Sparse Grid Approach for Non-Newtonian Fluids

Alexander Rüttgers
University of Bonn
ruettgers@ins.uni-bonn.de

Abstract

A computationally efficient algorithm for multiscale simulations of non-Newtonian fluids is presented. In contrast to Newtonian fluids, the viscosity of a non-Newtonian fluid depends on the fluid's shear rate. These fluids are of great practical relevance since most industrial fluids such as toothpaste, paint or shampoo exhibit a non-Newtonian behavior.

The presented algorithm bases on a sparse grid discretization. This work extends previous simulations with a FENE dumbbell model in three-dimensional square-square contraction geometries [1].

Multiscale simulations lead to model equations of high dimensionality. Depending on the number of spring segments, the configuration space for the polymer model has up to twenty dimensions. Therefore, multiscale simulations suffer from the curse of dimensionality and either require massively parallel computations or a problem-adapted approach such as sparse grids.

In this talk, we compare our multiscale simulation results for three-dimensional contraction and contraction-expansion flows with results from literature and obtain a good a good agreement.

References

1. M. Griebel and A. Rüttgers. Multiscale simulations of three-dimensional viscoelastic flows in a square-square contraction. J. Non-Newton. Fluid. Mech. 205 (2014) 41-63.