SIMULATION OF ELECTROCHEMICAL PROCESSES AT A ROTATING DISC ELECTRODE

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Because of controllable flow conditions and the nearly uniform density distribution along the electrode, the rotating disk electrode (RDE) is a powerful tool to investigate electrochemical reaction mechanisms.

In this contribution, a combination of RDE-experiments with a special simulation software [1] will be presented in order to study the response of selected electrochemical systems on transient currents. These experiments are useful to elucidate some special aspects concerning pulse plating processes.

The RDE-simulation is based on the non-simplified dilute solution model, which takes into account all driving forces causing the ion-movement (diffusion, convection and migration). By using the van Karman velocity field and solving the corresponding 1-dimensional mathematical model, the spatial potential field as well as the ion concentrations c(x,t) in the electrolyte and in the front of the electrode can be evaluated. In this contribution, the quantity of special interest is the dependence of the surface ion concentration c(0,t) on transient current signals.

A prerequisite in evaluating c(0,t) for a special ion of a given electrolyte is the precise knowledge of the electrochemical reaction mechanism and of all the parameters characterizing the ion system (diffusion coefficients, mobilities, viscosity), which, in general, are only partially known from literature. In this contribution, the RDE polarization curve is introduced into the above mentioned simulation software and compared with the simulated one in order to get a complete set of parameters.

We followed such a strategy for the copper deposition process using acid electrolytes by taking into account homogeneous reactions as well as the adsorption of chlorine. With the help of the resulting parameters the temporal fluctuations of the copper ion surface concentration c(0,t) were evaluated for a special pulse profile (see, Figs. 1 -3).

The parameters determined by this modelling strategy can be introduced into more sophisticated mathematical models to evaluate current densities and deposition profiles occuring in pulse plating techniques.

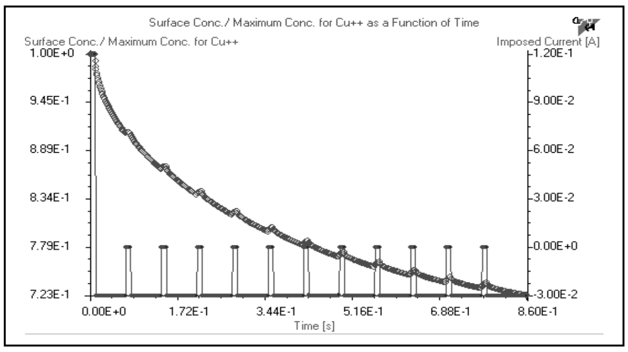

Fig 1. Cu^{++} surface concentration versus time depending on current pulses (12 pulses per cycle)

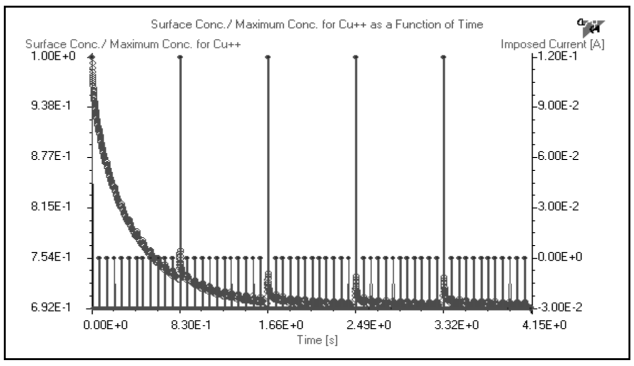

Fig 2. Cu^{++} surface concentration versus time depending on current pulses (5 cycles, every cycle consisting of 12 pulses).

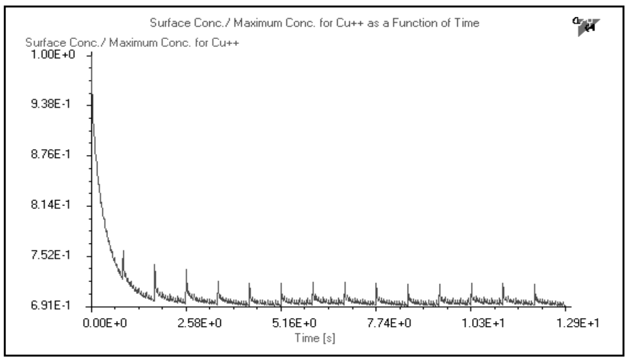

Fig. 3. Cu^{++} surface concentration versus time depending on current pulses (15 cycles, every cycle consisting of 12 pulses)

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