Two new concepts in rf plasma sources are developed as space thrusters, the low pressure (~1 mTorr) Helicon Double Layer Thruster (HDLT) and the high pressure (~1 Torr) hollow cathode Pocket Rocket (PR) plasma thruster. The density gradient in low pressure expanding radiofrequency plasmas creates an electric field that accelerates positive ions out of the plasma. Generally, the total potential drop is similar to that of a wall allowing the plasma electrons to neutralise the ion beam. A low pressure expansion dominated by a magnetic field can result in the formation of electric double layers which produce a very directed neutralised beam of ions of large area (HDLT). A high pressure expansion with no applied magnetic field can result in large dissociation rates and/or a collimated beam of ions of small area and a flowing heated neutral beam (PR). Two space simulation chambers of various size and pumping capability are used to measure the propulsion performances of these thruster prototypes. Optimization of the devices requires a thorough investigation of the physics of the discharge and its expansion in vacuum (the plume). Combining experimental, theoretical and computational analyses allows the optimization of each discharge mode to suit the required performances (thrust, specific impulse, life time, efficiencies), by quantifying the force from the electron, ion and neutral pressures and the force from the magnetic field pressure.


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