```
//
================================================================
//
//
//
//          50th. European Two-Phase Flow Group Meeting
2012.          //
//        16th-18th May 2012, by Universita degli Studi di
Udine       //
//                          in Udine,
Italy.                          //
//
//
//    Authors: Gustavo Rabello dos Anjos
gustavo.rabello@epfl.ch     //
//             Navid Borhani
navid.borhani@epfl.ch       //
//             John R. Thome
john.thome@epfl.ch          //
//
//
//               Heat and Mass Transfer Laboratory
(LTCM)             //
//            …cole Polytechnique FÈdÈrale de Lausanne
(EPFL)          //
//             Lausanne, Switzerland - phone +41 21
6935442           //
//
================================================================
//
```

Title: 3D ALE-FEM Simulation of Microscale Two-Phase Flows with Phase Change

Numerical simulation is employed to simulate diabatic two-phase flow phenomena using the continuum method for surface tension modeling. The
set of equations are based on the 'one-fluid' Arbitrary Lagrangian-Eulerian (ALE) description of the Navier-Stokes, which includes the mass, momentum and energy conservation equations. These equations are discretized by the Finite Element method on a tetrahedral
unstructured grid in which the phase boundary is represented by a triangular surfaces that are part of the volumetric computational mesh,
thus a sharp and precise representation is successfully achieved. This
geometrical procedure also ensures undesirable modes and spurious oscillations are damped out, thus leading to the convergence of the results. A Laplacian smoothing operator is applied to the volumetric and
surface meshes to keep the elements homogeneously distributed, thereby

avoiding large concentrations of nodes in one specific region due to the moving interface. Moreover, by varying a single parameter, the formulation can be set to a fixed or a complete moving mesh technique.
The new methodology proposed here to simulate diabatic two-phase flows in the ALE context is the fist time this has been done for phase change.
It is shown to provide an accurate description of the interfacial forces, bubble dynamics, the heat and mass transfer between phases. The employed formulation, the interface representation, the phase change model, and results will be presented. Furthermore, 3D microscale simulations of diabatic slug flow will be presented.

[1] J.U.Brackbill, D.B. Kothe and C. Zemach, A Continuum Method for Modeling Surface Tension, Journal of Computational Physics,100:335-354, 1992.

[2] J. Donea, A. Huerta, J.-Ph. Ponthot and A. RodrÌguez-Ferran, Arbitrary Lagrangian-Eulerian Methods, Encyclopedia of Computational Mechanics, Volume 1: Fudamentals, John Wiley and Sons, 2004.

[3] S. Negami, Diagonal flips in triangulation of surfaces, Discrete Mathematics, 135:225-232, 1994.

[4] A. Esmaeeli and G. Tryggvason, Computations of film boiling. Part I: numerical method, International Journal of Heat and Mass Transfer, 47: 5451-5461, 2004.

[5] G.R. Anjos, N. Borhani, N. Mangiavacchi and J.R. Thome, A 3D ALE-FEM Method for Two-Phase Flows, Journal of Computational Physics, submited, 2012.