Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Acoustically-Enhanced Direct Contact Vapor Bubble Condensation THOMAS BOZIUK, MARC SMITH, ARI GLEZER, Georgia Inst of Tech — Rate-limited, direct contact vapor condensation of vapor bubbles that are formed by direct steam injection through a nozzle in a quiescent subcooled liquid bath is accelerated using ultrasonic (MHz-range) actuation. A submerged, low power actuator produces an acoustic beam whose radiation pressure deforms the liquid-vapor interface, leading to the formation of a liquid spear that penetrates the vapor bubble to form a vapor torus with a significantly larger surface area and condensation rate. Ultrasonic focusing along the spear leads to the ejection of small, subcooled droplets through the vapor volume that impact the vapor-liquid interface and further enhance the condensation. High-speed Schlieren imaging of the formation and collapse of the vapor bubbles in the absence and presence of actuation shows that the impulse associated with the collapse of the toroidal volume leads to the formation of a turbulent vortex ring in the liquid phase. Liquid motions near the condensing vapor volume are investigated in the absence and presence of acoustic actuation using high-magnification PIV and show the evolution of a liquid jet through the center of the condensing toroidal volume and the formation and advection of vortex ring structures whose impulse appear to increase with temperature difference between the liquid and vapor phases. High-speed image processing is used to assess the effect of the actuation on the temporal and spatial variations in the characteristic scales and condensation rates of the vapor bubbles.

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Date submitted: 01 Aug 2017 Electronic form version 1.4