POWDER METALLURGY INDUSTRY, ECONOMICS, AND ORGANIZATION OF PRODUCTION

INCREASING THE LIFE OF DIES AND MOLDS BY APPLICATION OF ION-PLASMA COATINGS. I. THE INFLUENCE OF HEATING AND SPRAYING TEMPERATURE ON THE STRUCTURE AND PHYSICOMECHANICAL PROPERTIES OF THE TOOL MATERIAL

L. L. Il'ichev, Yu. S. Gushchin, and V. I. Rudakov

Intense development of machine building requires continuous improvement in methods of cold and hot forming and pressure casting of highly accurate parts. Parts for all branches of industry are produced in large-lot production by these methods. The accuracy of the dimensions and configuration of the parts and their surface finish depend to a large degree upon the effectiveness of the dies and molds.

High resistance of the forming portions of the equipment is a basic condition of profitable operation of production. However, as the experience of Orenburg Diesel Locomotive Repair Plant and other machine tool manufacturing plants shows, with a high cost of a set of molds or dies (up to 1000 rubles and more) their life is short (10,000-11,000 parts), which may be explained by the severe service conditions of the working portions. The temperature of the molten metal reaches 1373-1473 K for brass and 1093-1123 K for aluminum and the rate of operation reaches 450-600 parts/h.

Appropriate surface treatment of the press tool makes it possible to increase the hardness, wear resistance, and effectiveness under these conditions, the resistance to fatigue failure, and the crack resistance from the cyclic change in temperature and to decrease the loss of weight during hot forming or in contact with molten metal. The most promising in this respect are ion-plasma coatings obtained by ion bombardment and condensation [1-3].

The use of such coatings for increasing the wear resistance of dies and molds has become the subject of combined investigations of Orenburg Polytechnic Institute, Orenburg Diesel Locomotive Repair Plant, and Arrow Production Union.

To specimens of 3Kh2V8F and KhVG steels (GOST 5950-73) with a hardness of 53-55 HRC_eq, which corresponds to the standards used in production, were applied 5-8 μm thick coatings of titanium and chromium nitrides and TsG-20 alloy (80% Zr-20% Hf) using NVN-6.6-II and Balat-3T machines.

The structural condition of the coating and base materials was studied by microhardness, metallographic, and X-ray diffraction methods on oblique specimens prepared by the method proposed by the authors [4, 5], with use of ion etching in argon on a VUP-4 machine. The coating thicknesses were determined on perpendicular sections of the specimens on a PMT-3 microhardness tester in a dark field with a scale of 3.125·10⁻⁶ mm per division of the objective micrometer.

The ion-plasma spraying method includes heating of the parts to 573-773 K, which unavoidably involves a change in structural condition of the forming tool. Therefore the change in structure of the steels after heating in the 373-773 K range was studied. The specimens were tempered in the VUP-4 machine with an attachment for heating, maintaining the temperature at a certain level with an accuracy of ±1 K, in a vacuum of (5.32-6.65)·10⁻¹ Pa and also by ion bombardment. The hardness of the KhVG steel specimens was measured on a Sanodor tester with a diamond indenter and a load of 585 g. A significant change in hardness was noted after tempering at temperatures above 573 K (Table 1). This data correlates quite well with the results of x-ray diffraction analysis made on a DRON-2 diffractometer. The x-ray diffraction patterns (Fig. 1) were constructed to units of interplanar distance d_HKL, taking into consideration the integral intensities of the diffraction reflections from ferrite and...
The investigation results showed that in ion-plasma condensation steel parts may be heated to 573-623 K. The processes of structure formation which develop in this case do not significantly reduce hardness, providing quite high adhesion strength of the coatings to the tool. Similar results were obtained in investigation of 3Kh2V8F steel.

The microhardness of the surface of the specimens depends significantly upon the material and type of the coatings. For example, on specimens without a coating 47% of the area of the polished specimen is occupied by a structural constituent with a microhardness of 300-400 Mpa, 23% with a microhardness of 500-600 MPa, and about 10% with 700-800 MPa. On