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Cluster Structure Control of Coatings by Electrochemical Coprecipitation of Metals to Obtain Target Technological Properties

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Abstract. The article considers the possibility of controlling the macromolecular structure of ternary alloys in the form of compact coatings, which are obtained by electrochemical means. This method of obtaining metal clusters is more economical than from plasma one. The influence of the cluster structure of the synthesized coatings in the form of a triple alloy of polyligand complex electrolytes on their functional properties is shown. There are presented the results of testing coatings from this ternary alloy of different elemental and cluster composition for microhardness according to Vickers. The highest microhardness was obtained by the coating with the lowest molecular weight of the cluster, which provided a denser packing of atoms.

1 Introduction

The impetuous development of science and technology puts forward a number of requirements for the physical and mechanical properties of structural metals and alloys, as well as the modernization of equipment in the chemical industry, mechanical engineering and instrument making. At the same time, one of the main criteria for creating the latest functional materials is environmental friendliness and resource conservation of technological processes [1].

The performance of materials can be effectively improved by modifying the surface layer by applying electroplating coatings for the intended purpose. Low material consumption, technological simplicity of the process, the possibility of forming coatings of metals and multicomponent alloys, which are difficult to obtain by metallurgical or chemical methods, as well as wide variation in the properties of galvanic sludge depending on the nature of the precipitated components, determine the perspective of use the electrolyte alloys in industries [2, 3].

Electrolytic coatings based on chromium (VI), which are characterized by high hardness and wear resistance are often used to increase the strength of the working surfaces of parts. However, the aggressiveness and carcinogenicity of chromium electrolytes require additional measures to ensure the safety of personnel in the organization of the technological process, as well as special wastewater treatment [4]. Co-precipitation of platinum with Co, Mo, W is used to reduce the cost of platinum catalytic coatings.

2 Main Part

The properties and further target application of the synthesized electroplating coatings directly depend on the type of substance and its structure. Regarding the formation of the properties of the coating, it should be noted that metals are prone to the formation of clusters. Therefore, the question of the formation of the properties of the alloy is a question of the formation of the optimal cluster structure for the formation of the target properties. Electrochemical deposition is a convenient way to target the structure and composition of the cluster.

For solids, we can talk about the existence of a stable supramolecular structure, which is described by the concept of "cluster". The smallest supramolecular formation is a dimer. Nevertheless, the formation of clusters with a large coordination number is also recorded. There is a

optimal cluster structure. The highest strength of the alloy was obtained for the ratio Co–Mo–W (60 %, 22.1 %, 17.9 %, respectively), which allowed to form a cluster in the form of an icosahedron with a W atom in the center. Thus, the strength of clusters increases with decreasing molecular weight.

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