PLASMA-OPTICAL MODIFICATION of SURFACE PROPERTIES of constructional STEEL СТ3

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It is known that plasma processing is an effective way to enhance properties of the surface layer of material. In the process of high-energy exposure surface is subjected to ultra fast heating and cooling, as well as deformation impact. The result is a layer of several micrometers thickness, which stands in nonequilibrium state and has different properties than the core of the alloy. The structural condition of this layer, as well as its properties are of great practical and scientific interest.

The effect of modification of surface properties of low carbon steel Ст3 processed by high-enthalpy pulsed plasma flows in air atmosphere was investigated in this paper. For generation of the plasma flows there was used pulsed plasma torch on the basis of high-current discharge magnetoplasma compressor in the air. According to the performed measurements when energy stored in capacitors was 13,5 kJ (U0=3 kW) plasmatron provided the following parameters of processing of surfaces: the density of radiation flow to 330 kW/cm2 at temperature of impact-compressed plasma on the surface of approximately 15 kK, the plasma pressure is approximately 150 bar), the energy density up to 40 J/cm2; the characteristic time of impact – 120±10 msec. The diameter of plasma modified zone per pulse irradiation was close to the diameter of the outer electrode (anode) torch and came to approximately 40...50 mm.

Methods of metallographic analysis and scanning electron microscopy were used to investigate the structure of modified layers of Ст3. The thickness of the layer with modified structure is approximately 30 microns. The modified layer has a heterogeneous structure: there is a zone with needle-shaped martensitic structure on the surface with a thickness of about 10 microns, and ferritic-martensitic zone with thickness of about 20 microns under. Using electron microanalyser chemical composition of modified layers was defined. It is established that the composition of martensitic and ferritic-martensitic zones do not differ from the composition of the core alloy. X-ray structure analysis showed that the modified layers present α−phase (martensite and ferrite). Width of X-ray peaks α−phase significantly (5...7 times) increased in comparison with the width of the peaks of the source material. This result can be explained by the formation of a large number of defects of crystal structure in the process of plasma impact. This conclusion is indirectly confirmed by the anomalous high values of modified surface hardness of steel Ст3 – when core microhardness is 180 HV, plasma-treated surface hardness is 700 HV. For comparison hardness of martensite in St3 not exceed 400 HV after quenching in water with temperature 880°.

Method of accelerated corrosion tests shows that pulsed plasma-optical processing of steel Ст3 leads to a significant (5...7 times) increase corrosion resistance. The results obtained indicate the prospects of further research and development of this technology.