Nanocomposites and nanomaterials

Electrodeposition of nanostructured rhodium from low-temperature ion-organic melts

A.V. Savchuk, S.A. Kochetova, L.V. Bogdanovich, V.V. Malyshev

Department of Physical Chemistry of Ionic Liquids, V.I. Vernadsky Institute of General and Inorganic Chemistry, Natl. Acad. of Sci. of Ukraine.
Prospect Akademika Palladina, 32/34, Kyiv-03142, Ukraine.

This work is devoted to the electrochemical synthesis of complex compounds of rhodium ions in the urea and acetamide based ion-organic melts, to the study of their properties and structure, and to carrying out the cathodic deposition of Rh nanocoatings onto different metal substrates.

The anodic dissolution of rhodium was carried out in the melt of the individual urea and in the eutectic melt urea-NH_4Cl (16.8 mol. %) (T = 130°C). Anodic dissolution of rhodium in these electrolytes is accompanied by the passivation together with the formation of Rh(III) complexes.

The complex compound $[Rh(NH_3)_4Cl_2]^+$ in the investigated melts is electro-active, and its reduction is observed in the cathode part of the cyclic voltammo-grams as a maximum. Determination of kinetic parameters of the Rh(III) reduction process was carried out by a conventional method. Dependence $i_p/V^{1/2}$ on $V^{1/2}$ is straight and parallel to the abscissa indicating that the process goes in the diffusion mode but is irreversible since there is an i_p dependence on $V^{1/2}$. The diffusion coefficient of rhodium ions in the urea-chloride and chloride-acetamide melts is determined by their conductivity, and its value is $8.4 \cdot 10^{-6}$ cm^2/s for these systems. Rhodium ions reduction proceeds irreversibly in diffusion mode in one step to the metal.

Rhodium deposit particles size is within the range 10-22 nm. The size of rhodium crystallites was evaluated by physical extension of peaks and is equal to 5 nm. It indicates the formation of rhodium nanocomposites at the surface of Fe, Cu, and Mo metals in the melts under investigation. Rhodium coatings obtained from melts on the base of urea and acetamide with soluble rhodium anode are gray, uniform, and 6.1 micron thick. The current efficiency during their formation was 85-90%.