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INCREASING THE WEAR RESISTANCE OF CORROSION-RESISTANT STEELS BY COMPLEX LASER ALLOYING WITH NIOBIUM AND NITROGEN

ПІДВИЩЕННЯ ЗНОСОСТІЙКОСТІ КОРОЗІЙНО-СТІЙКИХ СТАЛЕЙ ШЛЯХОМ КОМПЛЕКСНОГО ЛАЗЕРНОГО ЛЕГУВАННЯ НІОБІЄМ ТА АЗОТОМ

Dmytro Marchenko
Mykolayiv National Agrarian University, Mykolayiv, Ukraine

Laser doping of steels with nitrogen and niobium allows the creation of barrier layers on the surface with a combined microstructure consisting of highly alloyed solid solutions reinforced with dispersed, uniformly distributed inclusions of nitrides, carbides, carbonitrides, and intermetallics [1-3].

The aim of the work was to investigate the effect of laser alloying with niobium and nitrogen on the wear resistance of corrosion-resistant steels of ferritic-martensitic (20X13) and austenitic (12X18H10T) grades used in the heat and power industry under the conditions of simultaneous action of contact forces and aggressive environments.

Experimental research methodology. The samples of steel 12X18H10T and 20X13 were studied in the delivery state (steel 12X18H10T quenched at 1050 °C in oil, steel 20X13 quenched at 980 °C in oil + tempering at 250 °C) and after laser doping with nitrogen and niobium on CO2, a continuous laser from the company "TRUMF", which provides uniform heating and minimal roughness values of the surface being processed.

Wear tests were performed on a specially created installation at the FMI NAS of Ukraine [4]. The friction unit (a pair of cylinders made of 12X18N10T steel and a plate made of the material under study) with a loading system is installed on the stage of a metallographic microscope MIM-9. which allows for visual observation and video filming. The speed of the counterbody is 0.15 m/s. The contact area provides a pressure not exceeding 0.02 MPa for a load of 40 g and 0.03 MPa for a load of 9.

Laser alloying of corrosion-resistant steels with niobium increases the microhardness of surface layers and contributes to the improvement of their corrosion-mechanical properties [5, 6]. Complex alloying with niobium and nitrogen allows to increase the specific density of nitride, oxynitride and carbonitride phases, which will contribute to the increase in wear resistance [7]. Metallographic studies of surface layers of alloyed steels have shown that they have a structure of a highly alloyed solid solution with inclusions of evenly spaced secondary phases with a flat structure for steel 12X18H10T and a cellular structure for steel 20X13 [8]. The value of the microhardness of surface layers after laser alloying increases compared to the untreated state to 5.5-6 GPa for steels of the ferritic-martensitic class and to 4.0-4.2 GPa for austenitic steels.

Wear resistance tests of steel 12X18N10T in a pair with a counter body made of the same material showed that its linear wear significantly depends on the applied load and the corresponding contact pressure [9, 10]. After 30 - 40 min of testing, linear wear is minimized due to the expansion of the contact zone and the corresponding decrease in contact pressure. Mass losses of samples increase in proportion to the applied load, and counter bodies, on the contrary, decrease.

Under these friction conditions, 20X13 steel in the as-delivered state is more resistant to wear than 12X18N10T steel. As a result of laser alloying, the wear resistance of the material increases sharply, and the mass losses of the counter body also decrease.

As the analysis of the microstructure of the counterbodies and the profilograms taken from their surface showed, under different friction conditions the nature of their wear differs sharply. In the initial state, the surface profile of the material corresponds to the 7th quality of roughness. After friction in a pair with laser-treated steel 12X18N10T, the height parameters of the counterbodies surface profile decrease by 2-3 times, and the step parameters by 5-10%, which corresponds to a decrease in the level of roughness [11].

Conclusions. Complex laser alloying of the surface of corrosion-resistant steels 12X18H10T and 20X13 with niobium and nitrogen significantly increases their wear resistance compared to the untreated state [12]. Combined supply of alloying elements to the molten zone allows for targeted dosing of the type and specific density of secondary phases formed as a result of reactive diffusion and thus, depending on the operating conditions, to increase either the corrosion-electrochemical properties (when the alloyed layers will mainly include nitride or oxynitride phases) or the wear resistance (when a larger specific volume will be occupied by carbide or carbonitride inclusions).

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