Non-intrusive assessment of transport phenomena at gas-evolving electrodes

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Gas-evolving electrodes are systems where gas bubbles are produced after a heterogeneous reaction. This thesis provides new insights into the multidisciplinary and multi-scale nature of the involved phenomena. A combined theoretical and experimental approach allows to successfully interpret and model the bubble nucleation, growth and detachment from the electrode. The importance of the different forces acting on moving bubbles is examined and a model is developed for describing the effect of bubble evolution on mass transfer by solving the unsteady diffusion-advection equation. The experimental techniques for measuring bubble size are reviewed and backlighting is selected as the most suited one. In order to overcome the difficulties arising with out-focus bubbles and bubbles overlapping, a model for bubble shadow and a module for bubble “erosion” are developed and implemented (FROG). This brings an increase of four times of the void fraction limit of the technique itself. The effect of the contact angle on the bubble diameter is investigated by varying the electrode potential difference.

Experimental results are presented and analysed for bubble evolution in A.C. graining, in a turbulent bubbly channel flow and in a rotating bubble plume. In order to better understand the bubble layer development, a model for micro bubble motion is developed and successfully validated with the measurements. The methodology developed proved to be effective.