Analysis of Effective Methods of Repairing the Surface Surface of Parts With Gas-Thermal and Electroplating Coatings

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ABSTRACT

This article discusses the methods of using gas-thermal and galvanic coating methods to restore the working surfaces of the details, their impact on the surface layer and the effectiveness of the restored surface in the working environment.

Keywords: Gas Thermal Methods, Coatings, Gas Character, Gas-Thermal Coatings, Galvanic Coatings, Laser Method, Chemical-Thermal Methods, Temperature, Graphite, Anti-Fractionally Coatings.

Some of the gas thermal methods – flame gas and electric arc metallization – are well known and widely used. Plasma and detonation coating is one of the most promising areas of powder metallurgy. The resistance to wear and corrosion of parts made of conventional structural materials can be increased many times with a slight consumption of powder materials.

During plasma coating, the material is melted and sprayed by a jet of low-temperature arc plasma consisting of electrons, positive ions and neutral atoms. The ionized gas flow is characterized by high temperatures (5000-10000°C) relatively low speeds (up to 250-600 m/s). Argon is most often used as a working gas. Since the plasma jet captures air, spraying of oxygen-active materials is carried out in chambers pre-filled with an inert gas. Other methods of coating in a "dynamic" vacuum have also been developed.

Plasma coatings have a complex arched structure. The porosity of the coatings ranges from 2-15%. Plasma methods can be applied coatings from almost all materials. Clad powders make it possible to include even materials that are insufficiently stable when heated (for example, $MoS2$) in the composition of coatings.

The high temperature and plasma energy make it possible to successfully use the plasma method for coating all refractory materials (with the exception of sublimating and intensively decomposing at the application temperature), characterized by high binding energy in the crystal lattice and, consequently, high hardness. The applied coatings are characterized by high wear resistance (Table 1)

Table 1
Relative wear resistance of plasma coatings (when worn on a grinding skin for 1 min. at a sliding speed of 8 m/s and a pressure of 1.7 MPa)

Coating material	Wear, mg	Relative wear resistance
Steel:		
low-carbon, molybdenum-doped	900	1
corrosion	711	1,27
chromomolybdenum	509	1,77
Stellite:		
№ 66	486	1,85
№ 33	289	3,11
№ 11	66,3	13,57
Kolomina:		
№ 4	142,1	6,33
№ 5	111,3	8,09
№ 6	35,5	25,35

In the detonation method of coating, a portion of the gas mixture capable of detonating during ignition and a portion of the powder of the applied material are fed into the channel open from one end of the barrel through the mixer. An explosion of the gas mixture is initiated with the help of the ignition device. The sprayed material heats up, accelerates and is ejected onto the surface of the part. As a result of an explosion of a mixture of combustible gas (usually acetylene) and oxygen, the particles of the sprayed material introduced into the gas are heated (no higher than 2850 ° C) and accelerated to very high speeds (up to about 1000 m/s). When particles with high kinetic energy hit a solid surface, a large amount of heat is released, and their temperature can reach 4000 ° C.

The plasma method provides heating of particles to higher temperatures than the detonation method. Temperature restrictions in the detonation method of coating are compensated by a higher kinetic energy of the particles, which allows the application of refractory materials. Due to the high velocities of the sprayed particles, detonation coatings have a higher density (98-99%) and adhesion strength to the substrate compared to plasma and even more so conventional gas-flame coatings. A significant advantage of the detonation method in comparison with gas-flame and plasma is its discreteness, and as a result, a lower heat intensity. The heating of the workpiece during the spraying process may not exceed 200 ° C.

The detonation method has mastered the application of coatings of a wide variety of compositions: carbide with the use of various carbides (tungsten, chromium) and bundles (Co, Ni, Ni+Cr); oxide (from aluminum, titanium and chromium oxides), metal. This makes it possible to repeatedly increase the wear resistance of machine parts and tools.

Detonation coatings have found wide application abroad, especially in aviation.

The application of detonation coatings makes it possible to multiply the wear resistance of machine parts.

Laser methods of modification and alloying of surface layers. Significant opportunities to increase the wear resistance of surfaces appeared with the development of industrial lasers. Due to the high energy density in the laser beam (up to 109 W / cm2), rapid heating of a thin surface layer of metal is possible, up to its melting. The subsequent rapid removal of heat into the metal volume leads to the hardening of the surface layer, giving it high hardness and wear resistance (the processes occurring in the surface layer, and therefore its properties are determined by the power and duration of the laser beam). It is also possible to dope the surface layer by pre-applying a layer of the alloying component to the surface in some way, followed by melting with a laser beam, and also to apply coatings by introducing the powder of the sprayed material into the laser beam. Quite a lot of experience has been accumulated in laser hardening of parts made of steels and cast iron.

Electric spark coatings. The method of electric spark alloying is based on the transfer of the electrode material (mainly the anode material) during a pulsed spark discharge in a gas medium to the treated surface. Vibrating electrodes are used for applying electric spark coatings. A method of hardening with a rotating electrode has been developed in Bulgaria.

When applying metal coatings, the initial phase reference is preserved in the base material. When alloying with compounds (metal-like), as a rule, chemical interaction with the base material occurs with the formation of chemical compounds of the elements included in the applied material with the base elements. The application of electric spark coatings significantly increases the wear resistance and anti-fractionality of surfaces.

With waterjet wear as a result of electric spark alloying, the wear resistance of steels increases significantly. The heat resistance of surfaces after electric spark alloying also increases significantly.

Electric spark alloying is used to increase the reliability of machine parts, instruments and mechanisms of tools (cutting and deforming), coquilles for casting metals, as well as for dimensional restoration of machine parts.

Electroplating methods can be applied to coatings of metals, alloys and composite materials.

The introduction of particles of other materials (CEP) into the composition of coatings based on chromium, iron and nickel significantly increases their trib technical properties. The introduction of powders of carbides, oxides, borides, diamond, etc., can significantly increase the wear resistance of coatings; the introduction of chalcogenide, graphite, graphite – anti-fractionality of coatings. The technology of electrolytic deposition makes it possible to obtain coatings with a particle content of up to 40% and a thickness of up to 100 microns.

With the simultaneous introduction of particles with high hardness and particles of solid lubricant into the coating, wear resistance and anti-friction properties increase. Nickel-based composite coatings have the best trib technical properties. The values of the coefficient of friction are significantly reduced when even a small amount of solid lubricant (about 1% MoS2) is introduced into the coating.

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