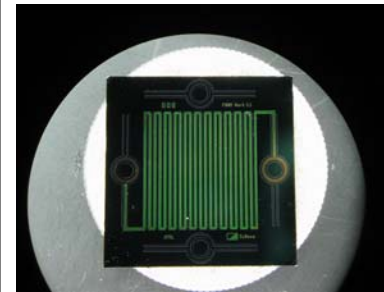
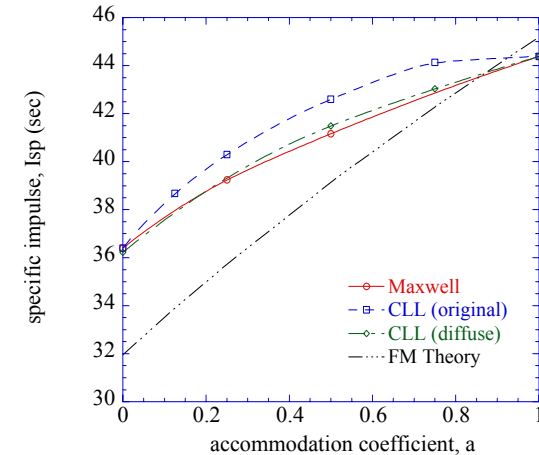


Goals and Potential Impact if Successful

- Enable design and fabrication of efficient microdevices for the control of aerospace vehicles
 - Microsatellites
 - Micro-Air vehicles
- Enable the efficient use of atmospheric sensors
- Understand physical processes of gas-surface interactions that drive microdevice performance
 - Surface area to volume increases significant of surface interactions of gas molecules
 - Current velocity slip models not adequate for some applications
- Kinetic (Molecular) approach required for even relatively high Reynolds number flows



MEMS fabrication of the Free Molecule Micro-Resistojet (FMMR). FMMR heater chip consists of thin-film metalized heater and gas expansion slots.



FMMR specific impulse versus energy accommodation coefficient for an Argon propellant (DSMC results vs. analytical theory)

Approach and/or Accomplishments

- Development of a Direct Simulation Monte Carlo (DSMC) kinetic code for low-speed, gas driven flows in microscale devices
- Use of available gas-surface interaction models for a MEMS fabricated propulsion device have been performed
 - Value of the energy accommodation coefficient is very important in determining device performance
 - Experimental data now becoming available to validate models
- Flows through micro- and nano-porous materials being investigated
 - Atmospheric sensors
 - Phase separators

Bottlenecks and Open Research Questions

- Details of gas-surface interactions on micro-engineered surfaces are not known
 - Relatively low speed flows
 - Potential for complex molecules
 - Surface roughness issues
 - Potential for complex surface chemistry and catalysis
 - Internal molecular energy accommodation
- Even relatively fundamental data may not be available
 - Energy/Momentum accommodation coefficients
- DSMC builds results based on statistical algorithms
 - Low-speed flows are traditionally noisy
 - Techniques required to obtain meaningful results