Designing Algorithms for Complex Processes:
Semiconductor Manufacturing and Industrial InkJet Printing

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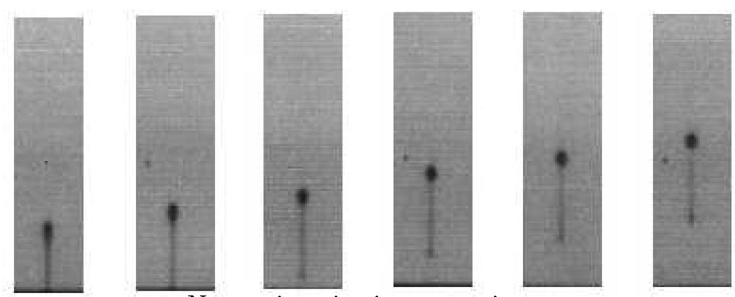
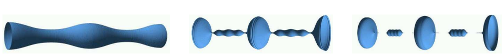
A key component in several manufacturing processes requires the accurate calculation of interfaces moving in complex ways. We will discuss how new algorithms need to be invented and tailored to specific industrial problems.

Ink Jet Technologies: Newtownian and Visco-Elastic Flow

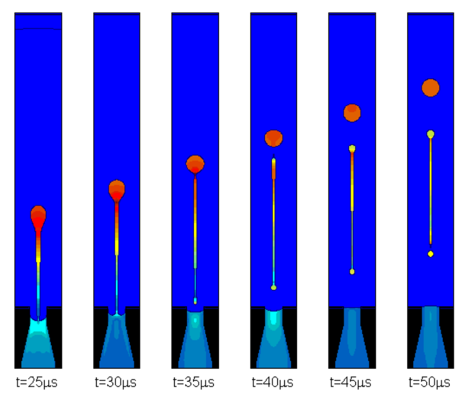
Ink jet technology, originally applied to commercial home printing, has now found its way into micro-fabrication of printed IC circuits, manufacture of plasma devices, and drug delivery systems: while desktop printers are Newtonian, pigment-based inks, introduced in the 1990's, are usually viscoelastic. At the core are two-phase immiscible incompressible flows with surface tension, with both viscosity and density jumps across interfaces separating viscoelastic fluids from air. We shall describe the models, algorithms, and numerics required to accurately simulate axi-symmetric 3D viscoelastic jets in a variety of geometries.



Newtonian ejection: experiment



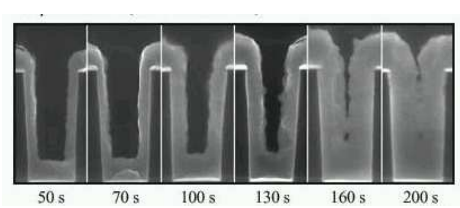
Collapsing fluid simulation: charged drop-on-demand



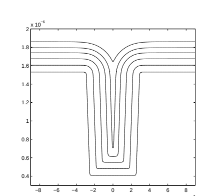
Newtonian ejection: full two-phase flow simulation

Semiconductor Manufacturing and SuperConformal ElectroDeposition

Semiconductor processing requires a series of intricate steps to model deposition and etching processes. In superconformal electrodeposition, copper is electrodeposited through a curvature-enhanced accelerator process: this requires simultaneous tracking of the copper/electrolyte interface location, surface coverage of the additives, and the concentration profiles of different components in the electrolyte. We describe work on several new algorithms, including conservative material transport algorithms and a new, one-sided multigrid techniques to track the accelerator coverage evolution, diffusion processes, and the evolving interface.

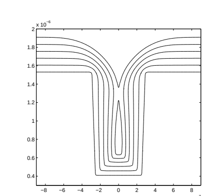


First Case: Experiment



First Case: Simulation

Second Case: Experiment



Second Case: Simulation

Figure 1: **Void Filling in Superconformal Electrodeposition**