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RESOURCE-SAVING TECHNOLOGY FOR STRENGTHENING PRESS EQUIPMENT IN CONDITIONS OF SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS WHEN OBTAINING SPECIAL-PURPOSE PARTS

РЕСУРСОЗБЕРІГАЮЧА ТЕХНОЛОГІЯ ЗМІЦНЕННЯ ПРЕСОВОГО ОСНАЩЕННЯ В УМОВАХ САМОРОЗПОВСЮДЖУВАЛЬНОГО ВИСОКОТЕМПЕРАТУРНОГО СИНТЕЗУ ПРИ ОТРИМАННІ ДЕТАЛЕЙ СПЕЦІАЛЬНОГО ПРИЗНАЧЕННЯ

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Strengthening of structural materials with multicomponent chromium coatings obtained under non-stationary temperature conditions of self-propagating high-temperature synthesis (SHS) is a promising way to obtain coatings with controlled composition, structure, and performance characteristics with limited or minimal time of their formation. Protective coatings were obtained on pressing equipment of dies used for pressing special-purpose parts made of elastomeric materials [1].

Degradation mechanisms observed in pressing equipment used in pressing processes are primarily associated with the surface layer of the tool. Given the above, modifying the properties of the surface layer of a forging tool is the most effective way to increase its durability. The formation of the properties of the tool surface layer is possible due to the development of surface engineering methods [2]. In general, methods of forming the properties of the surface layer can be divided into: methods based on thermochemical treatment (diffusion layers), methods of CVD and PVD coating deposition, mechanical methods (polishing, shot peening, etc.), radiation methods (ion implantation, laser treatment), hybrid methods.

Coatings obtained under SHS conditions have special characteristics. They are formed from a film of the applied product, similar to a gas-phase deposition process, and a wide transition diffusion zone, similar to diffusion saturation. These features allow SHS coatings to have superior properties compared to other analogs: they can have improved characteristics of the applied material (e.g., improved wear resistance or thermal resistance compared to the base material) and high adhesion strength between layers of powders where particles of one material are covered by a layer of another. This provides a large contact area for the reagents, especially when small particles are used. Micron particle sizes also remain acceptable under these conditions. If the particles do not melt, reactions between reactants proceed through the solid phase by reaction diffusion.

Process of applying protective coatings under SHS conditions was carried out on a specially designed experimental and industrial unit DDTU12. This unit includes not only reaction equipment, but also a system of control and regulation of technological parameters, as well as a system of gas utilization, which ensures safe and efficient coating process. For the application of protective coatings on samples of 40X steel, mixtures of powders with different dispersions from 60 to 150 microns were used. These powders included elements such as chromium, silicon, boron, aluminum oxide, aluminum, iodine and ammonium fluoride. Resource-saving technology makes it possible to produce multi-component chrome coatings on 40X steel in a short period of time, up to 60 minutes, with the following phases: a) when alloyed with boron and aluminum, it includes the following phases $(Fe,Cr,Al)_2B$, $(Fe,Cr)_7C_3$, $(Fe,Cr,Al)_{23}C_6$, Fe_3Al and a solid solution of boron, chromium, aluminum in α-iron; b) when alloyed with silicon and aluminum

(Fe,Cr,Al)$_3$Si, Fe_5Si_3, (Fe,Cr)$_7$C$_3$, Fe_3Al, (Fe,Cr,Al)$_{23}$C$_6$, (Fe,Cr,Al $_5$Si$_3$, under which the solid solution zone is located Cr, Al and Si in α– Fe; c) when alloyed with titanium and aluminum Fe_2Ti, Cr_2Ti, Fe_3Al, $TiAl_5$, TiAl, and solid solution of titanium, aluminum and chromium in α-iron.

Wear tests of the samples are carried out on the friction machine SMT-1 under the conditions of boundary friction-sliding with lubrication with motor-tractor oil M-10B$_2$) roller – pad design with a rotation speed of 500 rpm of the counter body (roller). The counter body is made of U8 steel with subsequent hardening and low tempering to a hardness of 61-63 HRC. The test results showed that, when tested under friction-sliding conditions, the best wear resistance among the alloy coatings under consideration was achieved by coatings alloyed with boron and titanium. Their wear resistance is 1.8-2.1 times higher than that of coatings obtained under isothermal conditions. The data obtained for comparing wear resistance with alloyed chrome coatings correlate with the values of microhardness, which is for coatings obtained under SHS conditions with boron alloying H100 = 15000 MPa, with titanium alloying H100 = 17000 – 18000 MPa.

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