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DEVELOPMENT OF OPTIMAL TECHNOLOGICAL PARAMETERS FOR PLASMA COATING DEPOSITION

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Using titanium nitride coating of mold surfaces by the condensation method with ion bombardment let us obtain different performance characteristics. It depends on amount of nitrogen pressure.

The problem of using ion-plasma spraying of mold surfaces is being discussed nowadays. Its solution makes it possible to replace scarce and expensive tungsten-containing steels with other materials. 4Х5МФС and 5ХНМ steel grades were chosen as materials for copper alloy die-casting molds in this work. The choice of these steel grades is due to the fact that these steels do not contain tungsten due to its sharply increased scarcity and limited molybdenum content, and they also meet the requirements for the substrate material on which the titanium nitride coating is applied. Coatings were applied to samples for laboratory tests and die-casting mold parts by the condensation method with ion bombardment. Titanium nitride is applied at different partial nitrogen pressures – from 3(10-3) to 1 Pa to determine the required nitrogen pressure, which ensures that the working surfaces of mold parts receive coatings with the best performance characteristics. The coatings obtained at different nitrogen pressures differ in the amount and size of the droplet phase. The largest amount of the droplet phase containing α-Ti is observed in coatings obtained at nitrogen pressures of 3(10-3, 3(10-2 Pa). An increase in nitrogen pressure (4(10-1, 1 Pa) significantly reduces the level of micro distortions of the crystal lattice in the coating, and its plasticity increases. That is why the coating brittleness is reduced to a sufficiently high hardness. The titanium nitride coating obtained at a nitrogen pressure of 1 Pa is the most effective in protecting the working surfaces of mold parts from destruction. Laboratory tests have shown that the titanium nitride coating applied under optimal process parameters increases the corrosion resistance of mold parts to which it is applied by 3 times and the scale resistance by 2–4 times.

Materials and methods of the study. The coatings can be applied by using a “Bulat-3T” unit. The CIB method includes two main stages:

1. Cleaning, heating, and activation of the substrate surface by ion bombardment of the material to be deposited, accelerated to the required energy.
2. Deposition of the coating during continuous ion bombardment of condensate in a mode that ensures the formation of a coating with the required service properties.

Using “Bulat-3T” unit helps to determine coating time, temperatures that dissolve most of the carbides and produce high-alloy martensite, the reaction gas pressure, the number of thermal cycles and etc.

We turn to the surface microstructure of the obtained coatings and their microhardness after coating

The coatings obtained at different nitrogen pressures differ in the amount and size of the droplet phase.

The microhardness decreases with increasing pressure. Laboratory tests on the thermal endurance of samples with coatings applied at different nitrogen pressures showed that the samples with titanium nitride coating obtained at a pressure of Pa can withstand the greatest number of cycles.

Increasing the nitrogen pressure significantly reduces the level of microdistortions of the crystal lattice in the coating, and increases its plasticity. In this regard, the brittleness of the coating decreases at a sufficiently high hardness.

Another important parameter that significantly affects the stability of plasma-coated parts is the temperature of the working surface during ion bombardment. Ion bombardment has the most favorable effect on the substrate made of 4Х5МФС and 5ХНМ steels at a temperature of 500 °C, which corresponds to the best adhesion of the coating to the substrate and, accordingly, the highest durability of parts with such a coating during operation. At lower temperatures, there is a tendency to decrease the adhesion of the coating, which is accompanied by peeling of the coating during operation and a significant decrease in durability.

The thickness of the coating significantly reduces the adhesive interaction of steels used as mold material with brass melt. As the coating thickness increases, the substrate should be more reliably protected from external factors due to increased hardness, temperature resistance against oxidation and corrosion.

Conclusion. The research has shown that mold parts with plasma coating applied to their working surfaces have maximum resistance when the coating is deposited at a substrate temperature of 500 °C and a partial nitrogen pressure of 1 Pa. Laboratory tests have shown that the titanium nitride coating applied under optimal technological parameters provides a 3-fold increase in the corrosion resistance of mold parts on which it is applied, and a 2–4-fold increase in scale resistance.

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