results of steel, salt spray*

| **Type of modification** | **Corrosion resistant steel** | | | |
|---|---|---|---|---|
| | **The time to occurrence of the first traces of corrosion (h)** | | **Corrosion-damaged area (%)** | |
| | **12 050** | **15 230** | **12 050** | **1 230** |
| **Without modification** | 3 | 3 | 100 | 100 |
| **Plasma nitriding** | 8 | 16 | 15 | 25 |
| **Oxinitriding** | 320 | 320 | 0 | 0 |

## 5 Conclusion

Plasma nitriding is a promising technology of chemical heat treatment of steel parts. The contribution of the military and civilian vehicles but can be seen in the increase of surface hardness, fatigue strength and corrosion resistance. New modes such as pulse nitriding extends further application of this technology in practice.

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