9th International Workshop on Electrodeposited Nanostructures

Electrodeposition and etching of metals in electrolytes under inhomogeneous magnetic field

Oksana Gorobets[1,2], Yuri Gorobets[1,2]

[1] Faculty of Physics and mathematics, National Technical University of Ukraine "KPI", Peremogy Avenue 37, Kyiv 03056, Ukraine, o_gorobets@ukr.net
[2] Institute of Magnetism NAS of Ukraine and MESYS of Ukraine, Vernadsky Avenue 36-b, Kyiv 03142, Ukraine, Gorobets@imag.kiev.ua

The investigation contains new approach to theoretical modeling of an inhomogeneous magnetic field influence on electrochemical reactions including electrodeposition and etching. The quantitative model is built and compared with new experimental data about anisotropic corrosion, chemical etching and deposition of metals under an inhomogeneous magnetic field influence. First of all, it was shown in this work that the certain part of ions in an electrolyte in a magnetic field enter into the composition of nanoclusters of effectively dia- or paramagnetic ions (further - magnions). The nanobubbles, stabilized by paramagnetic or diamagnetic ions in electrolytes, and colloid particles with their ionic surrounding render the major contribution into the formation of magnions. In this work it is shown that the significant difference of concentrations of reagents and reaction products arise between the different regions of the chemically homogeneous electrode surface due to the influence of a gradient magnetic force on magnions in inhomogeneous distribution of magnetostatic fields. The direction of a gradient magnetic force is defined by the sign of the effective magnetic susceptibility of magnions relative to the magnetic susceptibility of an electrolyte. Summarizing the results of this work it is obvious that the inhomogeneous distribution of a magnetostatic field at the surface of both ferromagnetic and non-ferromagnetic electrodes in an electrolyte and accumulation of the reaction products in the form of the effectively para- or diamagnetic magnions lead to the creation the quasi-stationary heterogeneous states of electrolyte at electrodeposition and etching process in a gradient magnetic field and to the creation of the magnetically induced electric cell voltage up to several tens mV at moderate magnetic fields 0.1 T – 1 T. These results have the general nature for different electrolytes and electrode materials. Besides, the effects of the gradient magnetic field at electrodeposition and etching become apparent at the very wide scale ranges from nano-size grains to micro- and mesoscale electrodes. Existence of magnions in electrolytes has the fundamental consequences for such field of research as magnetoelectrolysis.

References:

[1] M.Yu. Ilchenko, O.Yu. Gorobets, I.A. Bondar, A.M. Gaponov "Influence of external magnetic field on the etching of a steel ball in an aqueous solution of nitric acid", Journal of Magnetism and Magnetic Materials 322, 2075–2080 (2010).

[2] O.Yu. Gorobets, V.Yu. Gorobets; D.O. Derecha; O.M. Brukva, "Nickel Electrodeposition under Influence of Constant Homogeneous and High-Gradient Magnetic Field", J. Phys. Chem. C, DOI: 10.1021/jp0762572 (2008).