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Gravity Effects on Pool and Flow Boiling Heat Transfer Mechanisms

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Abstract: The relatively poor understanding of gravity effects on pool and flow boiling heat transfer can be attributed to the lack of long duration high-quality microgravity data, g-jitter associated with ground-based low gravity facilities, little data at intermediate gravity levels, and a poor understanding of the effect of important parameters even at earth gravity conditions. Recent techniques have enabled much more detailed information to be obtained at the liquid-solid interface. For pool boiling, results will be presented from a facility that obtained over 200 pool boiling runs aboard the International Space Station (ISS). For flow boiling a new and novel technique to measure heat transfer and liquid film thickness distributions over relatively large areas for two-phase flow and heat transfer phenomena using infrared (IR) thermometry is described. A midwave IR camera (3.6 m -5.1 m) is used to determine the temperature distribution within a multilayer consisting of a silicon substrate coated with a thin insulator. Since silicon is largely transparent to IR radiation, the temperature of the inner and outer walls of the multilayer can be measured by coating selected areas with a thin, IR opaque film. If the fluid used is also partially transparent to IR, the flow can be visualized and the liquid film thickness can be measured. The theoretical basis for the technique is given along with a description of the test apparatus and data reduction procedure. The technique is demonstrated by determining the heat transfer coefficient distributions produced by droplet evaporation and flow boiling heat transfer.

Biography: Jungho Kim is a Professor in the Department of Mechanical Engineering where he performs research and teaches courses in a broad range of thermal sciences areas. He developed the microheater array technique under NASA sponsorship to measure time and space resolved heat transfer rates during boiling, spray cooling, and within microchannels. NASA used the microheater arrays as the basis of an International Space Station experiment (MABE) that was used to study microgravity pool boiling in 2011. He is currently developing another technique to measure the heat transfer distribution within complex geometries using IR thermography. Other research includes the measurement of absorbance coefficient of reactants at high temperatures, and the development of fast response heat flux gages. He has received funding in the past from NASA, NSA, NIST, Parker Hannefin, ONR, NSF, Northrup Grumman, WPAFB, ATEC, and Weatherbug. He is active in ASME, having served as Chair of the K-13 committee on Multiphase Heat Transfer. He has won numerous awards for teaching and instrumentation design, and is the holder of two patents.