Liquid coverage of rotating discs

- a comparison of solvers and approaches

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Abstract

During various stages (especially cleaning) of the production of semiconductors the silicon-wafers have to be wetted by various liquids. Usually two contradicting requirements have to be met: the surface of the disc (which is usually rotating) should be fully wetted, while the smallest possible amount of liquid should be used. The goal of the RoWaFloSim project, of which this research is a part, is to develop the tools that help to optimize these processes.

To verify the reliability of the tools two test-cases ([1], [2]) from the literature were chosen for which experimental data exist. Both of these experiments consider axially symmetric conditions with respect to the rotation axis.

The flow is simulated using the Volume of Fluid (VoF)-method. The first calculations were done assuming axisymmetry according to the original experiments. The OpenFOAM interFoam-solver was compared with three VoF-based interface capturing methods implemented in FLUENT. Both solvers show similar results which are in accordance with the experiments and analytic solutions.

The problem with the current geometry in question is that the thickness of the film is rather thin (sub-millimeter) compared to the diameter of the wafers. To accurately resolve the liquid film very small mesh sizes would have to be used. This increases the computation times for 3D-cases (which are needed if the liquid jet does not impinge at the centre of rotation). Therefore, dynamic remeshing was investigated with OpenFOAM which shows similar results as the axially symmetric calculations.

As an additional option, the simulation of the liquid film using the Finite-Area discretization is currently investigated.

This presentation will concentrate on comparing the various solvers and approaches with the experimental data and highlighting the pros and cons for practical applications (which have transient boundary conditions and are not axially symmetric)

Key words: Wafer, Volume of Fluid, Comparison

References

[1] B. Ozar, B. Cetegen, A. Faghri, Experiments on the flow of a thin liquid film over a horizontal stationary and rotating disk surface, Experiments in Fluids 34 (2003) 556–565.

[2] A. F. Charwat, R. E. Kelly, C. Gazley, The flow and stability of thin liquid films on a rotating disk, Journal of Fluid Mechanics 53 (1972) 227–255.