Energetic Beams of Electrosprayed Nanodroplets: Applications in Spacecraft Propulsion and Surface Engineering

Manuel Gamero-Castano
Associate Professor; Department of Mechanical and Aerospace Engineering, University of California - Irvine

Electrospray atomization of liquids in the cone-jet mode generates narrow droplet distributions with average diameters as small as a few nanometers. These droplets are highly charged, and with the help of electrostatic fields can be accelerated to hypervelocities in a vacuum. The resulting energetic beams are useful for spacecraft propulsion (electrospray thrusters) and ion beam-like applications. Electrospray thrusters is a promising electric micropropulsion technology characterized by its ability to produce low thrust levels (as low as a fraction of a microNewton) at high specific impulse and efficiency unrivaled by plasma-discharge thrusters. The speaker will introduce this technology, and describe his own research on the structure and shaping of electrospray thruster beams. The second part of the seminar will introduce the phenomenology of nanodroplet impact on hard crystalline materials such as Si and SiC. Compared to ions, nanodroplets are massive particles of neutral molecules (e.g. ~153,000 molecules) with several elementary charges. Acceleration voltages below 20 kV produce kinetic energies of tens of eV per molecule. When such massive projectiles impact on a target they sputter atoms at high rate and, depending on the impact velocity, will amorphatize thin surface layers.

Bio: Manuel Gamero-Castaño received his B.S. in Chemical Engineering from Escuela Superior de Ingenieros (Universidad de Sevilla, Spain, 1995), and his Ph.D. in Mechanical Engineering at Yale University (1999). His Ph.D. thesis was awarded the S. K. Friedlander Award by the American Association for Aerosol Research in 2001. Gamero joined Busek Co Inc in 1999 where he worked in electric propulsion for spacecraft. He transferred to the Jet Propulsion Laboratory as a Senior Engineer in 2004, where he continued developing electrospray thruster technology for NASA’s DRS-ST7 and LISA missions. Gamero joined UC-Irvine’s Department of Mechanical and Aerospace Engineering in 2007, where he currently is an associate professor. His research focuses on electrospray thrusters, electrospray atomization, nanodroplet beams, and the development of aerosol diagnostics.