

SCALABLE FLAT-PANEL NANO-PARTICLE MEMS/NEMS PROPULSION TECHNOLOGY FOR SPACE EXPLORATION IN THE 21ST CENTURY

Brian Gilchrist
University of Michigan

A completely new style of charged particle space propulsion technology appears feasible using nano-particles with micro and nanoelectromechanical systems (MEMS/NEMS) technology. MEMS technologies are already being explored as a possible approach to achieve scalability and system simplification. However, they also appear to offer a way to eliminate life limiting physical characteristics present in state-of-the-art ion propulsion. Further, by also considering the use of nano-particles (with ions) as a propellant with electric field-emission based MEMS/NEMS thruster concepts, substantial new performance improvements appear possible. This includes (1) operations at high power levels at substantially lower system level specific mass (kg/kW) numbers, (2) higher efficiency, (3) an order of magnitude increase in thrust densities over present-day ion propulsion technologies, (4) substantially simpler propulsion sub-system integration requirements on a spacecraft using “flat-panel” nano-particle thrusters (5) along with substantial improvements to life-time limiting issues over ion thrusters. We suggest a vision that in 10-20 years, modern electric propulsion systems will be heavily leveraging nano-particle and MEMS/NEMS technologies to address everything from the movement of propellant using micropumps, integrated microsensors for performance improvement to lifetime extension, high levels of scalability and system simplification, and especially fundamental performance improvements (e.g. specific mass, efficiency, thrust density).