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Microfabricated Indium-fueled Electrospray Thruster Development

Electrospray thrusters are providing new capabilities in spacecraft propulsion. Colloid thrusters using an ionic liquid propellant are providing precision micronewton thrust for drag-free operations for the first time on the ST7/LISA Pathfinder Mission. Electrospray thrusters could provide attitude control capability for very small spacecraft, like cubesats, and replace reaction wheels for precision pointing in exoplanet observatories. Electrospray thrusters operate at very high efficiencies and have the potential for extremely compact architectures to be highly distributable on very large and very small spacecraft with microfabricated arrays of silicon emitters.

A Microfluidic Electrospray Propulsion (MEP) thruster is under development at the Jet Propulsion Laboratory using a novel silicon emitter array microfabrication approach using indium propellant. Electrospray thrusters extract charged particles from liquid propellants on needle emitters by electric field evaporation and ionization processes. Hundreds of tall complex silicon emitters were microfabricated in 1 cm^2 in arrays using grey-scale e-beam lithography, thick 3-D oxide masks and dry ion etching only. The thruster assembly was tested at an estimated thrust of >100 µN and specific impulse >3100 s with a mass of 26 grams and volume < 10 cm^3. The design, fabrication and demonstration of the microfabricated indium electrospray emitter arrays and the performance of the indium-fueled electrospray thruster with the microfabricated emitter arrays will be presented for discussion.

About the Speaker: C. Marrese-Reading received the BS in Engineering Physics in 1994 and MS/PhD in Aerospace Engineering from the University of Michigan in 1999. She has been working at Jet Propulsion Laboratory in the Electric Propulsion Group for more than 20 years. She has worked on the design, fabrication and testing of Hall thrusters, ion engines, electrospray thrusters and various cathode technologies. Marrese-Reading has been working on electrospray thruster development for more than 10 years. She is currently working on the Microfluidic Electrospray Propulsion (MEP) technology with microfabricated arrays of hundreds of silicon emitters for indium propellant. She is a member of the flight operations and system engineering teams for ST7/LISA Pathfinder, currently operating the first deep-space electrospray propulsion system to provide an ultra-stable drag-free platform for a space-based gravity wave observatory. She has co-authored more than 25 papers in journals and conferences and holds multiple patents.