NUMERICAL SIMULATION OF BUBBLE FORMATION AT MICROSCALE IN ELECTROCHEMICAL PROCESSES

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The simulation at micro-scale provides an accurate way for studying the formation of hydrogen bubbles by created by electrochemical processes. The current investigation focuses on the hydrodynamical effects of the growing bubble and its influence on the electrochemical process, e.g. due to changing conductivity of the solution.

The simulation at micro-scale means that the bubble size is much larger than the element size of the computational mesh (usually 50-100 times), allowing high resolution of the changing bubble shape and simulation of the complete velocity distribution in the vicinity of the bubble, during its formation and lift off.

The current work is based on an axisymmetric, incompressible Navier-Stokes single phase Finite Element solver with PSPG and SUPG sterilizations [1]. The two-phase problem is treated by changing material properties like density and viscosity, chosen differently in the gas respectively liquid sub-domains [2].

The surface tension on the bubble boundary is incorporated as a source term which acts on the interface in its normal direction. The bubble interface is tracked using a Level Set Method [3]. To follow the movement of the interface an adaptive mesh algorithm is used, having the crucial property that the edges of the elements are aligned with the interface. This approach allows to treat the bubble interface as an interior boundary on which the surface tension can be applied as a true boundary force. It also allows to incorporate the mass transfer boundary condition originating from the solver for multi-ion transport and reaction [4]. This boundary condition provides a hydrogen mass flux from the supersaturated liquid into the bubble which is responsible for the bubble growth and the displacement of the bubble boundary.

Computational results will be shown for the bubble growth and detachment process, coupling the flow with the electrochemical ion transport and hydrogen formation.

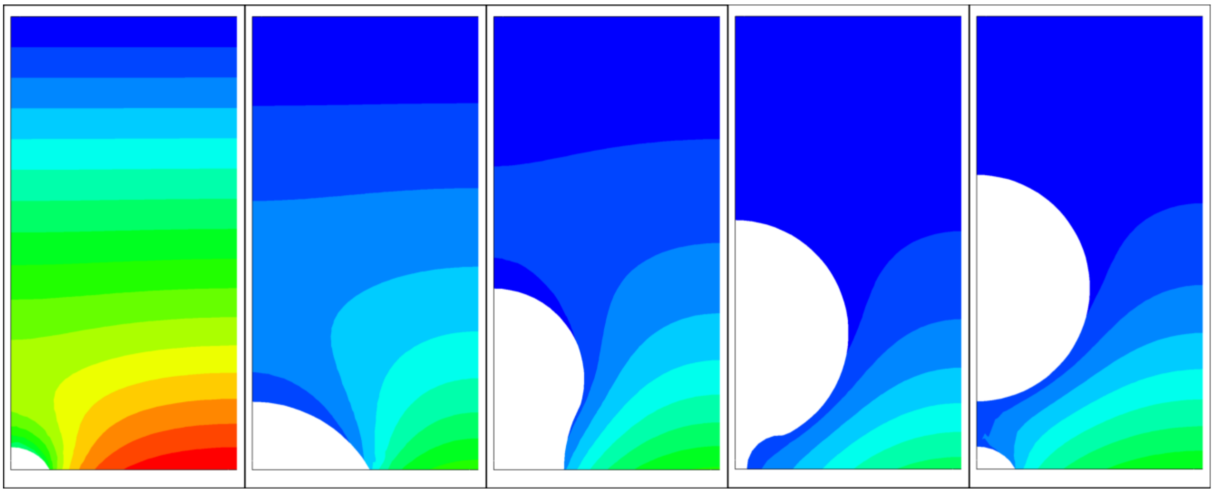

Figure 1: Hydrogen distribution during bubble evolution on the electrode

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