Aluminization Process From Ionic Liquid In Operative Conditions: Validation And Perspective

A. Giaccherini[1], E. Berretti[1], S. Martinuzzi[2], S. Caporali[2]
1. University Of Florence, Department of chemistry, Via Lastruccia 3-13, Sesto Fiorentino, 50019.
2. INSTM, Firenze, Italy

Introduction:

Obtaining a smooth film with high deposition rates is a difficult task for Ils base process, due to their peculiar transport proprieties, a careful design of the galvanic process is required. We recently developed a complete FEA model suitable for the description of a very specific electrodeposition process of Al from BMIMCl/AlCl3(1:1.5).[1] Here we report a labscale model for an electrodeposition process carried out in a stirred beaker.

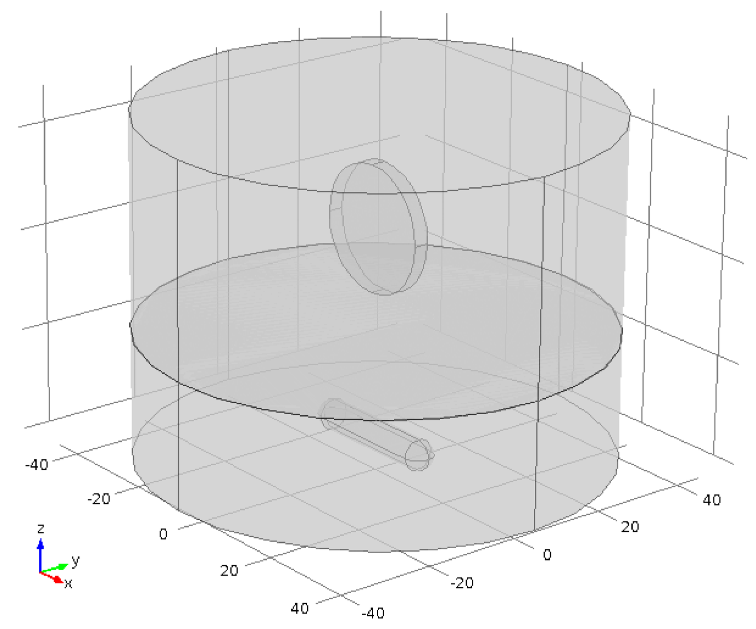

Figure 1. A typical beaker with a magnetic stirrer, a disk cathode and cylindrical anode

Computational Methods: The uncoupled problem has been solved in two step:
Solution for the pseudo stationary state of the Navier-Stokes equation. Laminar flow is assumed due to high viscosity of the IL.

$$k\nabla^2 v - \rho(v\nabla v) - \nabla\rho = 0$$

$$\nabla \cdot v = 0$$

The resulting laminar flow advection field has been given as input of the electrodepositionl interface, to solve for the time dependent current in order to estimate the tertiary current density distribution:

$$\nabla^2\phi_l = -\frac{Q_l}{\sigma_l}$$

$$\frac{dC_i}{dt} = \nabla \cdot (-D_i\nabla C_i - z_i u_{m,i} F C_i \nabla\phi_l + \underline{u} C_i)$$

CFD module supplies a method for simplifying the study of quasi steady state flow through the Frozen Rotor feature. The method assumes that the vessel and baffles are frozen relative to the stirring bar, and centrifugal and Coriolis forces are added to the domain surrounding the bar.

Results: Figure 2 reports the velocity field for in the frozen rotor approximation and the resulting current density streamline. While the first correspond to the velocity field that can be trace experimentally, the second one need more study to be validated.

a b

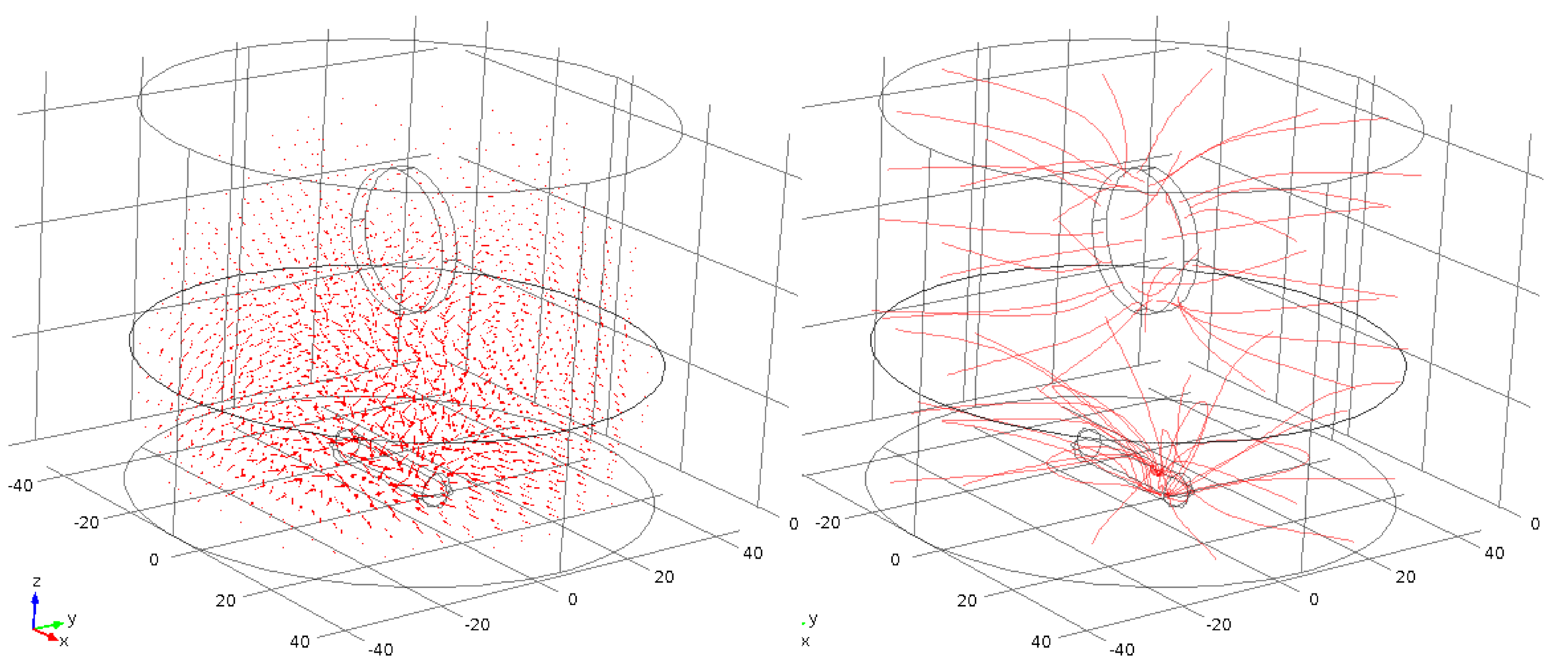

Figure 2. Velocity field (a) vectors and current density streamlines (b)

Conclusions: This work is a first evaluation of the validity of the frozen rotor approximation for the simulation of a stirred beaker. The agreement is good, further analysis will be carried before using the model to optimize labscale setup dedicated to IL electrochemistry.

References:

1. Giaccherini, A., et al. Current Density Distribution for a Full Scale Industrial Alluminization Process Comsol Conference 2015 Grenoble

Acknowledgements:

"The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 608698"