Modeling Ink Flow in Paper – a Capillary Driven Two-phase Flow Problem in a Complicated Geometry

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Abstract: Inkjet paper is a special fine paper designed for inkjet printers, typically classified by its weight, brightness and smoothness and sometimes by its opacity. High-quality inkjet printing with dark, crisp lines requires the paper to have exactly the right degree of absorbency to accept the ink but prevent its sideways spread. Compared with general purpose office papers or papers designd e.g. for laser printers, the paper differs in their layered structures and microscale porosity, which are designed for the special needs of each printing technology. Wouldn't it be nice to have one paper which fits all needs?

PTS is one of the large industrial research institutes in Europe. In its research work, PTS employs simulation tools to improve the entire paper development and production process. One research goal is the understanding of the wetting process of paper during printing on a micrometer scale. We model this issue using a two-phase fluid for the ink-air system in the resolved microscale structure of the paper with the ink driven by capillary forces.

The model is a standard Navier-Stokes-Cahn-Hilliard equation which is solved within the microscale structure of the paper using the diffuse domain approach introduced in (X. Li, J. Lowengrub, A. Rätz, A. Voigt: Solving PDEs in complex domains - a diffuse domain approach, Comm. Math. Sci. 7 (2009) 81-107). An adaptive finite element approach and energy-stable semi-implicit time discretizations are used for discretization. The simulations are done in parallel using the high performance computing resources at ZIH at TU Dresden.

We will introduce the model, discuss the numerical approach, demonstrate the validity of the approach on typical benchmark problems for capillary flow and hope to show first results and comparisons for real paper structures.

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