Nucleate boiling heat transfer depends on various aspects of the bubble ebullition, such as the bubble nucleation, growth and departure. In this work, a synchronized high-speed optical imaging and infrared (IR) thermography approach was employed to study the ebullition process of a single bubble on a hydrophilic surface. The boiling experiments were conducted at saturated temperature and atmospheric pressure conditions. De-ionized (DI) water was used as the working fluid. The boiling device was made of a 385-um thick silicon wafer. A thin film heater was deposited on one side, and the other side was used as the boiling surface. The onset of nucleate boiling (ONB) occurs at a wall superheat of $\Delta T_{\text{sup}} = 12$ °C and an applied heat flux of $q'' = 35.9$ kW/m². The evolution of the wall heat flux distribution was obtained from the IR temperature measurements, which clearly depicts the existence of the microlayer near the three-phase contact line of the nucleate bubble. The results suggest that, during the bubble growth stage, the evaporation in the microlayer region contributes dominantly to the nucleate boiling heat transfer; however, once the bubble starts to depart from the boiling surface, the microlayer quickly vanishes, and the transient conduction and the microconvection become the prevailing heat transfer mechanisms.

Bubble Ebullition on a Hydrophilic Surface

Aritra Sur, Yi Lu, Carmen Pascente, Paul Ruchhoeft and Dong Liu
University of Houston, Houston, TX 77204