Equilibrium Electro-convective Instability in Electrodeposition with Butler-Volmer Kinetics

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Abstract

In this presentation we report that equilibrium electro-convective instability is possible in concentration polarization in the course of cathodic electrodeposition. The cathode is modelled as an ideally perm-selective interface with infinite lateral conductivity. The cation transfer across the cathode/solution interface is assumed to obey the Butler-Volmer kinetics with parameters typical of copper deposition. It is shown that deviation from the local reaction equilibrium due to the final deposition reaction rate renders possible the equilibrium electro-convective instability with a critical wavelength on the scale of diffusion layer width. This scaling may be recognized as a characteristic signature of equilibrium instability as opposed to the non-equilibrium one, related to the extended space charge. This latter instability, owning to its shortwave character, is characterized by origination of critical small vortices with a wavelength considerably shorter that the width of the diffusion layer. Interaction of these small scale vortices yields their fusion through which they evolve until reach a size comparable to the width of the diffusion layer.