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UDC 621.357.7

*RESONANCE PHENOMENA AT THE BISMUTH ELECTRO-DEPOSITION FROM THE MAGNETIZED ELECTROLYTE**

SUMMARY. The polarization curves (PC) of the electrodeposition of the pre-activated with magnetic field (MF) bismuth from unmagnetized electrolytes are registered by the disk electrode rotating method. The influence of the magnetic field intensity on the behavior of the polarization curves of the bismuth electrodeposition from the trilonate electrolyte is studied. It is found that the electrolyte magnetizing results in the resonant change in the cathode current density caused by the MF intensity. The periodic fluctuations in the current density due to the MF intensity correlate to the dependencies of the electrical conductivity of the electrolyte on this parameter, and in case of using non-conductive glass or PVC tubes for the bismuth-formation electrolyte magnetizing, no changes in the electrical conductivity are registered. According to the data obtained, the optimal condition for the pre-magnetization of the electrolyte is selected as equal to 190 kA/m. It is the electrolyte activated by the magnetic field of the specified intensity, which enables the disperse coatings of the highest quality with a subdued relief and gloss to be deposited.

KEY WORDS. Magnetic field, polarization curves, resonance phenomena, cathode polarization.

While solving a number of applied problems of electrodeposition, we are interested in the changes in the parameters of the electrolytes when not only the chemicalization, but also external physical influence (ultrasonics, magnetic fields, etc.) is applied. It was previously found [1], [2], [3], [4] that the influence of magnetic fields on the electrolyte solution improves the process characteristics of electrolytes and increases the quality of the coatings obtained.

In this paper, the influence of the bismuth electrolyte magnetization on the bismuth electrodeposition is studied.

The polarization curves of the bismuth electrodeposition were recorded by the potentiodynamic method with the potential scan rate of 0.004 V/sec using the *IPC-Pro* potentiostat-galvanostat, a software-hardware complex, consisting of a potentiostat, measuring module, and a personal computer. The three-electrode cell, consisting of a working glassy-carbon electrode rotating with the face end area $S = 6.15 \cdot 10^{-2}$ cm^2), an auxiliary glassy-carbon electrode, and a reference silver chloride electrode (*JeVL-1M*), was used.

* The authors would like to express their deepest appreciation to M.S. Barsukova who helped them in the experimental work.

The bismuth electrodeposition was carried out from the electrolyte of the following composition: $BiCl_3 \cdot H_2O$ — 0.01 M; Trilon B — 0.006 M; NH_4Cl — 0.01 M. The electrolyte was prepared on distilled water from chemically pure reagents.

The electrolyte was magnetized at the transformer-type lab-scale plant, with a solenoid energized. The electrolyte solution was fed with the rate of 0.22 m/sec through a metal tube (Steel 3) 10 cm in length and 0.9 cm in diameter, which was located in the pole gap of the plant. The magnetic field intensity varied in the range of 0-220 kA/m. The electrolyte had been activated immediately before the electrolysis.

The analysis of the polarization curves obtained (Fig. 1) enabled determining a periodical dependence of the cathode current density on the magnetic field intensity at various values of the cathode polarization (Fig. 2). Besides, the higher the cathode polarization was, the more significant the current density changed during the bismuth electrodeposition. Such dependence correlates well with the changes in some physicochemical properties of water solutions with the MF intensity increase while water-based systems are magnetized [5-7].

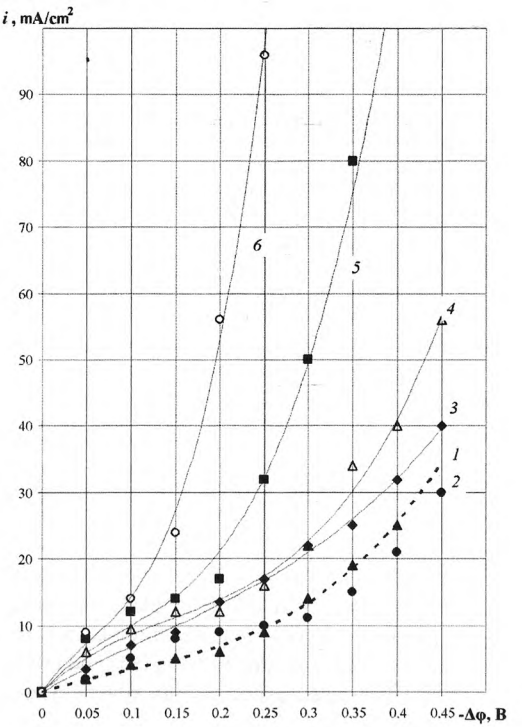

Fig. 1.The polarization curves of the bismuth electrodeposition from the trilonate electrolyte at the stationary electrolysis (1) and magnetoelectrolysis (2-6) at the MF intensity values (kA/m) as follows : 25 (2); 170 (3), 210 (4), 115 (5); 190 (6)

According to the data published [5], [6], [7], the periodical change in water properties with the MF intensity increase is explained by the Larmor regularity. Its point is that, when the MF intensity changes, resonance systems may occur in water solutions. At this moment, the equality of the three frequencies is registered: the vibration frequencies of two adjacent water molecules and the Larmor frequency. The Larmor frequency permanently increases, when the MF intensity increases, and, since the vibration frequency spectrum of water molecules is discrete, the equality of all the three frequencies is possible only at the certain MF intensity value. These are the intensity values when the hopping of water physicochemical properties (electroconductivity, wettability, viscosity, surface tension) is registered, and the dependency of the polyextreme type is observed.

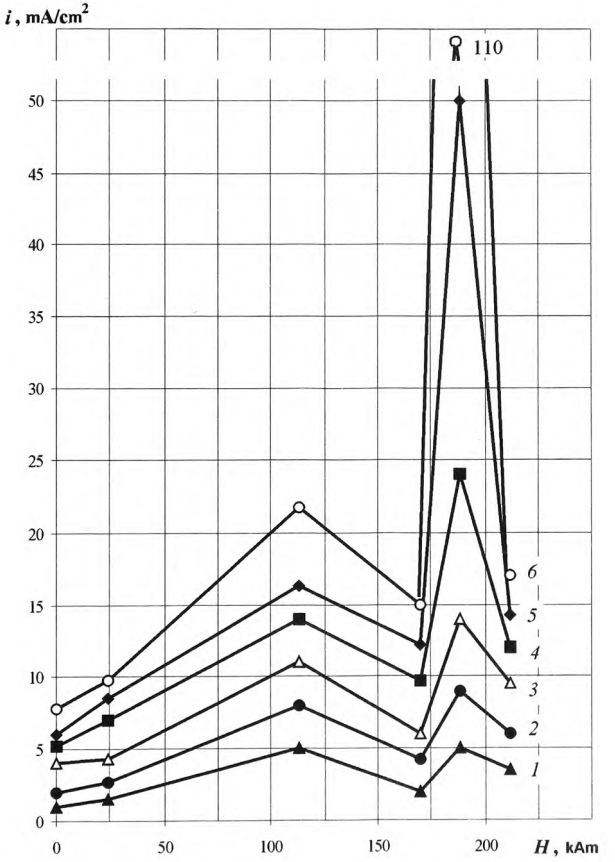

Fig. 2. The dependence of the current density on the MF intensity at the cathode polarization, V: 0.025(1); 0.05 (2); 0.1 (3); 0.15 (4); 0.25 (5); 0.3 (6)

The investigations of the bismuth-formation electrolyte electroconductivity with the MF intensity increase confirmed the polyextreme type of this dependency (Fig. 3). Noticeable changes (10-12%) in the electrolyte electroconductivity occurred exactly at the same MF intensities as the cathode current density increased in the bismuth electrodeposition. Moreover, in case of using non-conductive glass or PVC tubes for the electrolyte magnetizing, no changes were registered.

Thus, the MF influence on water-based systems is obviously connected with the phenomena of the resonance type [5], [8], [9]. According to this idea, water molecules, their associates, and hydrated ions vibrate at the frequencies with the corresponding energy levels. When the optimal frequency affects the MF system, the resonance is possible, and it is accompanied by the appearance of energy quanta that can deform the bonds between the particles and change the structural pattern of the system.

According to the data obtained, the optimal condition for the pre-magnetization of the electrolyte was selected as equal to 190 kA/m. It is the electrolyte activated by the magnetic field of the specified intensity, which enables the disperse coatings of the highest quality with a subdued relief and gloss to be deposited.

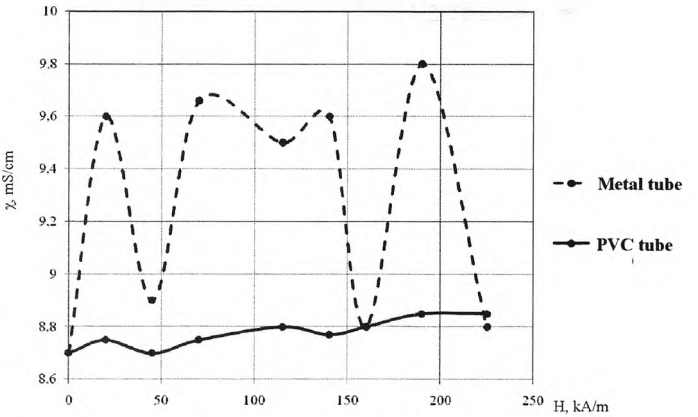

Fig. 3. The dependence of the electrical conductivity of the bismuth-formation electrolyte on the MF intensity

This may be probably explained by the increased number of active and simultaneously growing nuclei of crystallization, as the Lorentz force causes the decrease in the diffusion limitations and in the diffusion layer thickness, which results in the accelerated metal ion recovery on the cathode surface [11], [12].

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