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Formation of Modified Layers on low carbon Steel Surface by a Plasma Electrolytic Effects Method

ABSTRACT

Dissertation submitted in fulfillment of the requirements for the degree Doctor of Philosophy (PhD) in specialty 6D072300 Technical Physics

Urgency of research

Questions of use the electrolytic-plasma treatment, especially cathode heating, both in scientific and in practical terms are highly relevant.

Studies showed efficiency of electrolytic-plasma treatment for structural steels. Traditionally treated materials out of this class of steels possess increased fragility of the surface layer and the relatively low complex of properties of the transition layer. Use of electrolytic-plasma treatment will significantly improve the properties of the modified layer and the core. Structure formation features of 18CrNi3Mo structural low carbon steel allow offering new regimes that enhance the technological capabilities of the hardening heat treatment.

To date structure of 18CrNi3Mo steel modified layer were studied by microscopy methods, low resolution, more optical. Significantly more profound and advanced results can be achieved when using electron microscopy, in particular transmission electron diffraction microscopy. Using this method in process studies showed great promise of this approach. This applies to the methodological and practical, and a fundamental side of the question. Therefore in the present work was developed and used for processing tasks in plasma electrolyte new approach - the use of the transmission electron diffraction microscopy method. This will get the essentially new and in-depth results that help identify basic features of modified layer structure.

Purpose of work: develop the technology and the optimal modes of 18CrNi3Mo steel surface hardening in plasma electrolyte, providing a combination of high performance mechanical properties and high wear resistance of surface; research of phase transformations, structure and properties of steel exposed to the electrolyte plasma.

To achieve the purpose were as follows **tasks**:

1. Develop technology and optimal modes of surface hardening in plasma electrolyte for 18CrNi3Mo steel the material drilling tool and to give practical recommendations;

2. Investigate the structure, phase composition, hardness and wear resistance changes of 18CrNi3Mo low carbon steel surface layers depending on the mode of electrolytic-plasma treatment;

3. Research the fine structure formation features of 18CrNi3Mo steel by electrolytic-plasma treatment;

4. Establish the quantitative laws, when characterizing the 18CrNi3Mo steel substructure initial and treated in the plasma electrolytic.

Subject of research – phase composition, structure and mechanical properties of 18CrNi3Mo steel modified layers after electrolytic-plasma treatment.

Object of research – 18CrNi3Mo structural low carbon steel before and after exposure to the plasma electrolyte used in the manufacture of parts for drilling tools.

Methods of research. Optical microscopic, scanning electron microscopic and transmission electron microscopy, X-ray structural analysis, methods for the determination of hardness and wear resistance of materials.

Scientific novelty.

Achievement of formulated purpose in accordance with the research general plan is almost entirely reflects the scientific novelty of the data obtained in the dissertation.

Obtained new experimental data about effect of cathode heating in the electrolyte plasma exposure on the structural and phase transformations in 18CrNi3Mo steel surface layers.

Disclosed laws formation of 18CrNi3Mo steel modified layer structure and properties by the electrolyte plasma influence.

First time forth new results on the study of surface and transition layers fine structure of 18CrNi3Mo steel after treatment in plasma electrolyte.

Determined the optimal mode technology for electrolytic-plasma surface hardening of 18CrNi3Mo low carbon steel with the ability to control the heating temperature, surface modification, ensuring high kinetic efficiency of diffusion saturation process.

Is shown that the formation of a gradient austenitic-martensitic structure in the surface layer and the packet martensite structure in the transition layer as a result of nitrocarburizing in plasma electrolyte allows to obtain increased hardness and wear resistance of 18CrNi3Mo steel.

Main provisions submitted within presentation of the thesis:

1. Electrolytic-plasma treatment technology and the optimal modes providing increase of modified layer thickness and strength properties of low carbon steel by high-speed heating;

2. Basic laws of structural phase transitions in 18CrNi3Mo steel by electrolytic-plasma treatment;

3. Scientifically based recommendations for the electrolytic-plasma hardening technology for 18CrNi3Mo steel as material drilling tools.

Scientific and practical significance of the work.

Determined the optimal mode of electrolytic-plasma treatment for low carbon steel surface modification with high performance properties.

Established that after electrolytic-plasma treatment in material formed carbides and carbonitrides, which help strengthen of steel surface layers, and therefore information about them is important to improve the working life of the product and its recovery.

Fine structure, properties and substructure parameters study results of 18CrNi3Mo steel identified in present work, has a decisive influence on steel surface hardening can be taken into account and used at researches the modified layers of other materials.

The proposed electrolytic-plasma treatment technology and optimal modes for 18CrNi3Mo steel protected by copyright certificates on inventions, and are recommended for use in practice by manufacturing drilling tools of "Vostokmashzavod" JSC.

Publications. Total relating to the dissertation published 25 printed works co-authored, 4 of which were published in journals recommended by the Committee for Control of Education and Science of the Republic of Kazakhstan, 1 paper published in journal with non-zero impact factor, is part of Thomson Reuters database, 3 papers in international journals included in Scopus database, and 9 papers 4 theses in the proceedings of international conferences, 2 papers in the proceedings of republican conferences, 2 inventor's certificates.

Structure and volume of the thesis. The work consists of an introduction, five chapters, conclusion and list of references. It stated on 158 pages, contains of 100 figures, 21 tables and 182 references.