CHARACTERIZATION OF A PIEZOELECTRIC TRANSFORMER PLASMA SOURCE

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ABSTRACT

The piezoelectric transformer plasma source (PTPS) is a compact RF driven plasma source developed for near-space and microspacecraft propulsion. The PTPS uses the mass transfer of emitted charged particles from the plasma to produce thrust.

The PTPS utilizes the piezoelectric transformer effect to aid in plasma production. The applied RF signal induces a vibration in the piezoelectric material through the converse piezoelectric effect. The strain induced in the crystal then generates an electric potential within the aperture of the PTPS. With an electrode pattern of a large annular electrode with a small aperture in the center the generated output voltage is larger than the applied voltage. Near the resonant frequency, the voltage step-up ratio can be very large. The large induced RF voltage in the aperture results in ionization of gas to produce plasma due to the high electric field inside the aperture. The plasma is also accelerated from the PTPS by the generated voltage.

Research on the PTPS has focused on optimizing the integrated PT within the PTPS and characterizing the plasma source operation at background gas pressures of 100-2000 mTorr. Simulations with COMSOL Multiphysics were used to optimize electromechanical coupling in the PT. Diagnostics used in the characterization of the PTPS include current and voltage monitors, emission current measurements with a Faraday cup and retarding potential analyzer, and imaging with an optical spectrometer and an ICCD camera.