A Digital Photographic Study on Nucleate Boiling in Subcooled Flow

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Abstract

The behavior of near-wall bubbles in subcooled flow boiling has been investigated through digital visualization of water flow in vertical rectangular channels at atmospheric pressure. At subcooled and low-quality conditions, nucleation site density increases with the increases in heat flux and channel-averaged enthalpy, while discrete bubbles coalesce and form large bubbles, resulting in large vapor clots. Waves formed on the surface of the vapor clots are closely related to Helmholtz instability and CHF occurs in the procedure of repeated formation of the vapor clots. The liquid sublayer beneath large coalesced bubbles is identified photographically and tiny bubbles on the heated surface in the sublayer are also observed. Therefore, a flow nucleate boiling structure consists of the superheated liquid layer containing tiny bubbles, the flow bubble layer containing large coalesced bubbles over the superheated liquid layer and the liquid core over flow bubble layer. The CHF mechanism is related to the formation of large vapor clots due to coalescences of bubbles and dryout of the liquid sublayer.