Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

The behavior of vapor bubbles during boiling enhanced with acoustics and open microchannels[1] THOMAS BOZIUK, MARC K. SMITH, ARI GLEZER, Georgia Institute of Technology — Boiling heat transfer on a submerged heated surface is enhanced by combining a grid of surface micromachined open channels and ultrasonic acoustic actuation to control the formation and evolution of vapor bubbles and to inhibit the instability that leads to film boiling at the critical heat flux (CHF). The microchannels provide nucleation sites for vapor bubble formation and enable the entrainment of bulk subcooled fluid to these sites for sustained evaporation. Acoustic actuation excites interfacial oscillations of the detached bubbles and leads to accelerated condensation in the bulk fluid, thereby limiting the formation of vapor columns that precede the CHF instability. The combined effects of microchannels and acoustic actuation are investigated experimentally with emphasis on bubble nucleation, growth, detachment, and condensation. It is shown that this hybrid approach leads to a significant increase in the critical heat flux, a reduction of the vapor mass above the surface, and the breakup of low-frequency vapor slug formation. A large-scale model of the microchannel grid reveals details of the flow near the nucleation site and shows that the presence of the microchannels decreases the surface superheat at a given heat flux.

[1]Supported by ONR.

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Date submitted: 03 Aug 2012

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