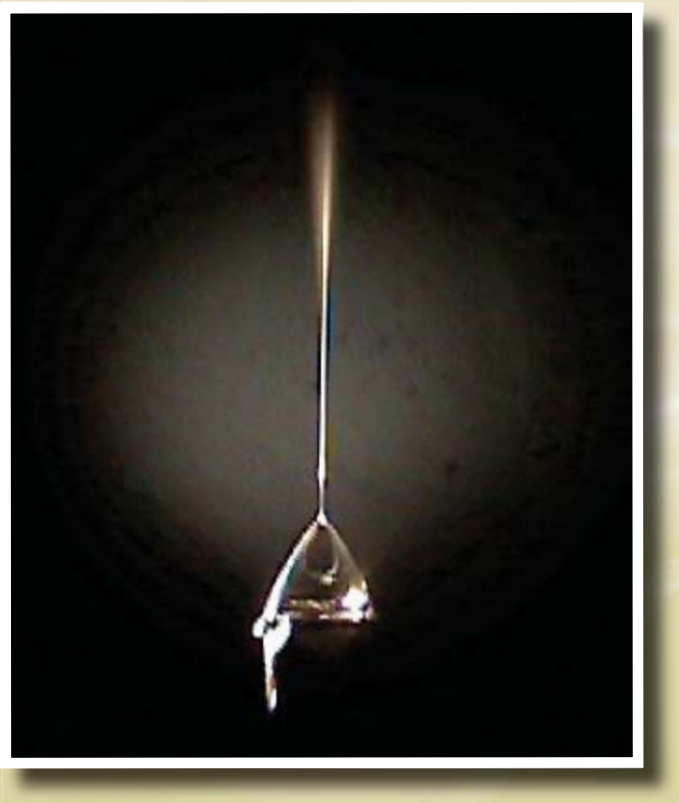
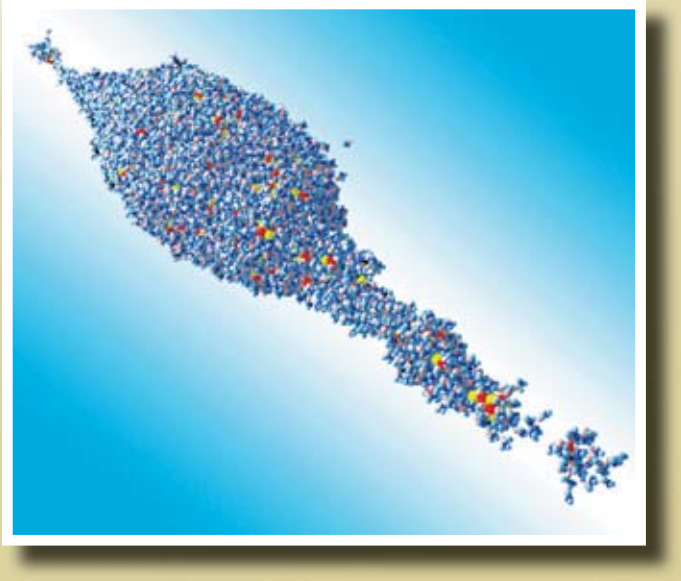
Nano-Jet Micro-Thrusters for Space Propulsion

Accomplishment: A new micro-thruster using a nano-jet spray of ionic liquid propellants has been developed and successfully validated. These electro-spray nano-jets produce nanometer-sized vapor droplets that give a ten-fold improvement in micro-thruster propulsion efficiency.



Impact: Electro-spray nano-jets enable the miniaturization of conventional electric thrusters, producing a new electric micro-thruster. Nano-jet micro-thrusters are essential for long-term precision positioning of satellites and for future Air Force nano-satellite missions. They also give improved mission flexibility by significantly reducing the lift-off mass of next-generation spacecraft, or by increasing mission lifetimes by roughly an order of magnitude at equivalent launch weight. These nano-jet micro-thrusters have been incorporated in upcoming NASA space missions as a transition path toward military applications.

Motivation and Approach: Air Force satellite missions require a choice between chemical propellants, which give very high thrust for relatively short periods of time, or electric propulsion, which gives low thrust for very long periods of time. Electric propulsion is the preferred approach for long-duration satellite maneuvers and for miniaturized satellites (nano-satellites). However, present plasma electric thrusters become much less efficient upon miniaturization, forming a significant barrier to future AF satellite missions. Electro-spray nano-jets enable electric propulsion that can be miniaturized without loss of efficiency. The nano-jet micro-thrusters developed here use ionic liquid propellants that give significant power savings, greatly improving the miniaturization potential and enabling a dramatic extension of propulsion efficiency. As a result of these efforts, nano-jet micro-thrusters using an ionic liquid propellant will be used for high precision positioning of an upcoming NASA satellite mission.



Team: This research was led by Dr. Yu-Hui Chiu (Space Vehicles Directorate) and Dr. Tommy Hawkins (Propulsion Directorate), in collaboration with Prof. Uzi Landman (Georgia Institute of Technology), Prof. Manuel Martinez-Sanchez (Massachusetts Institute of Technology) and Prof. Juan Fernandez de la Mora (Yale University). The research was funded by the Air Force Office of Scientific Research (Dr. Michael Berman and Dr. Mitat Birkan, Program Managers).