NON INTRUSIVE ASSESSMENT OF TRANSPORT PHENOMENA IN ELECTROCHEMICAL PROCESSES

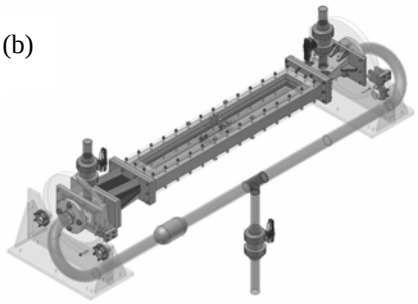
Flora Tomasoni, Italy
Supervisors: Prof. J.-M. Buchlin & Prof. J.P.A.J. van Beeck
Promoter: Prof. J. Deconinck (Vrije Universiteit Brussel, Belgium)

Electrochemical processes are governed by multi-component mass, heat and charge transport in laminar and turbulent flows that are often of multi-phase type due to the gas evolution at the electrodes. The common characteristic in all these processes is “charge-driven mass transfer".

The influence of gas evolution on the electrochemical production process is investigated. Bubbles formation, growth, detachment and dynamics are studied in order to achieve a fundamental understanding of the influence of gas evolution on the flow field and on the mass transfer. The characterization of the flow field that develops in the reactor is necessary to understand the influence of turbulence on the mass transfer.
To achieve such an objective, extensive experimental campaign is conducted on laboratory models of industrial electrochemical reactors.
The theoretical part of this study is to provide new analytical models with the aim of correlating the bubble formation mechanisms and evolution with the characteristics of the mass and momentum boundary layer.

The reactors under investigation are the Inverted Rotating Disk (Figure 1a) and the Parallel Flow Reactor (Figure 1b). The first reactor facilitates gas evolution and free convection studies, while the second one can be considered as a prototype of an industrial reactor (high Reynolds number).
Shadow imaging and the software Focused-Recognition-Overlapping-Globules (FROG), which take into account the out-of-focus bias and discriminates overlapping bubbles (Figure 2), provide bubble size distribution.
Flow field characterization has been performed by means of two components Laser Doppler Velocimetry (LDV) measurement technique. Figure 3 shows a plot of the velocity profile in wall units: the experimental data and the theoretical predictions in the viscous sublayer and in the logarithmic region are in good agreement.

(a)



(b)

Figure 1: Inverted Rotating Disk Electrode (a) and Parallel Flow Reactor (b)

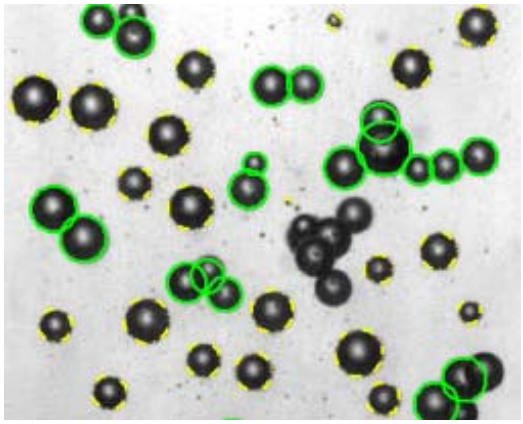


Figure 2: Bubble sized with FROG. Dashed line: in-focus bubbles; continuous line: overlapping bubbles

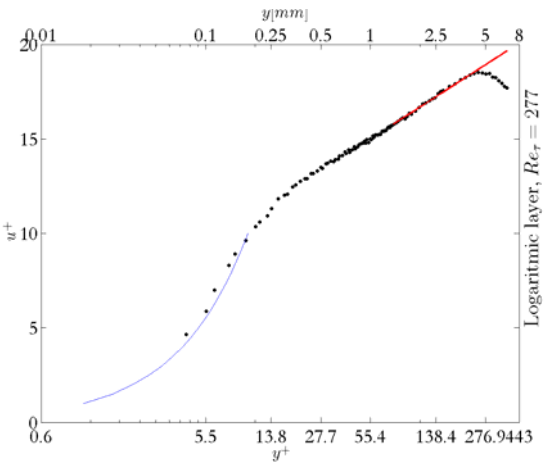


Figure 3: Average velocity profile