Nanocomposites and nanomaterials

Electrochemical formation of multilayer metal and metal-oxide coatings in complex electrolytes

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Multilayer coatings, consisting of periodically alternating layers of metals with thickness from several nanometers to several tens of nanometers, have a number of improved properties compared to the component metals. The electrochemical method of formation has great potential because of simple and cheap implementation in production. Using complex electrolytes for coating deposition allows producing films and coatings, which significantly differ from those obtained in electrolytes based on simple metal salts.

The method of Cu/(Ni-Cu) multilayer coating formation in pyrophosphate-ammonium electrolyte is proposed [1]. Due to complex nature of discharging metal compounds, it is possible to deposit thick coatings as well as thin films. These coatings are nonporous at the thickness of 4-4.5 μm and corrosive resistant. The microhardness of coatings is 530-740 *HV*, the internal stresses is 80-240 *MPa*.

Catalytically active nickel-copper multilayer coating was formatted in the same electrolyte by cathodic deposition of metals and metal-hydroxides layers on the extended copper substrate with following anodic oxidation in sodium hydroxide solution. Complex electrolyte allows achieving the mechanically strong hierarchically extended structure. The catalytic activity of the electrode with multilayer coating (tested in the methanol oxidation reaction) is 20-30 % higher in comparison with copper-nickel alloy coating.

The method of formation of multilayer coating of tin dioxide doped with antimony on titanium substrate in the pyrophosphate-tartrate mono-bath is proposed [2]. The electrode has higher operating life then electrode with thermolysis-formated active layer.

1. *Maizelis A.A., Bairachniy B.I., Trubnikova L.V., Savitsky B.A.* The effect of architecture of the Cu/(Ni-Cu) multilayer coatings on their microhardness // Functional Materials.-2012.-**19**, N 2.-P. 238-244.
2. *Maizelis A. Bairachniy B.* Electrochemical formation of SnO_2-Sb_xO_y composition-modulated coating // Technology audit and production reserves.-2015.-**6**, N. 4(26).-P. 59-61.