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WEAR RESISTANCE OF SILICON COATINGS OBTAINED IN THE CONDITIONS OF SELF PROPAGATING HIGH-TEMPERATURE SYNTHESIS

Siliconized coatings of steels and alloys, obtained by self-propagating high-temperature synthesis, can significantly increase wear resistance, corrosion resistance and heat resistance, and often obtain the required combinations of them. With increasing temperature, the amount of products in the gaseous phase increases and condensed products are released. Characteristically, in the temperature range of 500–1600 K, the proportion of the condensed phase decreases, which is associated with the evaporation of the carriers used. The main compounds in the gas phase in the temperature range of 500 - 1600 K are: SiCl, $SiCl_2$, $SiCl_3$, $SiCl_4$, SiJ_2, SiJ_3, AlJ, AlJ_2, AlCl, $AlCl_2$, $CrCl_2$, CrF, CrF_2, CrF_4, BF_3, $TiCl_2$, $TiCl_3$, $TiCl_4$, WCl_2, WCl_3, WCl_4, and others, as well as iodine in atomic and molecular form.

Simultaneously, starting from a temperature of 850 K, the reaction products decompose, which confirms the appearance of decomposition products and a sharp increase in the number of gas moles. Gaseous products interact with elements of the powder system (Al, Si, B, Ti, W, Cr) and transfer them to the gas phase (appear SiCl, $SiCl_2$, $SiCl_3$, $SiCl_4$, SiJ_2, SiJ_3, AlCl, $AlCl_2$, $AlCl_3$, BF_3, CrF, CrF_2, CrF_4, $TiCl_2$, $TiCl_3$, $TiCl_4$, WCl_3, WCl_4, AlJ and etc.). At temperatures above 850 K, the fraction of the condensed phase practically does not change. This fact suggests that in the temperature range of 850–1500 K, reactions occur with the release of a condensed phase, but without a change in the number of moles, which is typical for reactions of decomposition, disproportionation, or exchange with the substrate, i.e. in essence, chemical transport of elements takes place.

As a result of the thermodynamic calculation of the equilibrium composition of the reaction products, we can assume the following kinetic scheme of chemical transformations in the systems under study: The microhardness of siliconized coatings doped with Cr and Al on the surface of the samples is H_{50} = 6500 - 7000 MPa; alloyed Cr, Al, B: H_{50} = 13000 - 15000 MPa; alloyed Cr, Al, Ti: H_{50} = 9000 - 10000 MPa and alloyed Cr, Al, W: H_{50} = 12000 - 13000 MPa. After carrying out the combustion process and obtaining protective coatings, a standard heat treatment was carried out, consisting in hardening and low tempering, to prevent the layers from “punching”. With an increase in the carbon content in the sublayer, the microhardness increased. The wear resistance of protective coatings has increased by 1.8 - 2.5 times. The best indicators of wear resistance (test on the SMT-1 friction machine) were shown by siliconized coatings alloyed with chromium, aluminum and boron.

References

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