Modeling and Control of Micro Calorimeter

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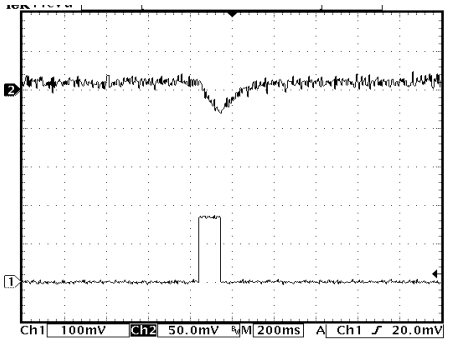
Goals and Potential Impact

- Closed-loop differential calorimetry for:
  - –High-throughput screening array
  - –Gas-phase chemical sensing
- Calorimetry on microporous surface avoids long mixing time and provides well-less analysis
- High sensitivity sensing for:
  - protein-protein folding
  - DNA hybridization
  - small molecule-protein binding
  - ➢10^{-8} J requires control-loop around dynamic system subject to thermal and electronic noise

Packaged single-element

1.8 mm plate
35 μm tether width

- Heating rates > **500 ºC /s**
- Cooling time constants in air:
  - Empty plate: **0.11 s**
  - With droplet = **2.4 s**



Sensor output

Heater E ~ 3 μJ

Technical Approach/Accomplishments

(Mark Mescher, Amy Duwel, Keith Baldwin, Tom King)

- Modeling
  - – Modeling of hybrid MEMS technology accurately predicts device performance w/o Rx.
  - – Current best noise model predicts noise floor well below sensitivity objective (~10^{-8} J).
- Readout electronics calibrated using 10^{-6} J pulse
- PCB being designed to improve signal to noise ratio
- Developing LabView data collection and processing

Open Issues and Research Questions

•Lack of models for calorimetry of biological system contained in microporous environment with uncertain hydration

•Surface regeneration for protein bound to sensor surface.

•Traditional understanding of macro scale solution-based calorimetry of biological systems not readily applicable to microscale reactions on surfaces

- Fidelity of Simulink model
  - •Add noise sources
- Demonstration of 10^{-8} J sensitivity