Micromachined Joule-Thomson Cryosurgery Probe

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The goal of this project is to create a miniature micromachined cryosurgical probe based on silicon micromachined technology that can reach a temperature of 150K with at least 20W cooling power. Cryosurgery is a procedure that exposes cancerous tumors to cryogenic temperatures such that pathological tissue is locally destroyed during repeated freeze/thaw cycles. In order to kill the cancerous cells effectively, the surface of the cryosurgical instrument must be maintained at a temperature significantly below -50°C and freeze rate between 25–50°C/min. 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. Micromachining technology offers the miniaturization and precision needed for developing high-performance cryosurgical probes. A cold, high-pressure fluid leaving a recuperator 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 size of the first generation of micro recuperative heat exchanger is 6cm x 1.5cm with a total of 2.5mm thickness. This project is an associated project of the WIMS Center and supported by National Institutes of Health (NIH), and also by NIH, under Contract R21 EB003349-02.