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Modelling the Scaling-Up of the Nickel Electroforming Process

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Electroforming is increasingly gaining recognition as a promising and sustainable additive manufacturing process of the "Industry 4.0" era [1], allowing for development of structures from the nanoscale [2, 3] to macroscale [4, 5]. Numerous important laboratory-scale studies try to shed light onto the pressing question as to which are the best industry approaches to be followed towards the process's optimisation. However, for electroforming to be successfully optimised and efficiently applied in industry, systematic scale up studies need to be conducted. Nowadays, well-informed simulations can provide a much-desired insight into the novelties and limits of the process, and therefore, scaling up modelling studies are of essence. Targeted investigations on how the size and geometry of an electroforming reactor can affect the final product could lead to process optimisation through simple modifications allowing immediate time- and cost-effective adjustments within existing production lines.

To model the scale up of the nickel electroforming process we will present two 3-D, time-dependent, secondary current distribution electrodeposition models, one of a recessed RDE and one of a 18 L electroforming reactor, which was 90 times larger than the RDE system. The RDE system was chosen because it is a common laboratory-scale apparatus to gather electrochemical data. Both systems were subject to geometry and model sensitivity studies using a commercial software (COMSOL Multiphysics®) as is often done in industry. The results of the two models were compared to identify the key model parameters during scale up. The model results were validated against experimental data collected in the laboratory for both cases to assess model validity.

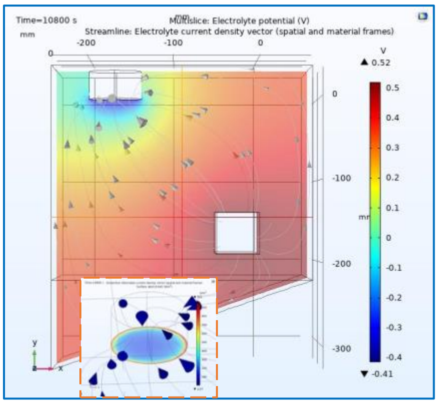

Figure 1: 3-D representation of potential and current distribution in an electroforming reactor.

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