ских эффектов или превращений, достичь таких уникальных свойств просто невозможно.

Таким образом, разработаны модели фазово-структурной эволюции интеллектуальных материалов на протяжении их жизненного цикла, объясняющие повышенный и уникальный уровень их свойств. С их использованием могут создаваться высокоэффективные интеллектуальные материалы нового поколения, проявляющие значительно более высокие эксплуатационные свойства, а при необходимости и уникальный их комплекс, значительно превышающие показатели традиционных аналогов (со стабильной структурой).

IMPACT OF THE COMPLEX SURFACE HEAT TREATMENT ON THE PROPERTIES OF STRUCTURAL STEEL

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The problem of increasing wear resistance and service lives of carbonized machine parts remains a vital one. Plasma treatment, owing to high concentrated rapid heating ensures microstructure dispersion and creates a possibility of formation of meta-stable phase-structural austenite modifications in carbonized surface layers of metal parts. The objective of the work is to investigate opportunities of strengthening and improving of wear resistance of structural carbonized steel by modifying the amount and meta-stability of austenite, by means of plasma treatment.

Carburizing steel 18CrMnTi was performed in a box furnace in production conditions machine "MAGMA" carburizer solid at temperatures 920 – 950 ºC for 12 -14 hours, cooled in a box. Plasma hardening was performed using plasmatron "PPU 004" indirect action, designed at SHEI "PSTU", using argon as the plasma gas.

Plasma heating of steel 18CrMnTi was carried out without melting

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at different temperatures within the range from 800 to 1300 ºC and the melting of the surface layer of varying degrees: micro-melting (t = = 1400…1500 ºC), the average melting (t = 1500…1600 ºC) and the macro-melting (t > 1600 ºC) which regulated by the speed of vertical movement of the plasma jet relative to a horizontal surface of the samples with speeds ranging from 81 to 625 mm/min. After plasma exposure natural cooling of the strengthened areas, due to heat conductivity occurred.

After plasma quenching from relatively low temperatures (800…900 ºC) in the carburized layer a significantly greater amount of A_{ret} in carburized layer was observed apart of martensite and carbides. It is located in bright microdomains between martensite needles.

After plasma quenching from higher temperatures ~ 1200…1300 ºC microstructure of the carburized layer in steel 18CrMnTi was characterized by greater dispersion of the carbide phase and sites A_{ret}, which were evenly distributed over the depth of the layer. This is due to the start of dissolution of cementite particles in the austenite, but some of them are retained in the structure.

After plasma treatment with micro-melting at temperatures of ~ 1500 ºC, the structure of the hardened layer varies considerably in the surface zone. A lot of cementite particles and martensite needles and a small amount of A_{ret} are observed. As the distance from the surface to the core increases the amount of A_{ret} and cementite gradually decreases while quenching martensite hardening increases. Further hardening depth structure passes into the mixture of troostomartensite and cementite.

With increasing temperatures of plasma heating (~ 1600 ºC and > 1700 ºC), a significant macro-melting becomes obvious. The microstructure of the remelted surface layer consists of rather large needles of martensite and cementite particles on the background of A_{ret}. This area is quite extended, gradually transformed into fine-crystalline mixture of (M + cementite + A_{ret}).

It was found that different quantity of A_{ret} and its dispersion structure determining the degree of stability and its ability to deformation $\gamma_{ret}\rightarrow\alpha'$ DIMT in wear (DIMTW), which significantly affects the performance characteristics.

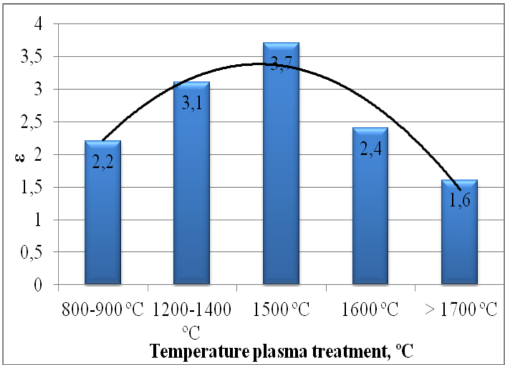

Fig. 1. Effect of plasma treatment temperature on the relative wear resistance of carburized steel 18CrMnTi

Experimental test results for dry sliding wear by scheme "metal-metal" are shown in Fig. 1. Depending on the temperature of the plasma heating changed the relative wear resistance according to the curve with a maximum $\varepsilon = 3.7$ (similar hardness change), which corresponds to micro-melting at 1500 ºC. This is explained by obtaining the most dispersed mixture of quenching martensite, cementite with a high content of metastable A_{ret}.

Developing $\gamma_{ret} \rightarrow \alpha'$ DMTW itself was accompanied with additional hardening of a thin surface layer in the process of wear, as formed by the test deformation martensite has a higher dispersion and hardness than that of quenching martensite. An additional and very significant contribution to the improvement of wear resistance is given by $\gamma_{ret} \rightarrow \alpha'$ DMTW that provides the effect of strain hardening of the surface layer itself. Note that DMTW accompanied with micro-stressing relaxation is an effective mechanism for redistribution and absorption of input mechanical energy of friction and wear.

Thus as the result of plasma strengthening of the carburized steel surface layer of 18CrMnTi grade by means of controlled heat input values of the plasma jet, provides differential phase-structural states with different content and the degree of retained austenite metastability along with the presence of hard phases - quenching martensite and carbides.