INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: *Development of Pseudopotential-Based LBM Solver to Explore the Microdynamics of Liquid-Vapor Phase Change Processes*

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SHORT ABSTRACT

The pseudopotential-based LB multiphase model has enormous potential in the simulation of phase-change heat transfer problems. It facilitates the natural development and migration of interfaces during the multiphase simulation as well as saves a lot of computational time. Along with these, this model enjoys several advantages like simple implementation procedure, excellent parallelizability, and easy applicability in complex domains. Due to these superiorities, it is becoming increasingly popular among researchers working on numerical simulation of multiphase flow. A pseudopotential model based thermal multiphase flow solver is developed as this thesis work, which is employed in several phase change heat transfer problems related to boiling and condensation. The first problem successfully explores the capability of the pseudopotential-based thermal lattice Boltzmann model in emulating the underlying thermohydrodynamics of subcooled flow boiling in a narrow fluidic horizontal channel in detail. The next study uses the multiple-relaxation time based LB model to explore the role of surface morphology and cold spot temperature in determining the visual state of the condensate droplet, i.e. Cassie and Wenzel mode of droplet nucleation and associated rates of energy and mass interactions in temperature controlled condensation process. The same numerical framework is employed to study condensate droplet formation and movement on several vertical and inclined microstructured surfaces, and corresponding mass condensation and heat transfer rates are analyzed thoroughly. Being motivated by the prime weakness of the pseudopotential based thermal LB model about its incapability of simulating boiling problems with a large density ratio, the last work of this thesis focuses on augmentation of the basic pseudopotential based thermal multiphase algorithm by enhancing the isotropy of the discrete equation and thermodynamic consistency of the overall formulation, to expedite simulation of pool boiling at higher-density ratios. Various pool boiling scenarios, and all three regimes of pool boiling have aptly been captured with both plain and structured heaters, allowing the development of the boiling curve. The predicted value of critical heat flux for the plain heater agrees with Zuber correlation within 10%, illustrating both quantitative and qualitative capability of the proposed algorithm.