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SPACE PROPULSION SYMPOSIUM (C4)
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CATHODIC ARC THRUSTER STUDIED BY PARTICLE-IN-CELL SIMULATIONS

Abstract

The cathodic arc thruster is a newly developed electric propulsion system. It provides a stream of ions with very high velocities from a solid conducting cathode. A high ion velocity in combination with a high ionization fraction makes the cathodic arc thruster attractive for spacecraft propulsion. In the past a record-high specific impulse was measured for such thrusters. The thruster uses a voltage of -220V at the cathode for several microseconds, producing plasma from cathode material which then streams out of the thruster producing thrust. In this work a two-dimensional axial-symmetric fully kinetic PIC code with Monte-Carlo collisions is used to simulate a cathodic arc thruster. The code was verified for several other applications like low temperature laboratory plasmas and different ion thrusters. The simulations reach runtimes that covers some arc pulses. After about 3-4 pulses a quasi-steady state for each pulse is developed. By using a self-similarity scaling the original size of the experiment can be simulate. During the simulation electrons from the initial arc source create some neutrals from the copper cathode by electron sputtering and these neutrals get ionized by other electrons. Ions produced by this process are accelerated and produce the thrust. To get deeper understanding of the underlying physics several diagnostics were developed. Averaged densities, energies, temperatures, velocity distribution functions can be diagnosed for all species time averaged or time-dependent. Additionally, diagnostics for plasma potential, thrust and power consumption are available.