DPP16-2016-001945

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Theory and Numerical Simulation of Plasma-wall Interactions in Electric Propulsion

IOANNIS MIKELLIDES, Jet Propulsion Lab

Electric propulsion (EP) can be an enabling technology for many science missions considered by NASA because it can produce high exhaust velocities, which allow for less propellant mass compared to typical chemical systems. Over the last decade two EP technologies have emerged as primary candidates for several proposed science missions, mainly due to their superior performance and proven record in space flight: the Ion and Hall thrusters. As NASA looks ahead to increasingly ambitious science goals, missions demand higher endurance from the propulsion system. So, by contrast to the early years of development of these thrusters, when the focus was on performance, considerable focus today is shifting towards extending their service life. Considering all potentially life-limiting mechanisms in Ion and Hall thrusters two are of primary concern: (a) the erosion of the acceleration channel in Hall thrusters and (b) the erosion of the hollow cathode. The plasma physics leading to material wear in these devices are uniquely challenging. For example, soon after the propellant is introduced into the hollow cathode it becomes partially ionized as it traverses a region of electron emission. Electron emission involves highly non-linear boundary conditions. Also, the sheath size is typically many times smaller than the characteristic physical scale of the device, yet energy gained by ions through the sheath must be accounted for in the erosion calculations. The plasma-material interactions in Hall thruster channels pose similar challenges that are further exacerbated by the presence of a strong applied magnetic field. In this presentation several complexities associated with plasma-wall interactions in EP will be discussed and numerical simulation results of key plasma properties in two examples, Hall thrusters and hollow cathodes, will be presented.