An Actively Controlled Piezoelectric Microvalve for Distributed Cryogenic Cooling Systems

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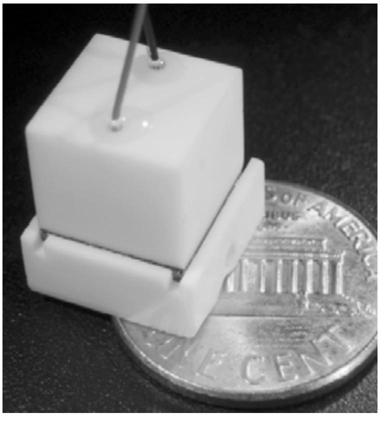
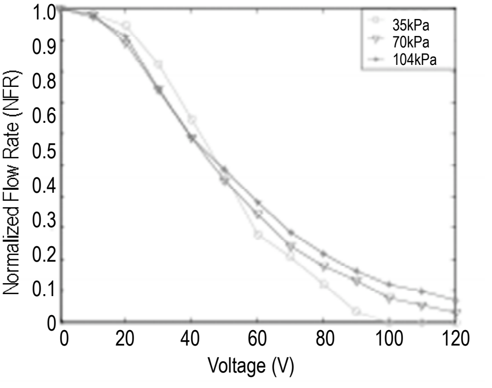


A picture of the assembled valve structure shown with a U.S. penny.



The normalized flow rate as a function of actuation voltage obtained at cryogenic temperature illustrates consistent modulation of the valve over the range of inlet pressures.

The main focus of this project is to create a micromachined actively controlled va1ve that is capable of operating reliably at cryogenic temperatures and accommodate high-flow rates of both liquids and gasses. In this project, an out-of-plane piezoelectrically driven microvalve scheme is chosen in order to overcome high-inlet pressure and low-power constraints. Silicon and glass micromachining technologies combined with ceramic packaging were used to create a valve with a final volume of 1cm^3. A perimeter augmentation scheme for the valve seat was implemented to provide higher-flow modulation. Nitrogen flow rates at cryogenic temperatures (80K) have been modulated from 166mL/min down to 5.3mL/min. The valve has been successfully operated from 80K to 380K. The valve has also been used to modulate and stop the flow of pressurized gas and liquids at room temperature. Development of a drug-delivery mechanism that uses the valve is underway. Liquid flow of water regulated in this manner has been varied from 10μL/min–500μL/min. This is an associated project of the WIMS Center and is supported by the National Aeronautics and Space Administration (NASA).