Simulation on the Electroless Plating Problem with Moving Boundaries

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ABSTRACT

Electroless plating technique has been widely used in electrical industry. Recently, electroless plating within microfluidic channels has been proposed as a novel packaging technology at micrometer scale. However, the presence of fluid motion in microchannel remarkably complicates the interpretation of experiments. Therefore, modeling of electroless plating coupled with fluid flow equation is essential for a better understanding of its underlying physical and chemical mechanism. In this study, the change of physical domain is investigated by a series of algorithms governed by chemical reaction on the boundary with fluid flow in the domain. We first propose and realize the strategy of combination of chemical reactions and fluid flows in the governing equations including advection-diffusion equation, Navier-Stokes equation, and level set equation for capturing interface. In the frame of finite element method, we apply Chorin's scheme for Navier-Stokes equation, Crank-Nicolson-Galerkin scheme for advection diffusion equation, and Taylor-Galerkin finite element model for solving level set equation. Further, some new methods which offer a pathway to identify the mixed potential on surfaces and the topological change of the domain are developed for the purpose of solving the coupled equations. Numerical tests in two dimensional cases will be carried out to justify our proposed numerical schemes and solution algorithms.

REFERENCES

[1] R. Rannacher: On Chorin's projection method for the incompressible Navier-Stokes equations, in "Navier-Stokes Equations: Theory of Numerical Methods" (R, Rautmann, et al., eds.), Proc. Oberwolfach Conf., August 19-23, 1991, Springer, 1992

[2] J. Douglas, Jr, and T. Dupont, Galerkin methods for parabolic equations with nonlinear boundary conditions, Numer. Math. 20, 213-237 (1973)

[3] D. Peng, B. Merriman, S. Osher, H.-K. Zhao, and M. Kang, A PDE-based fast local level set method, J. Comput. Phys. 155, 410-438 (1999)

[4] O, Lakkis, A. Madzvamuse, and C. Venkataraman, Implicit-explicit timestepping with finite element approximation of reaction-diffusion systems on evolving domains, SIAM J. Numer. Anal. 51, 2309-2330 (2013)

[5] F. Duarte, R. Gormaz, S. Natesan, Arbitrary Lagrangian-Eulerian method for Navier-Stokes equations with moving boundaries, Comput. Methods Appl. Mech. Engrg. 193, 4819-4836 (2004)