



UA Huntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

SURFACE ROUGHNESS EFFECTS ON MICROGRAVITY BOILING

10/2/2012

1

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Instrument Design

- Mission statement
 - To prepare an instrument for providing experimental data to better understand microgravity boiling properties related to surface roughness
- Simple design objectives
 - Multiple test samples
 - Small size to fit experimental platform
- Continuation of previous work¹

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Why do we care?

- Plan-B
 - What if a cooling pump breaks?
 - What can we do to maximize pump-free heat transfer?

3



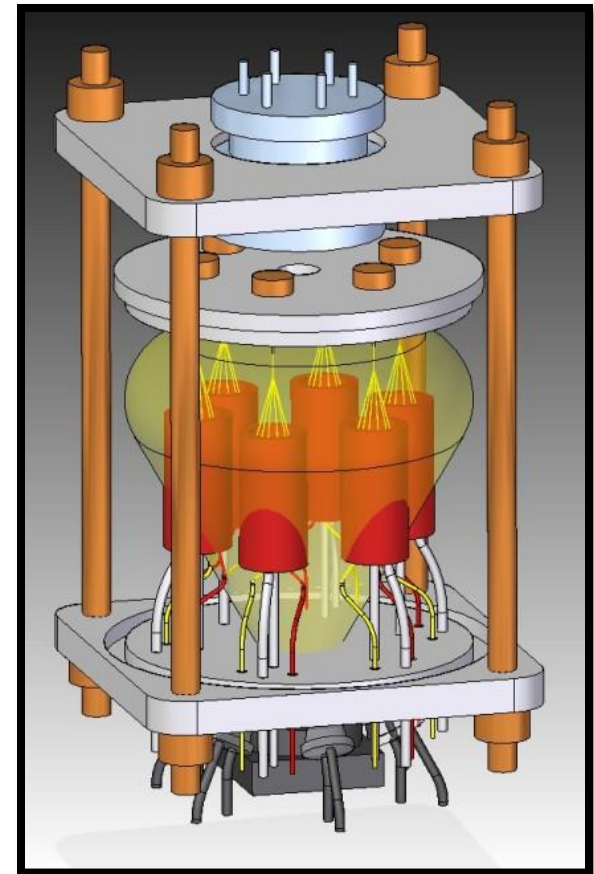
Characterize Heat Transfer

- Measure
 - Surface Temperature
 - Fluid pressure and saturation temperature
 - Heat transfer/surface area
 - Acceleration
 - Surface roughness



Instrument Concept Design¹

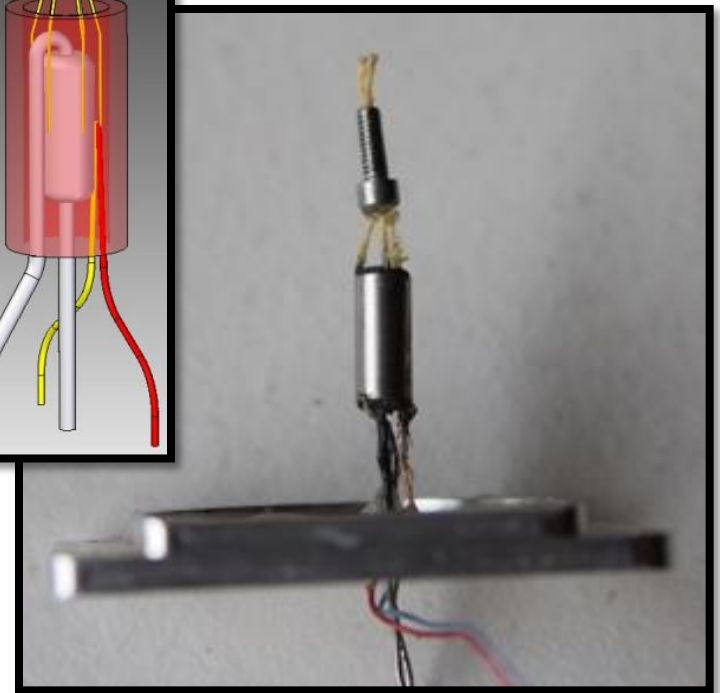
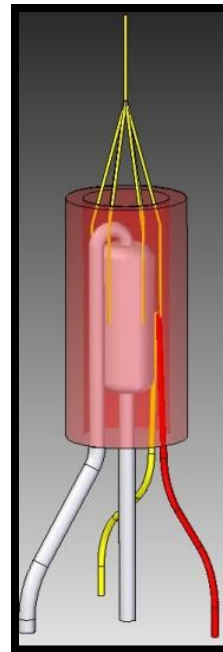
- Chamber
 - Top
 - Pressure sensor
 - Pressure relief foam
 - Six test samples
 - Bottom
 - Wire pass-through
 - Camera view



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Experiment sample

- Metal Sample
- Heated resistor
- Thermocouple
- Epoxy



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Assembled under water



7

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Supporting electronics

- Required measurements
 - Voltage
 - Current
 - Pressure
 - Temperature
- Additional measurements
 - Camera image
- Design hosted my a single imbedded controller



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Initial testing configuration

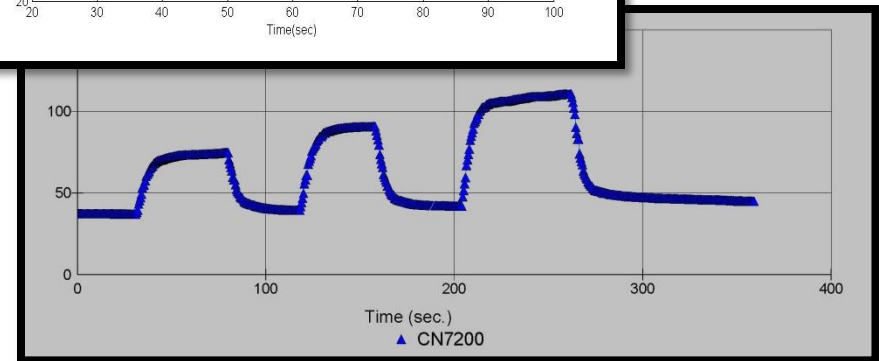
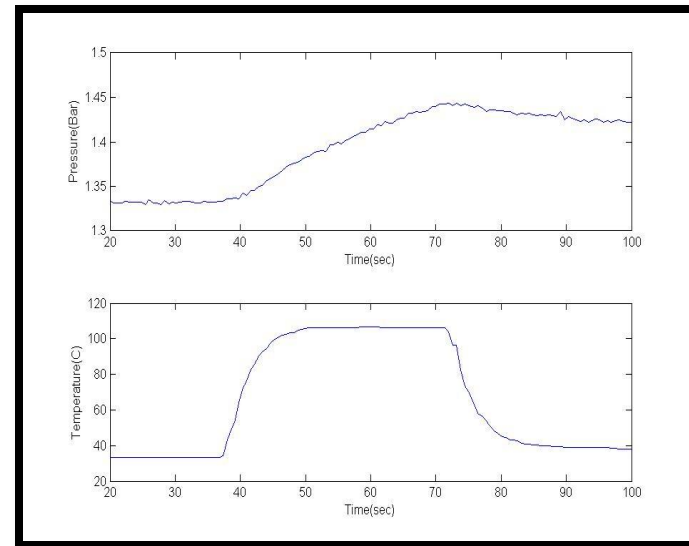
- External measurement tools
 - power supply
 - Temperature process controller
- Imbedded controller
 - Pressure sensor



Experimental Data, sealed chamber

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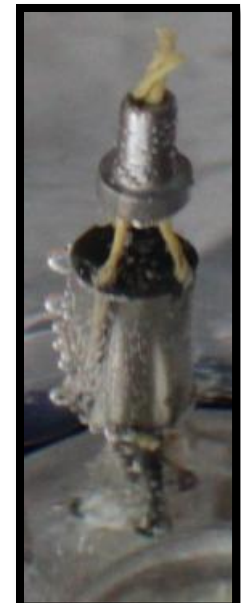
- Sample heating is coupled with the pressure change
- Various heat is applied to test what peak temperature is reached



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Experimental Data, open chamber

- Open Chamber
 - Controlled environment
 - No pressure change
 - Direct view of boiling
- Problems identified
 - Hot spot found



Test Sample limits

- Insufficient conduction caused overheated core
- Unbalanced encapsulation caused hot spot
- Thermocouple placement is not reliable

Results of initial testing

- Shows that chamber survives
- The sample reached the nucleate boiling regime
- Some simple issues are identified
 - But not show stoppers
- Imbedded controller will help automate the testing process

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Future Missions

- Parabolic flight
 - Functional testing
 - Low gravity science data set
- Orbital flight
 - Micro gravity science data set

14



Sponsors

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References

1. Becnel, E. B. and Wessling, Francis. C. (2011). Surface Tension Effects on Microgravity Boiling. *62nd International Astronautical Congress* (pp. IAC-11-A2.2.10). Cape Town, SA: International Astronautical Federation.

