Improvement of ironing technology in restoring and hardening worn out car parts

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Abstract. Currently, active research is being conducted in Russia and abroad to study the so-called composite electroplating coatings (CEC). The promise of this method lies in the fact that by introducing special additives into the electrolyte, which are usually fine powder, coatings can be obtained with properties unattainable with ordinary electrolytes. For the introduction into the electrolyte, as a hardening additive, it is recommended to use powders obtained by the method of electroerosive dispersion. The process of obtaining powder materials by the method of electroerosion dispersion differs favorably with the possibility of obtaining powders even from particularly hard and refractory materials. In the case of grinding material with this method, the only important criterion is the electrical conductivity of the material being ground. Worn parts and other scrap can be used as feedstock during the process. The purpose of the study is to improve the technology of restoring worn automotive parts with composite electroplated coatings due to the use of electroerosive powders as a hardening phase. Due to the study of samples of the used powder, as well as the study of the properties of the deposited coatings on modern devices, results were obtained showing the high potential of this recovery method. It has been established that even a small addition of EDM powder to the electrolyte (5 g/l) allows to improve the performance of the deposited coating.

1. Introduction
Analysis of the literature examining various methods of restoring worn parts showed that the most accessible and at the same time ensuring high quality of the parts to be repaired are galvanic restoration methods. Using electroplating methods, not only restoration of the surfaces of worn parts is carried out, but also special coatings are applied to give the parts corrosion protection or decorative properties. In industrial practice, the most common methods are chroming, ironing, copper plating, and galvanizing.

Among the electroplating methods for restoring parts, ironing is of the greatest interest. This process has a high current output and a high deposition rate of the material on the part. Also, ironing allows to obtain a thick (up to 1-1.5 mm) layer of a deposited coating, and if necessary, one more layer of material can be deposited on the reprocessed part. The most widely used in industrial practice hydrochloric acid electrolyte zhelezneniya, although it provides high quality deposited coatings, is inconvenient to use. Hydrochloric electrolytes are rapidly oxidized by oxygen from the air, becoming unsuitable for further use, without elaboration, which serves to remove iron ions Fe+3.

Currently, active research is being conducted in Russia and abroad to study the so-called composite electroplating coatings (CEC). The promise of this method lies in the fact that by introducing special
additives into the electrolyte, which are usually fine powder, coatings can be obtained with properties unattainable with ordinary electrolytes. The electrolyte for the application of CEC is a suspension; in the course of the bath operation, the powder particles are maintained in a suspended state, thus, their uniform distribution is achieved within the base material of the coating (matrix). Using this method you can combine dissimilar materials. For example, metal coatings are known with the introduction of polytetrafluoroethylene powder. If polytetrafluoroethylene is introduced in large quantities, the part acquires high hydrophobic properties and is not wetted by most liquids. Small amounts of polytetrafluoroethylene provide the parts with a better glide, and the ability to work without lubrication for some time due to the own lubricating properties of polytetrafluoroethylene [1-9].

For the introduction into the electrolyte, as a hardening additive, you can use powders obtained by the method of electroerosive dispersion (EED). The process of obtaining powder materials by the method of electroerosion dispersion differs favorably with the possibility of obtaining powders even from particularly hard and refractory materials. In the case of grinding material with this method, the only important criterion is the electrical conductivity of the material being ground. Worn-out parts and other scrap can be used as feedstock during the process [10-12].

The purpose of the study is to improve the technology of restoring worn automotive parts with composite electroplated coatings due to the use of electroerosive powders as a hardening phase.

2. Materials and methods
The composition used in the experiment electrolyte: iron sulfate 450 g/l; sodium chloride 250 g/l. The addition of EED powder to the electrolyte was 5 g/l.

Technological modes of coating: current density 20A/dm²; current output 90-98%; temperature 100 °C.

As the anodes were used plates of transformer steel. The plates have a convenient form, are available, and have a chemical composition close to pure iron.

In solving these tasks, modern methods of testing and research were used, including the microstructure of the obtained coating was studied using a Quanta 200 3D electron-ion scanning microscope and an OLYMPUS GX51 inverted optical microscope; For testing samples to determine adhesion / cohesive strength, scratch resistance and to determine the mechanism of destruction used scratch tester Revetest (CSM Instruments).

3. The study of the assess the wear resistance of electro-spark coatings
Figure 1 shows the microstructure of the sample to which the composite electroplating was applied. The coating thickness was 368,37 microns.

![Figure 1. The microstructure of the coating obtained in the electrolyte with the addition of EED powder](image)

Figure 2 presents the results of testing the adhesive strength of a composite electrolytic coating based on an electroerosive powder.
Depending on the change in acoustic emission and friction coefficient on the applied load

When scratching the coating on both samples abrasion, peeling and destruction of the coating were not recorded by the cohesive mechanism. The adhesive and cohesive strength of the coatings for both samples exceeds 190 N.

The experiments on the deposition of CEC showed that even a small addition of the dispersed phase in the form of solid powder material can improve the performance of the resulting coating. The method compares favorably with the ease of coating directly on the part. The low cost of consumables and equipment makes this process even more attractive for industrial implementation.

As a practical application of composite electroplating, based on ferrous sulfate electrolyte and electroerosive powder material, the piston pin was restored.

4. Conclusions
The paper solved an important scientific and practical task aimed at improving the quality of parts restored by electroplating.

Due to the study of the used powder samples, as well as the study of the coatings properties on modern devices, results were obtained showing the high potential of this recovery method. It has been established that even a small addition of EED powder to the electrolyte (5 g/l) allows to improve the performance of the deposited coating.

The availability of reagents and equipment used in this process, in combination with a high rate of material deposition on a part, makes this method promising for industrial realization.

Based on the results of the coating samples study, a technological process was developed to restore the piston pins of diesel engines.

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