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Enhanced Condensation of Vapor Bubbles by Acoustic Actuation

THOMAS BOZIUK, MARC SMITH, ARI GLEZER, Georgia Institute of Technology — The effects of acoustic actuation on enhancement of the condensation rate of vapor bubbles in a liquid pool are investigated experimentally. Vapor bubbles are formed by direct injection into quiescent liquid in a sealed tank under controlled ambient pressure that varies from atmospheric to partial vacuum. The bubbles are injected vertically from a pressurized steam reservoir through nozzles of varying characteristic diameters, and the actuation is applied during different stages of the bubbles formation and advection. It is shown that kHz range acoustic actuation leads to excitation of high-amplitude surface capillary (Faraday) waves at the vapor-liquid interface that significantly increases the condensation rate. The concomitant controlled changes in bubble volume and in the structure of the vapor interface strongly affect bubble advection in the liquid pool. The increase in condensation rate is affected by the surface waves that increase the mixing in the thermal boundary layer surrounding the bubble, and on the advection of the bubble within the pool. High-speed image processing is used to quantitatively measure the scale of the capillary waves and their effect on vapor bubble dynamics at several ambient pressures that affect the global condensation rate.

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