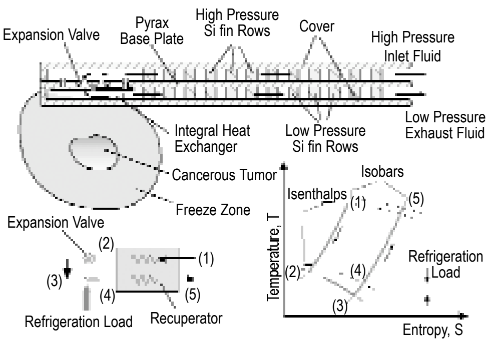
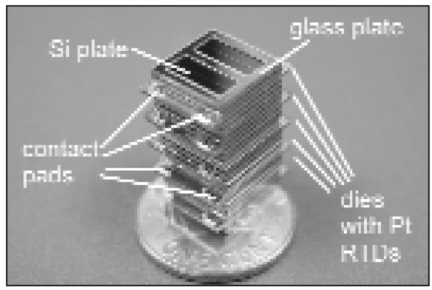
Micromachined Joule-Thomson Cryosurgery Probe

Weibin Zhu and Yogesh B. Gianchandani
Other Investigators: Michael J. White (UW-Madison),
Gregory F. Nellis (UW-Madison), and Sanford A. Klein (UW-Madison)



Schematic diagram of micromachined Joule-Thomson cryosurgical probe. High-pressure inlet fluid is from an external compressor.



The second generation of micro-recuperative heat exchanger integrated with platinum resistance temperature detectors (Pt RTDs).

The goal of this project is to create a miniature micromachined cryosurgical probe based on silicon micromachining technologies that can reach low temperatures with high-cooling power for cryosurgery and other applications. In cryosurgery, cancerous tumors and pathological tissues are locally destroyed in repeated freeze/thaw cycles. Mixed-gas Joule-Thomson cooling cycle offers high-thermodynamic efficiency and can be potentially implemented with structures that are simple enough to be realistically micromachined from silicon and glass. In this cycle, a cold, high-pressure fluid leaving a recuperative heat exchanger expands through a valve and thus results in temperature drop through the valve if the state of the fluid lies below the inversion curve before expansion. The probe is expected to be reliable because of the absence of cold moving parts. The second generation of microrecuperative heat exchanger with a footprint of 1cm x 1cm has a perforated-plate design composed of multiple glass/Si stacks and integrated with temperature sensors. The temperature sensors allow us to monitor the temperature distribution inside the heat exchanger and therefore, accurately validate our theoretical model, as well as control the cooling process. This is an associated project of the WIMS Center and is supported by the National Institutes of Health (NIH) under contract R33 EB003349-05.