

Low Vapor Pressure Precursor Delivery: A Case Study in MLD of Polyimide

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Molecular Layer Deposition

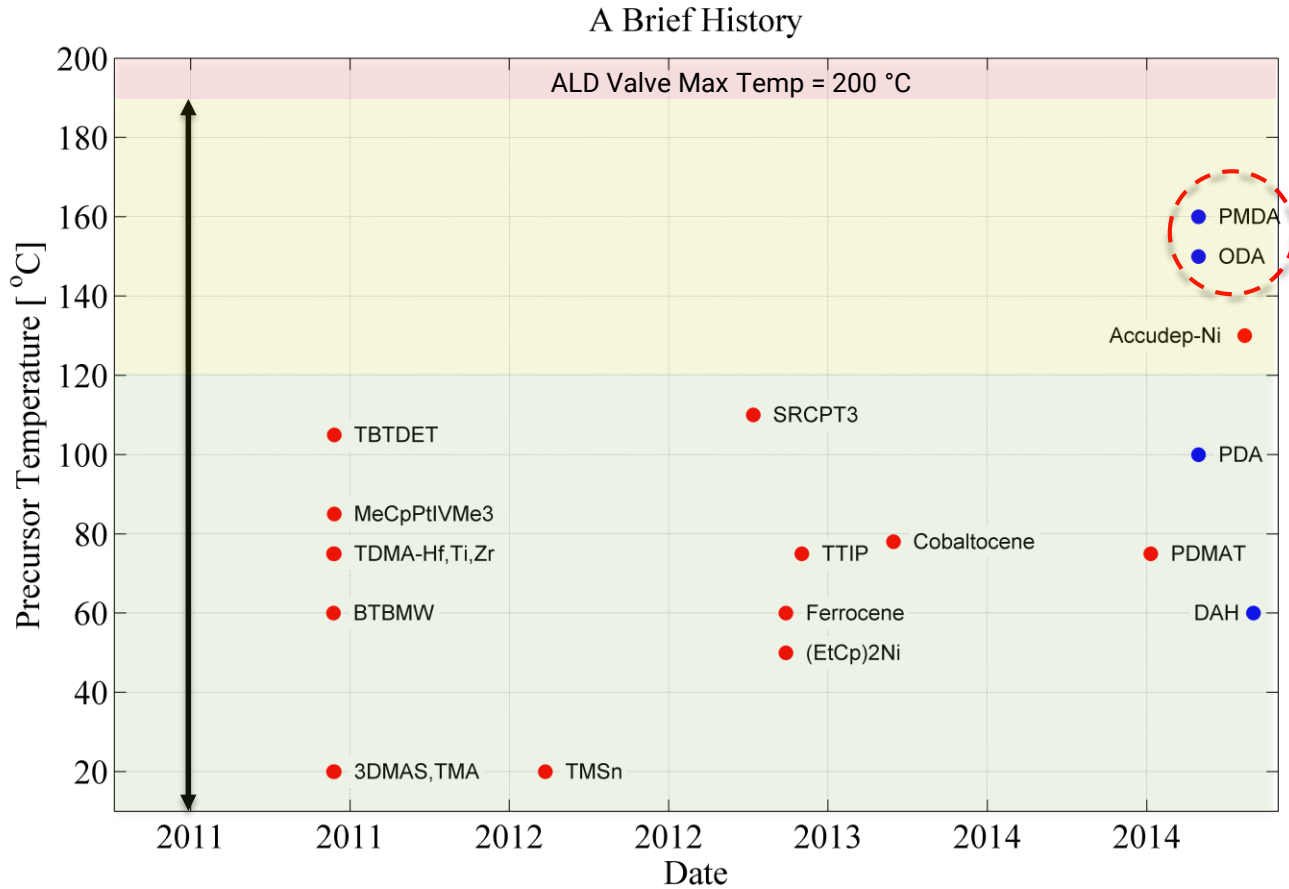


- Leverages the benefits of an ALD process for organic films

The screenshot shows a website navigation menu with tabs for Home, Equipment, Process, Materials/Chemicals, Safety/Policies, Training, Links, and Community. Below the menu is a breadcrumb trail: "You are here: Home / Equipment / Chemical Vapor Deposition / ALD / ALD Tutorials". A sidebar on the left lists categories: Equipment, Equipment Summary, Beam Tools, Optical, Photolithography Overview, and Chemical Vapor Deposition. The main content area is titled "ALD Tutorials" and contains two entries: "ALD Introductory Tutorial 2012-11-01" and "ALD In Depth Tutorial 2012-11-01", both presented by Dr. J. Provine at Stanford University. A callout box on the right contains the text "Tutorials on the SNF Website!".

- MLD of polymer as an enabling process module:
 - Hybrid organic-inorganic thin films and multilayers
 - Conformal polymer coating for bioencapsulation
 - Pyrolysis and graphitization of MLD polymer to form ultrathin carbon films
 - Solvent resistant, thermally robust, and mechanically compliant passivation enabling microfluidics, operation in harsh operating environments, stress mitigation, and flexible substrate processing
 - Polymer photoresists and masking of high aspect ratio structures

SNFALD Precursors



Clogging



Temperature Uniformity



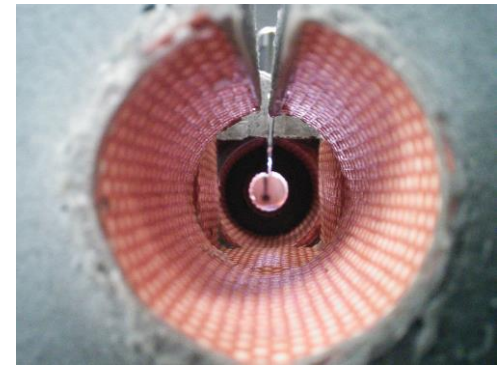
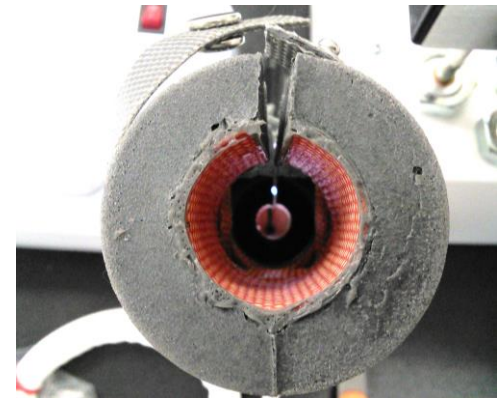
Precursor
Cylinder



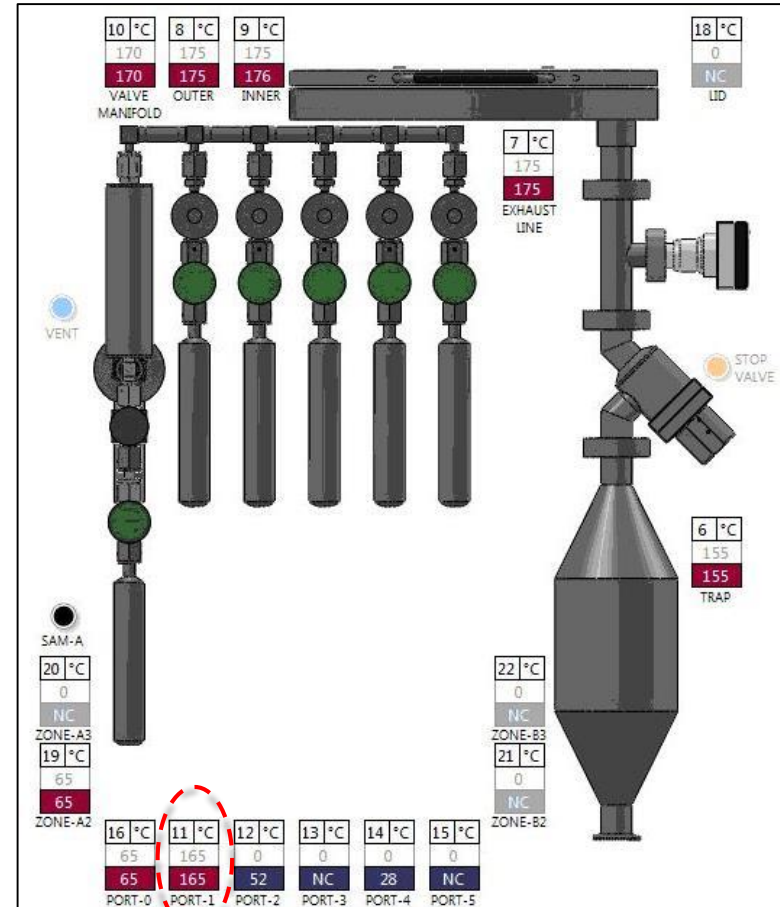
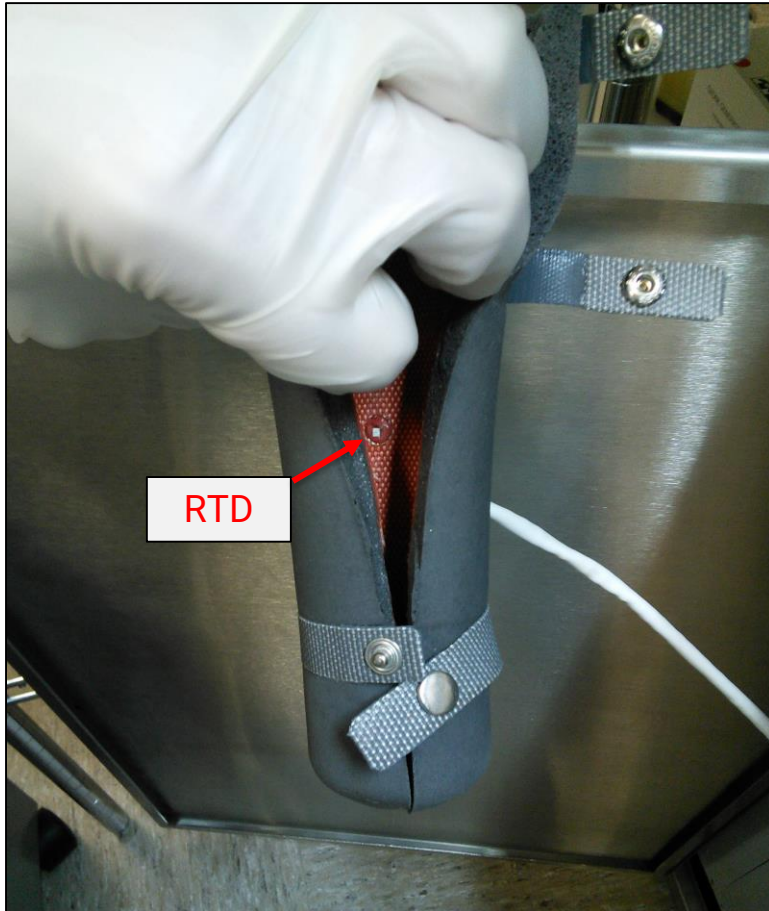
Traditional
Jacket



Molded
Jacket

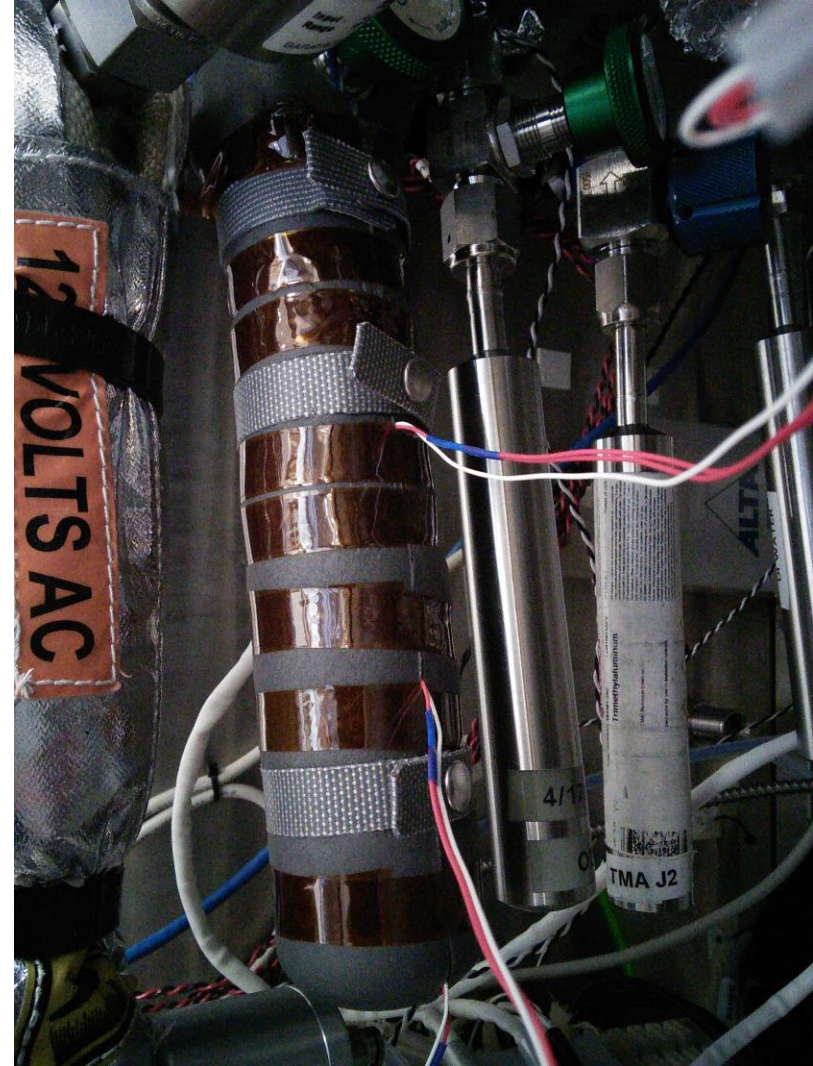


Isothermal Assumption

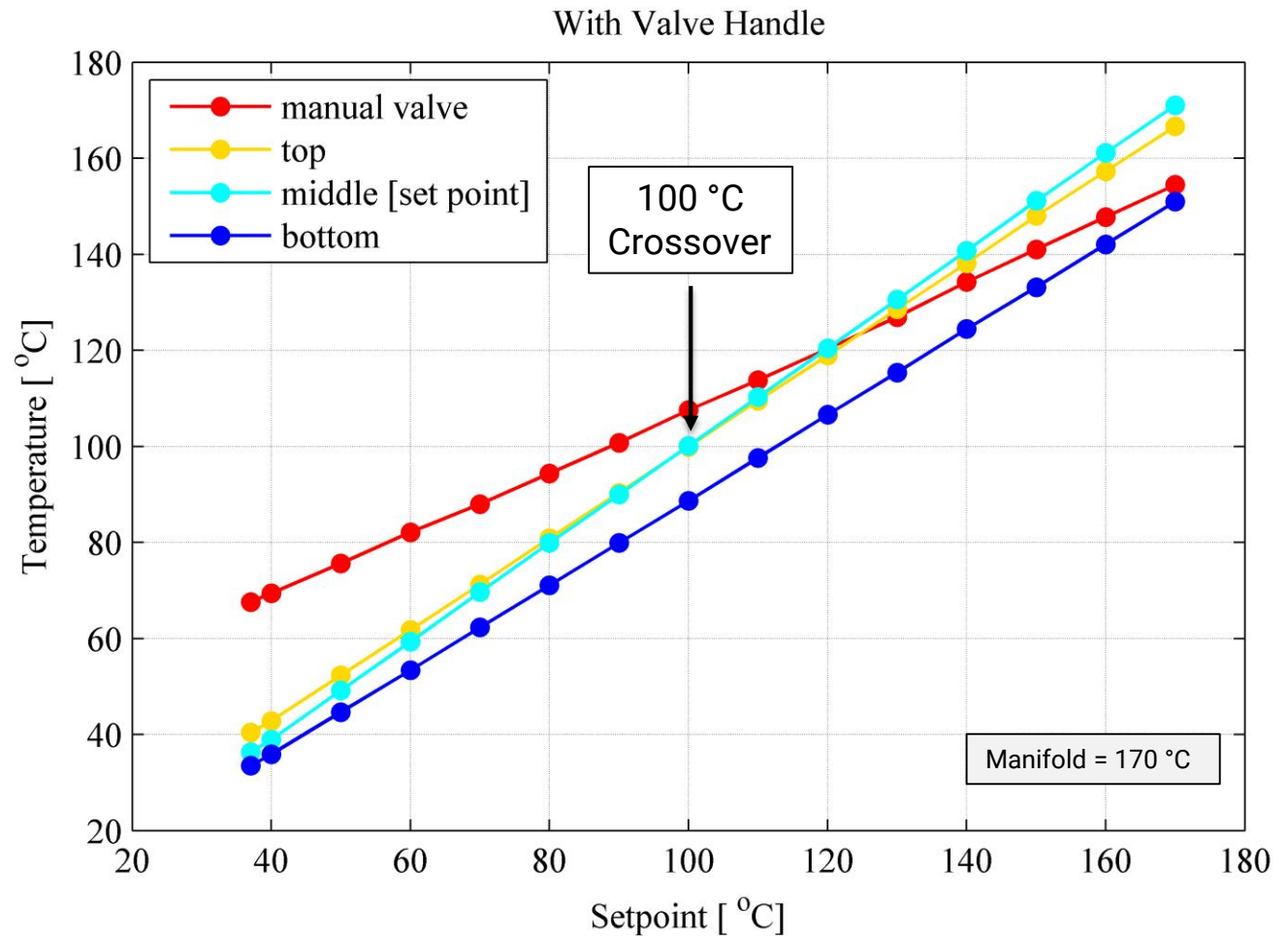
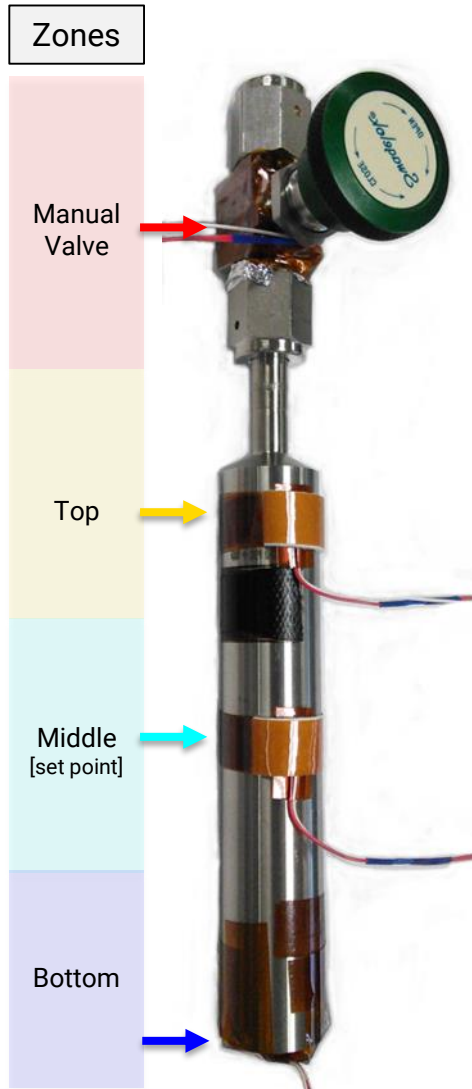


Set Point

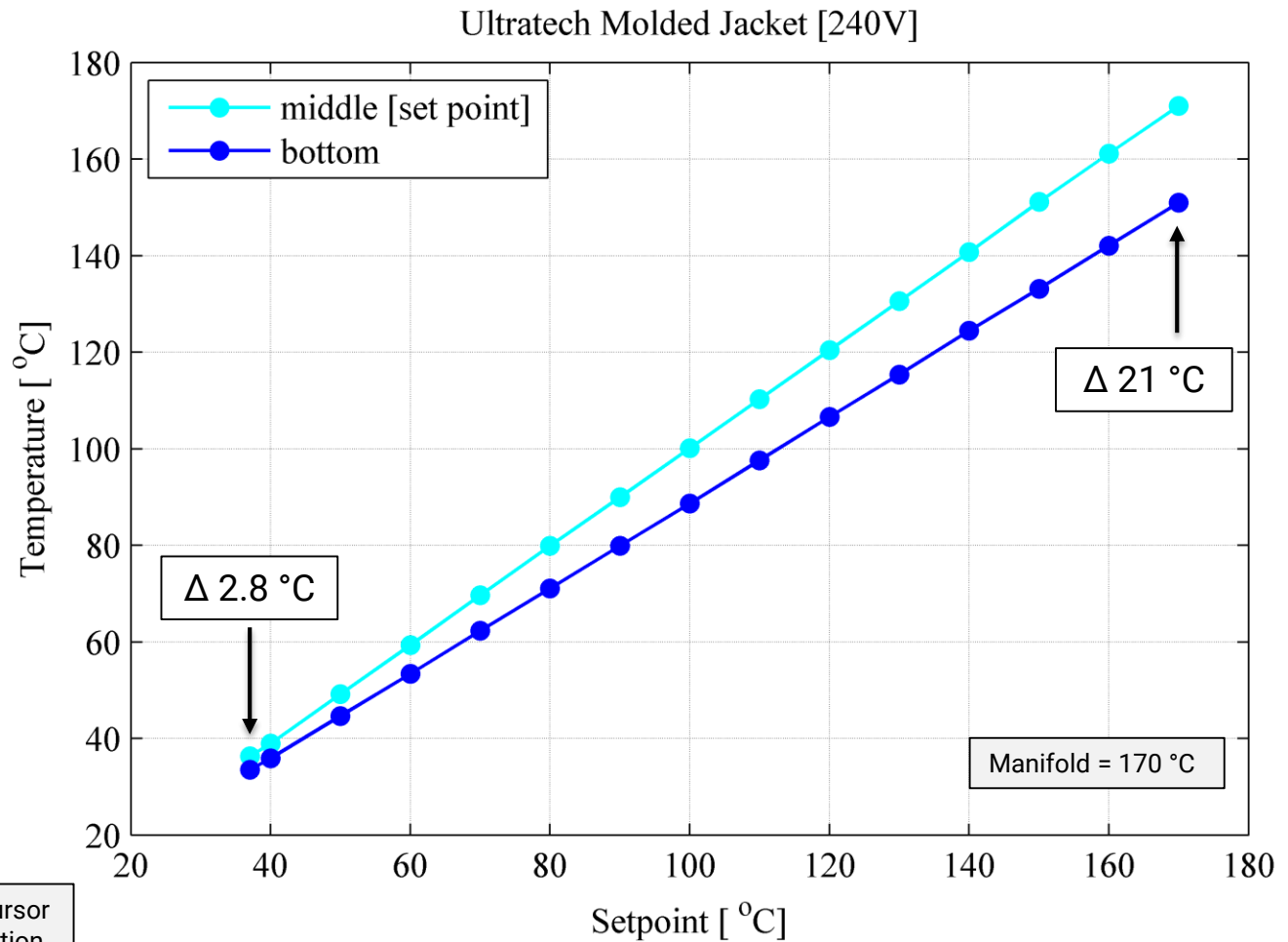
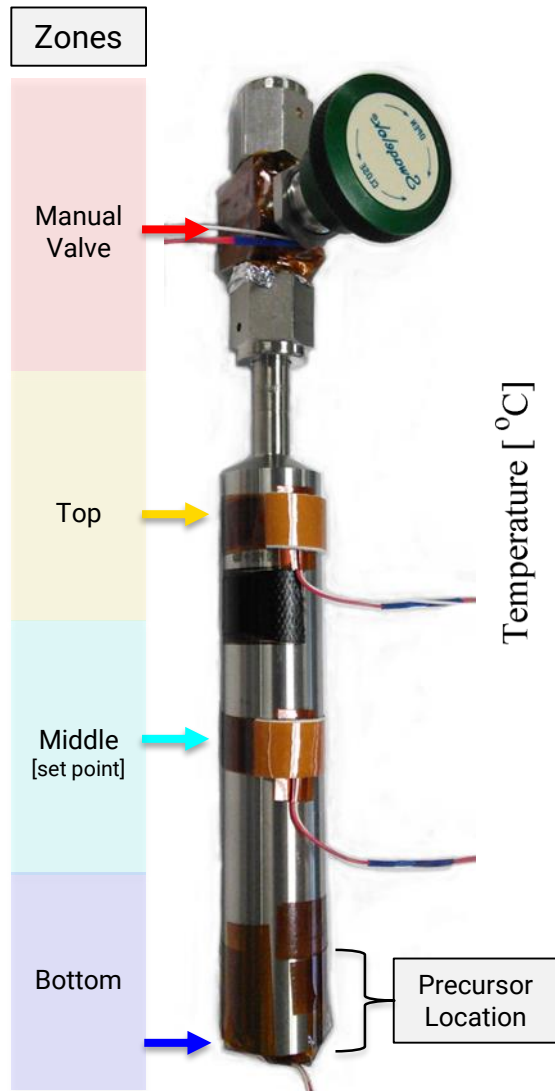
Molded Precursor Jacket



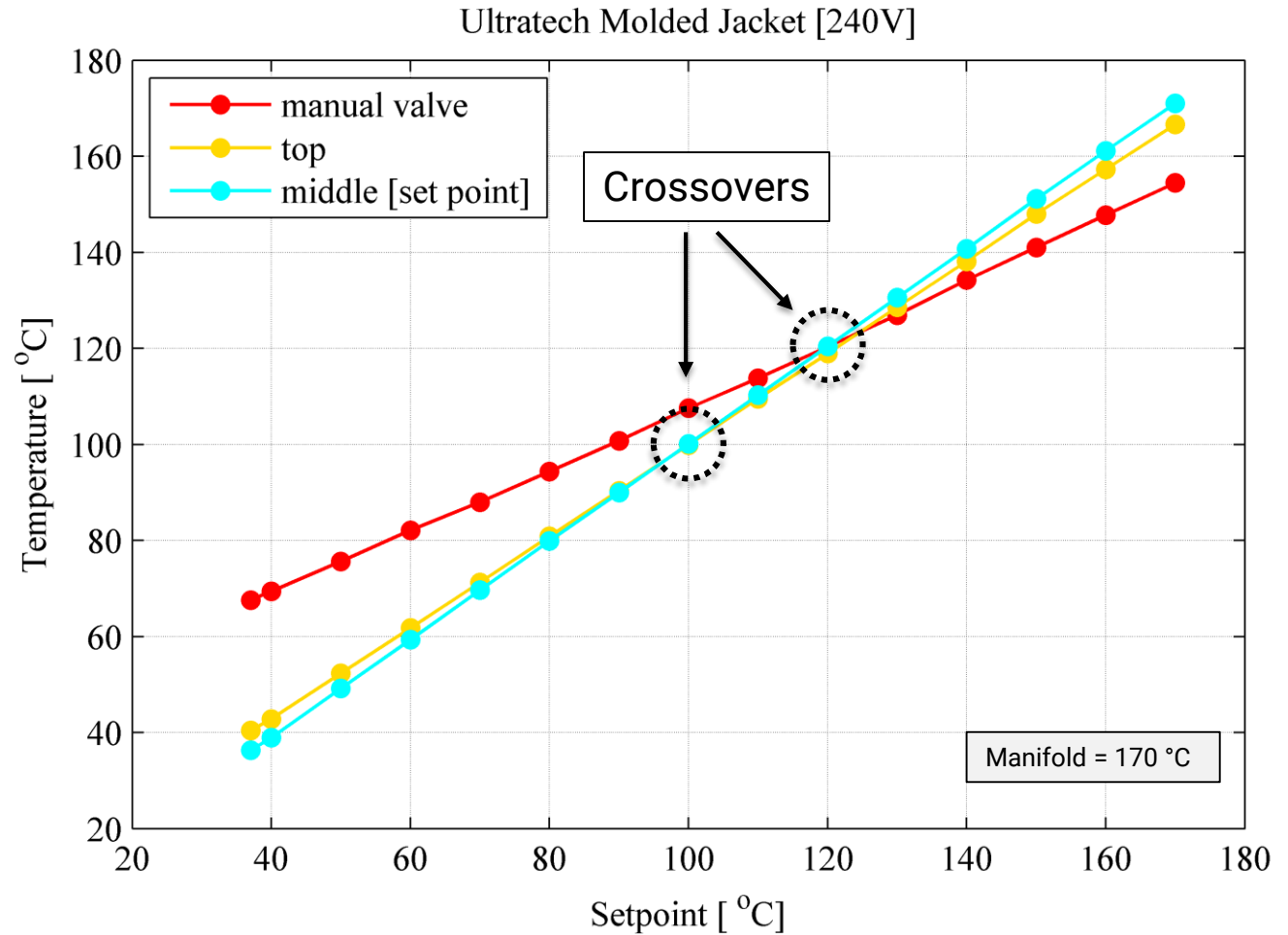
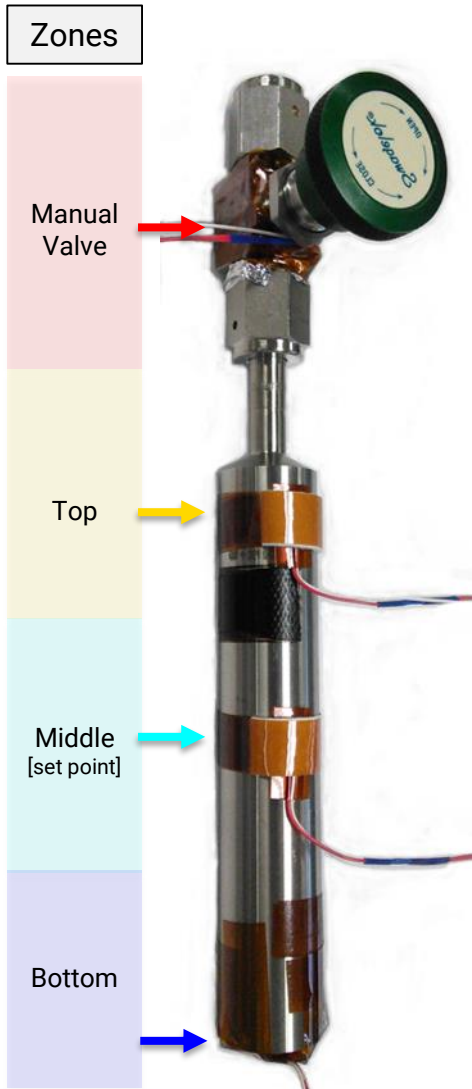
Molded Precursor Jacket



Temperature Offset Error

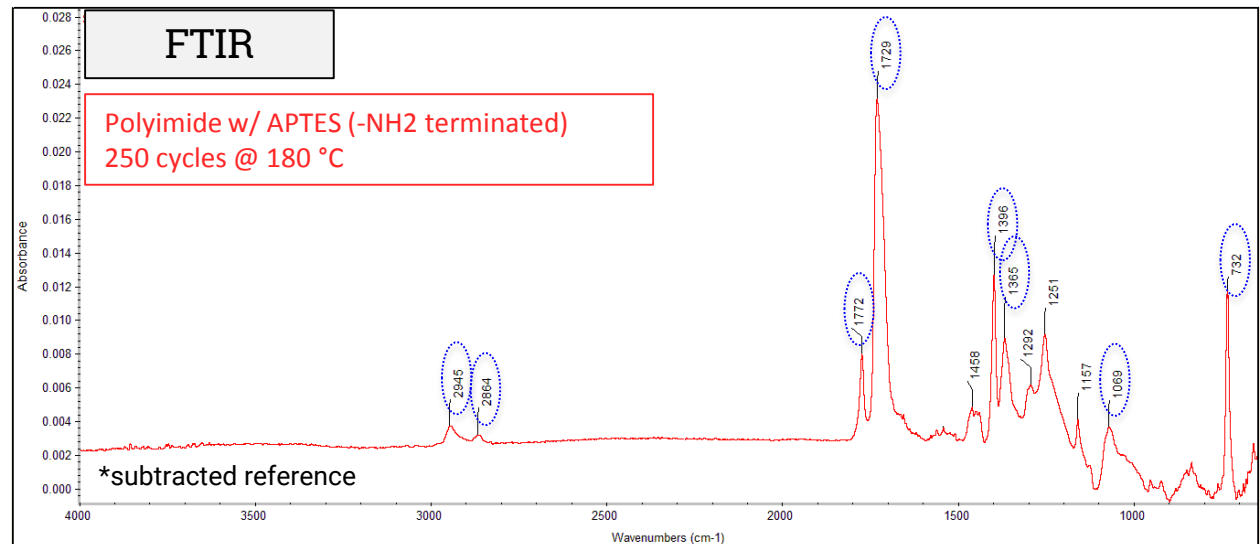
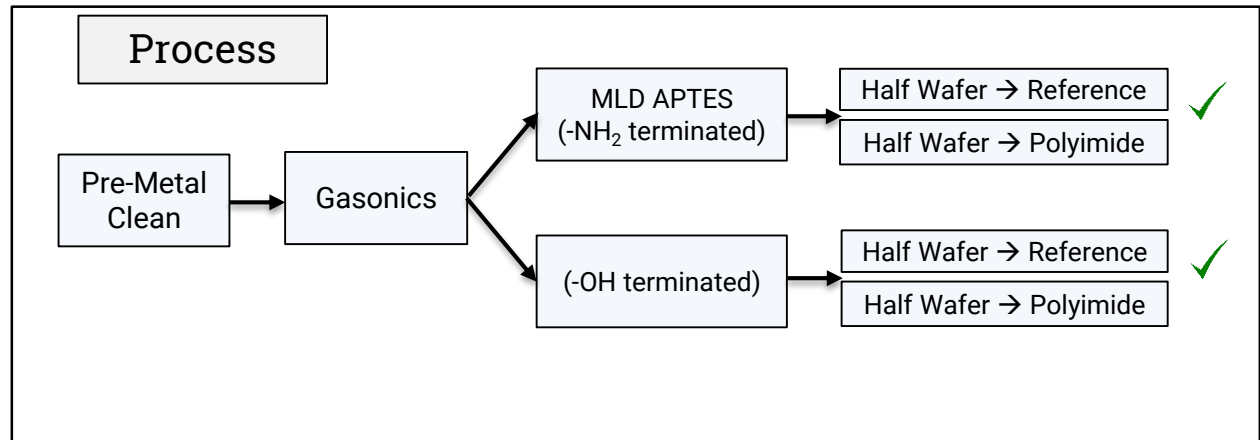
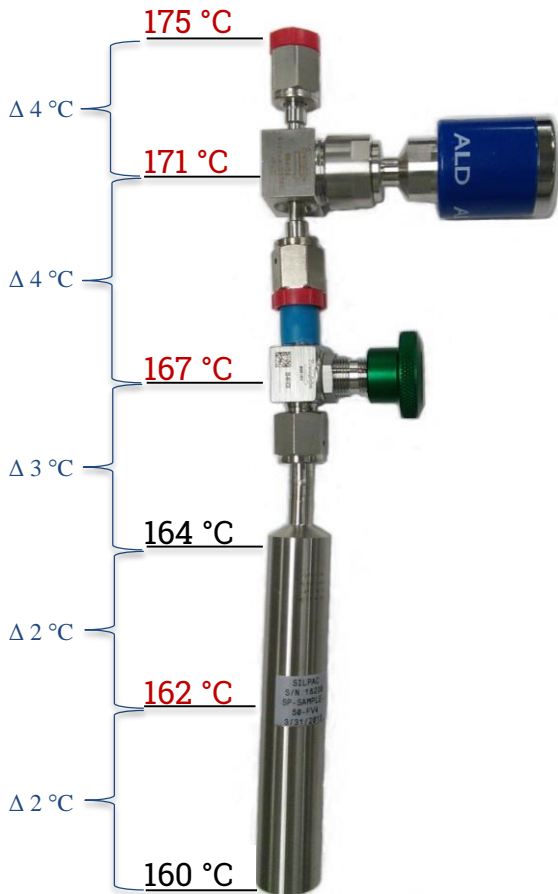


Thermal Gradient Crossover



Thermal Management

6 temperature zones
4 PID set points





Conclusions

- Precursor Lessons
 - Fundamental design limitations with manual valve exposed
 - Constant-wattage heater tape with single PID controller
 - Tradeoff → one vs. many temperature zones
 - Jacket data reference for Savannah/Fiji/MLD tools
- Temperature Offset
 - Increases with set point temperature
 - 21 °C @ set point = 170 °C
- Temperature Gradient Crossover
 - 100 °C → middle & top of cylinder (dosing)
 - 120 °C → manual valve (risk of solids clogging)
- Software debugging
 - No crashes since 3/24/2015



Thank You

- Mentors: Dr. Michelle Rincon
Dr. J Provine
- Stanford NPL: Dr. Jan Torgersen
- Organizers: Dr. Roger Howe
Dr. Mary Tang