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Analyzing the mechanism of magnetic gradient field based electrochemical structuring by in situ velocity measurements

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The ability of structuring electrodeposits by means of magnetic gradient fields has been studied intensively within recent years. It was reported that the structuring is induced by the magnetic field gradient force. Yet, different suggestions regarding the actual structuring mechanism were proposed in the literature for different electrochemical systems [1,2].
In this work we present in situ measurements of the electrolyte convection during electrodeposition in magnetic gradient fields. Two different sets of electrolytes were investigated. The first, an electrolyte containing electro-active paramagnetic Cu^{2+} ions, enabled structured deposition yielding the "standard" structure, i.e. increased deposit thickness results in regions of maximum magnetic gradients [3]. The second, a solution containing diamagnetic Bi^{3+} ions as the electroactive species and electrochemically inactive paramagnetic Mn^{2+} ions, enabled "inverse" structuring. Here, a decreased deposit thickness is observed in regions of high magnetic gradients [4]. Both types of magnetic gradient field-based structuring were found to originate from locally induced electrolyte convection. In regions of maximum magnetic gradients this convection is directed towards the working electrode in the Cu^{2+} containing electrolyte, while for the Bi^{3+} containing electrolyte the flow is directed away from the electrode in these regions. Consequently the mass-transport is locally increased or decreased, respectively, causing the observed differences in electrode thickness.

Refernces:

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