

## Progress Toward Highly Miniaturized Vacuum Pumps

Dean Wiberg, Beverley Eyre, Kirill Shcheglov, Victor White and Vachik Garkanian  
Jet Propulsion Laboratory, California Institute of Technology

A project was initiated at JPL to fabricate a miniature quadrupole mass spectrometer system using micro fabrication technology. In the course of designing this system, it became apparent that the choice for highly miniaturized vacuum pumps was very limited and in fact the pumping function dominated the power, mass and volume of the system. This presentation describes the approach and results to date to satisfy the vacuum pump requirements of the project. To address this issue within the funding envelope available to the project, two approaches were taken: 1) several Small Business Innovative Research (SBIR) projects were initiated specific to the project together with closely following a similar project funded by the Defense Advanced Research Project Agency (DARPA), 2) research was undertaken directly under project funding to develop a vacuum roughing pump to compliment the high vacuum pumps in development under the SBIR funding. Under approach 1 three contracts have been awarded to Creare, Inc of Hanover, NH (Mark Kenton, 603 643 3800). These have included a piezoelectric actuated parastaltic roughing pump, a miniature turbomolecular pump (TMP) and a subminiature (D cell flashlight battery size) TMP. Pumps were delivered at the conclusion of phase II under the piezo roughing pump and TMP contracts. Engineering considerations during development of the piezo roughing pump drove it to a mass and volume which were impractical for the intended application. The TMP effort resulted in a pump providing 4 l/sec of air to an ultimate vacuum of  $2 \times 10^{-6}$  torr discharging to about 100 mtorr. The pump occupies a volume of about 165 cm<sup>3</sup> and draws less than 1 watt. A phase I SBIR contract was awarded under the FY00 solicitation for a subminiature TMP equal in volume to about a D size flashlight battery. A Phase II SBIR award was made to Phoenix Analysis and Design Technology (PADT) in Phoenix, AZ (Mark Johnson, 480 813 4884). Fabrication is currently in progress with delivery expected in approximately six months for a TMP with drag stages to provide 10 l/sec pumping speed in a volume of about 154 cm<sup>3</sup> and drawing 7 watts. A pump developed by Sarcos Research Corporation, Salt Lake City, UT under DARPA funding (Mark Olivier, 801 581 0155). This pump provides pumping speeds of 0.8 l/sec at a minimum pressure of 1 mtorr discharging to Earth ambient. The pump represents a combination of piston and rotary drag sections. The smallest configuration of the pump occupies a volume of 118 cm<sup>3</sup> and draws 7 watts. A miniature scroll pump for vacuum roughing is in progress at JPL under direct project funding (Dean Wiberg, 818 354 5724). This device is fabricated using an X-ray lithography technique and is intended to achieve milli torr pressures from Earth ambient at a pumping speed of about 1 l/sec.