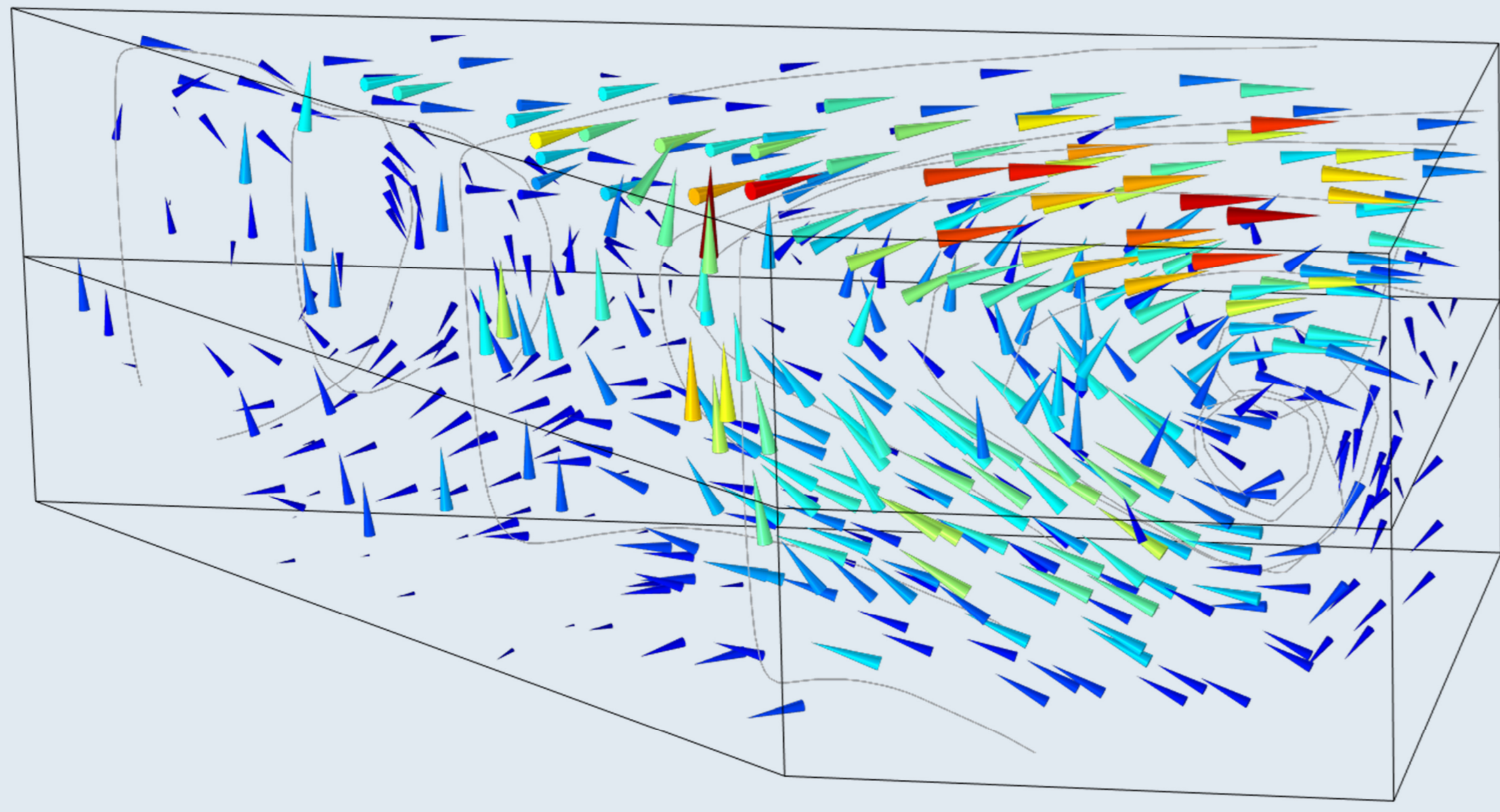


# Influence of the Complexing Agent on the Throwing Power during Silver Electroplating



Simulation of electrochemical deposition through combination of the Tertiary Current Distribution, chemical equilibrium reaction, CFD and the particle transport via Nernst-Planck.

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## Introduction

The modeling of silver electroplating must consider the complexation of the silver ions, the movement of the ions to the cathode and the reactions that take place there. An important criterion in electroplating especially for the industrial use of an electrolyte is the throwing power, which describes the uniformity of the electroplated metal thickness [1]. The stronger the complexation of the silver ions, the better the throwing power. For this reason, the model and simulation can be tested by using different complexing agents and their

influence on the thickness distribution. For this purpose, a special experimental setup the Hull cell is commonly used. The geometric structure of the Hull cell makes it possible to achieve different current densities on the cathode in one experiment and to compare the resulting layer thicknesses with these [2]. In the case of poor throwing power, the layer thicknesses correspond to the distribution of the electric field; in the case of maximum throwing power, the layer thickness is constant over the entire cathode.

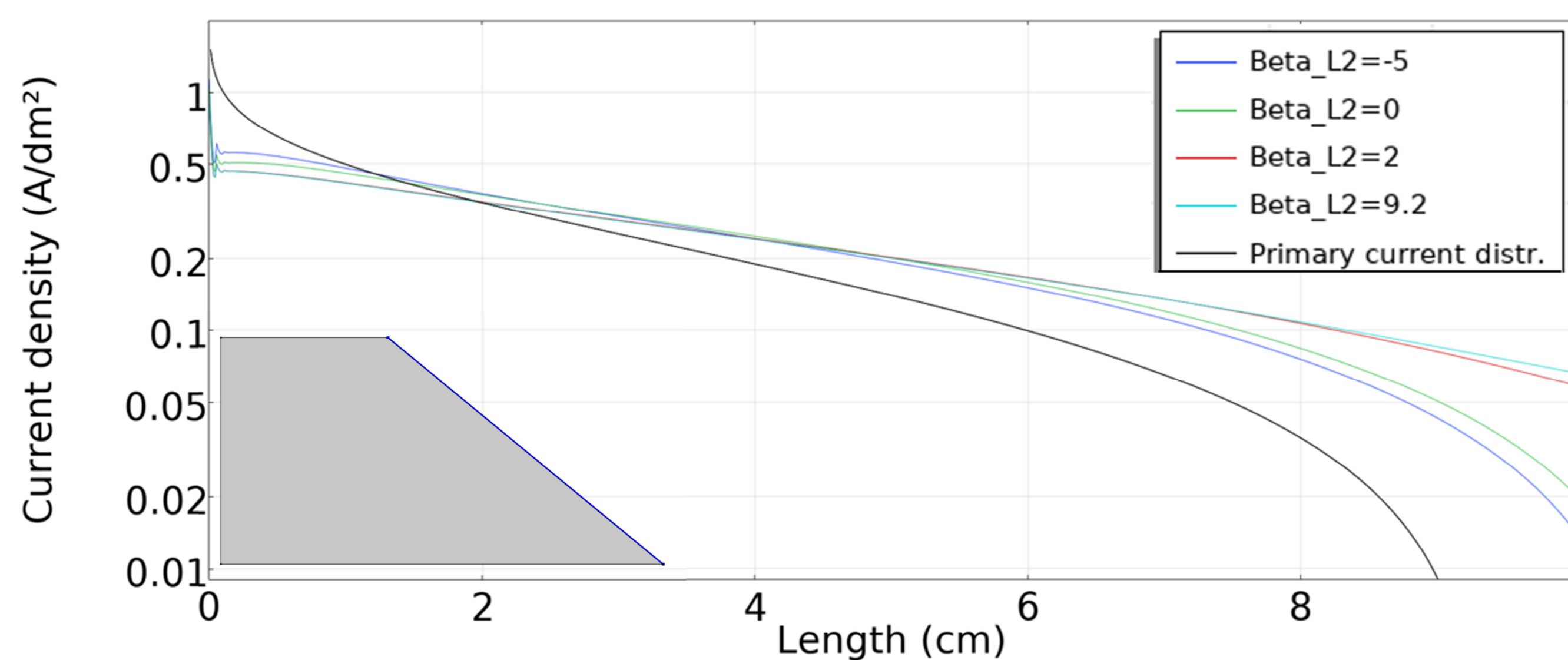


Figure 1: Thickness distributions across the Hull cell depending on the strength of the silver complex, comparison between simulated and measured data

## Methodology

For a realistic description of an electrochemical deposition the electrical field, chemical reactions in the electrolyte and on the surface and the mass transfer of the ions must be considered. For this purpose, the CFD Module is combined with the Tertiary Current Distribution and the particle transport via Nernst-Planck. The complexing of the silver is modeled as a chemical equilibrium reaction, however the use of it impairs the convergence of the model. The general influences were simulated in 2D. The model was then expanded into 3D under the assumption of natural convection because of density gradients of the electrolyte in front of the electrode. The Boussinesq approximation was used to simulate this effect.

## Results

The 2D simulations of the Hull cell are showing, that the complexing agent has an influence on the distribution of the current density. But for the industrial application significantly matters only a very strong complexation of the silver ions otherwise the thicknesses are not sufficient uniform (Fig 1). Overall, there was a good correlation between the experimental (Fig. 2 bottom left) and simulated thickness distribution (Fig. 2 bottom right) on the cathode. The decrease of the layer thickness with height on the Hull cell plate is caused by a continuous upward flow of low metal concentration electrolyte at the cathode due to natural convection. This results in a lower local exchange current density corresponding to the concentration-dependent Butler-Volmer kinetics (Fig. 2 top right).

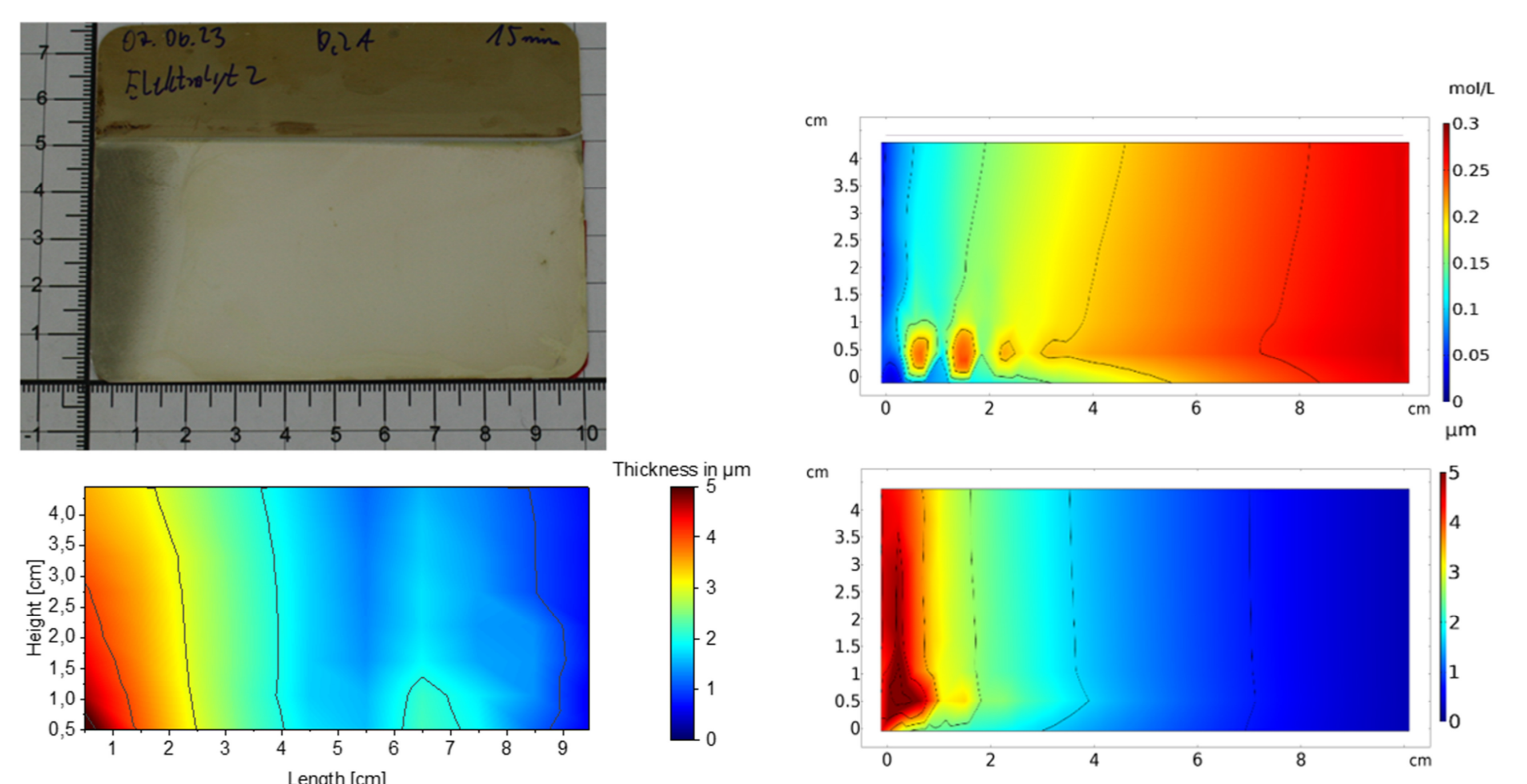


Figure 2 left: Hull cell deposition and measured thickness distribution (bottom); right: Simulated metal concentration at the cathode and resulting thickness distribution (bottom)

## REFERENCES

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