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Increase The Wear Resistance And Service Life Of Dyes Based On Modern Technologies

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ABSTRACT

The main ways to increase the durability of the working parts of the stamping tool are considered, including the processes of cold plastic deformation during the application of wear-resistant coatings by ion-plasma spraying. A physical model of the process of cold plastic deformation of samples from heat-resistant steel X12M is presented.

KEYWORDS

Stamp, mold, mechanical activation, deformation, wear resistance, coating, ion-plasma spraying, adhesion.

INTRODUCTION

The main trends in modern machine-building production are the creation of new machines and mechanisms with high performance characteristics based on the manufacture of parts and blanks with a high level of physical, mechanical, technological and consumer properties. At the present stage of scientific and technological progress, the strength, toughness and other characteristics of structural materials increase so rapidly that the tool materials available to production, in a number of cases, do not allow high-performance processing of workpieces. In connection with these features of modern

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production in metalworking, along with other methods of intensifying technological operations, a direction is developing to increase the durability of working parts of dies and molds.

All the variety of methods of surface hardening treatment used in tool production can be divided into five groups: deformation effect; thermal effect; surface alloying; coating; combined processing.

Under cold deformation effect, the surface layer of the cutting tool is hardened, its microgeometry and energy reserve change. The result of thermal action on the surface layer of the tool is a change in its structure, while its chemical composition remains unchanged. Surface alloying changes the chemical composition and, as a rule, the structure of the surface layer of the tool.

When applying coatings on the surface of the cutting tool, a thin film is formed, which increases the physical and mechanical characteristics of the surface layer. Mechanical activation is the main method of mechanical action on solids, causing distortion of the crystal lattice due to the strain hardening of the metal. It was found that MA causes the following physical phenomena:

- Emission of electrons and creation of a potential difference;
- An increase in the free surface of a substance, the appearance of elastic and plastic deformations, and, as a consequence, an intense strengthening of the metal, relaxation of stresses. The resulting distortions of the crystal lattice of minerals are the cause of the appearance of point defects and linear dislocations carrying the corresponding reserve of "excess" energy, which leads, as a consequence, to an increase in the adhesion capacity of the "substrate-coating" system. It is known that the most effective method of increasing tool performance is the application of wear-resistant coatings. The purpose of coating is to obtain a tool with a wear-resistant surface layer and a tough, tough base. The refinement of the structure (decrease in the grain size) of the coating material is accompanied by an increase in hardness up to a certain critical average size of the nano-grain (nanoscale effect). A decrease in hardness with a further decrease in the average grain size in the coating occurs due to slippage along the grain boundaries (rotational effect). To further increase the hardness, it is required to slow down the sliding process along grain boundaries, which can be achieved by forming a corresponding structure with strengthening of grain boundaries.

The developed technology for increasing the durability of working parts of dies and molds due to a complex modification of the surface layer is as follows: working parts of sheet, cold volumetric and hot stamping dies are subjected to cold plastic deformation before spraying a wear-resistant coating by the ion-plasma method, which causes mechanical activation of the substrate metal, contributing to an increase in the adhesion properties of the "under-tray-coating" system. At the same time, a favorable texture (macro-, micro-) is formed, activation and mechanical work hardening (strain hardening) occurs in the working area, which makes it possible to reduce the thermal conductivity of the metal, reduce the temperature effect on the metal by creating a localized (local) zone of temperature influence in the surface layer and reduce the softening of the metal. Modification of the surface due to mechanical activation will significantly increase the adhesion capacity of the "substrate-coating" system while increasing the operational and resource properties.

The developed surface modification technology can be used to increase the durability and performance of the working

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surfaces of the rollers, dies for sheet, cold forging and hot stamping (punches, dies, signs, inserts) from semi-heat-resistant and heat-resistant steels of increased viscosity, as well as molds in the processes of extrusion of profiles. The task of the study is to choose rational modes of mechanical activation of the surface layer due to cold strain hardening of the metal. For the design of the stamping process, it is important to know the stress and strain state of each section of the workpiece during the entire process, which is determined by the mechanical deformation scheme. To increase the efficiency of the adsorption process, in a number of publications by foreign authors, it was proposed to use mechanical deformation, which consists in the mechanical activation of the metal when implementing the scheme of uniaxial compression of the workpiece. Based on the experimental work, a theoretical model was proposed that combines mechanical deformation with the binding energy between the elements of the system under consideration: the substrate (acting as a catalyst) and coating (acting as a reagent). It was found that to increase the adsorption efficiency, it is necessary to reduce the activation energy in the longitudinal direction of the crystal lattice (its stretching), which corresponds to the effect created by mechanical uniaxial deformation of compression. As established in, the resulting mechanical stress increases the strength of the bond between the elements of the "substrate-coating" system, which is the result of the "pulling" of the substrate metal atoms at a certain amount of deformation of the substrate surface.

In order to study the nature of the stressed and deformed state of the body during preliminary cold plastic deformation, a model of the settlement process was developed using the LS-Dyna software package, and an analysis of the adequacy of the obtained model was presented. Upsetting processes were simulated using the LS-Dyna software environment, a multipurpose program designed to analyze the nonlinear dynamic response of three-dimensional inelastic structures. It includes full with an automated process for solving contact problems, as well as many functions for checking the obtained solution, they can successfully solve the most complex problems of impact, destruction and shaping.

The deceleration of the growth of potential energy is also due to the fact that for the beginning of deformation it is necessary to achieve stresses exceeding the yield point of the metal. A further increase in energy is due to an increase in the dislocation density of the workpiece material and the force required for its deformation. The program allows calculating the dependences of mechanical parameters both for the entire volume of the workpiece and for its individual elements of the finite element model. Conclusion. Based on the results of modeling the upsetting process, it can be concluded that it is correct to use the computational model of the uniaxial compression process to assess the physical and mechanical characteristics of the deformed metal, the stress state of the structure, the values of the distribution of deformation, energy and other parameters of the processed products. In this case, a high accuracy of the output parameters is achieved, provided that the verified input data are introduced into the model. It is also worth noting that to improve the accuracy of the output data, one should strive to increase the number of elements of the computational grid. The use of such models for preliminary calculation of deformation modes, assessment of processes occurring during plastic deformation will reduce the cost of carrying out field experiments.

The use of the technology of complex modification of the surface layer will provide:

1. Increase in service life, durability and performance of the most loaded parts of

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stamps and molds (punches, dies, signs, inserts, etc.);

2. Improving the quality of products made on a tool with a modified surface by reducing wear on the working surfaces of the stamp (increasing dimensional accuracy, no burrs);
3. Reducing the cost of production (an integral criterion for assessing the effectiveness of technology). Reliability and efficiency of technological processes of rotary drawing of smooth and complex-profile axisymmetric parts are ensured by the correct choice of technology parameters and geometry of the working tool. Recommendations for the selection of technological parameters of the rotary drawing process were obtained on the basis of theoretical and experimental studies, taking into account the technical requirements and the mechanical properties of the material of the part.

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