9th International Workshop on Electrodeposited Nanostructures

Inverse structuring of electrodeposits in applied magnetic field gradients

Tschulik, Kristina; Uhlemann, Margitta; Mutschke Gerd; Gebert, Annett; Schultz,Ludwig

Leibniz Institute for Solid State and Materials Research Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Structured deposits can be generated by electrodeposition of metals in magnetic flux density gradients. The distribution of the deposit thickness was found to correlate directly with the distribution of the magnetic flux density and its gradient at the working electrode. This structuring was reported to be only successful when paramagnetic ions are the electroactive species. Resently it was demonstrate that magneto-electrochemical deposit structuring also succeeds when only diamagnetic electrochemical active ions are involved in the deposition process, but electrochemically inert paramagnetic species are present in the electrolyte [1-3]. Structured Bi layers were derived from these systems, while homogeneous Bi deposits were obtained without addition of paramagnetic species. To clarify the mechanism potentiodynamic and potentiostatic investigations were performed, including measurements of the deposited mass with an Electrochemical Quartz Crystal Microbalance. The structured deposits show an inverse correlation between deposit thickness and superimposed magnetic field gradient. Minima of film thickness are observed in regions of maximum magnetic gradients. The morphology of the Bi deposit remained almost unaffected. The magneto-electrochemical structuring by deposition of diamagnetic ions is discussed considering the acting magnetic forces. It was revealed that during the reverse-structuring convection is induced in the electrolyte, which is directed away from the working electrode in regions of high magnetic gradients. Due to this additional convection, the overall deposition rate is increased, whereby it is locally reduced in regions of high magnetic gradients.

References:

[1] K. Tschulik, C. Cierpka, G. Mutschke, A. Gebert, L. Schultz, M. Uhlemann, "Clarifying the mechanism of reverse structuring during electrodeposition in magnetic gradient fields", Analytical Chemistry **84** (5), 2328-2334(2012)

[2] K. Tschulik, X. Yang, G. Mutschke, M. Uhlemann, K. Eckert, R. Sueptitz, L. Schultz, A. Gebert "How to obtain structured metal deposits from diamagnetic ions in magnetic gradient fields?", Electrochemistry Communications **13**, 946-950(2011)

[3] Dunne,P.; Mazza,L.; Coey,J. M. D. "Magnetic Structuring of Electrodeposits" Phys. Rev. Lett.**107**, 024501, (2011)