

OPPORTUNITY ELECTROCHEMICAL DEPOSITION OF ALUMINUM - NICKEL ALLOY

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In this paper we investigate the theoretical possibility of intensifying the process of electrochemical synthesis of protective thermal barrier coating aluminum-nickel at room temperature. We propose to use a pulsed deposition method from electrolyte based on aprotic organic solvent containing coordination compounds of aluminum and nickel.

Currently, there is a need to increase the reliability and service life of high-tech products, operating at high temperatures. This poses the problem of the development of fundamentally new materials and methods for their preparation. One solution to this problem is to form the film of heat-resistant coating on the surface of material, e.g. an aluminide of nickel, which provides effective thermal protection material in an oxidizing atmosphere. However, existing methods of obtaining such coatings (self-propagating high-temperature synthesis, hardfacing, spraying, mechanosynthesis, etc.) not only don't give required protection of material, but are complex, energy-intensive and inefficient.

The greatest interest and the relevance acquire electrochemical synthesis methods, which differ low cost and ease of hardware design. These methods of synthesis are possible to produce structures of a given composition and properties by controlling the process parameters. However, the production of aluminum alloys by this method is associated with a number of difficulties. The main difficulties are the inability of aluminum deposition from aqueous solutions and its simultaneous precipitation with other metals due to significant negative standard potential ($-1,66$ V) [1].

We investigated the possibility of forming an electrochemical alloy of aluminum-nickel, depending on the nature of the solvent. It is necessary to use organic aprotic solvents which do not contain mobile hydrogen atoms, such as ethylbromide, DMF (N,N-dimethylformamide), N,N-dimethylaniline, etc. They are electrochemically stable and may not recovered to potential $-3,0-3,5$ V. Their anodic oxidation potential is close to $1,0 \dots 1,5$ V.

Other factors affecting the electrodeposition process of this alloy are the choice of aluminum and nickel salts and electrolysis mode. It is known the alloy formation in electrochemical systems is only possible when combining of standard potentials. This can be achieved in several ways, one of which is the formation of coordination compounds. Bromide and aluminum chloride with the above solvents to form complexes, which shift the positive standard potential in the region of the side potential of nickel was investigated. Nickelsulphate contrary, forming a complex with these solvents, shifts of nickel deposition potential in the negative region [2]. As a result of combining the potentials of both metals, is possible formation of alloy NiAl, and intermetallic composites of Ni_3Al , Ni_2Al_3 .

Electrodeposition mode also plays an important role. When using the DC cathode layer depletion of ions is achieved too quickly. This can lead to changes in the nucleation and complete cessation of the formation of the coating [3]. Pulse mode of deposition provides better control of the microstructure of sediment, allowing adjusting the speed of crystal growth. This leads to more subtle grain structure, stress decrease, high wear resistance. It is also increases corrosion resistance, hardness, porosity, and decreases amounts of impurities. This mode also allows using higher current density, which helps to avoid the limitations of the concentration [4].