SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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SURFACE ELECTRICAL RESISTIVITY OF RANDOMLY CAESIUM CONTAMINATED FEEP CERAMIC

Abstract

The FEEP (Field Emission Electric Propulsion) is a low thrust and high specific impulse thruster which is currently baselined for the Lisa Pathfinder micro-propulsion subsystem. The working principle consists in the extraction of ions from a liquid metal source and, subsequently, acceleration by means of an high electric field. During the thruster operation, atoms of caesium are evaporated from the emitter slit and part of them remains inside the thruster unit contaminating many surfaces. In particular, the electrode insulator, which is responsible of the insulation of the two high voltage electrodes (accelerator and emitter) is subjected to caesium coverage (by means of physical and chemical phenomena) and possibly leading to loss of electrical insulation.

The decrease in surface electrical resistivity of the ceramic insulator due to the exposure to caesium vapour random contamination is investigated. Two main mechanisms are identified: Caesium – Caesium electron tunnelling described by J.D. Levine [NASA Contractor Report, December 1965] and ohmic conduction. The latter mechanism is studied considering the ceramic sample contaminated by random Caesium spots as a two phases random heterogeneous material.

A procedure to reconstruct samples of the micro-structure from a limited morphological descriptors extracted from microscope images is used. The effective conductivity of the digitized media is evaluated by employing a Brownian motion simulation method of Torquato, Kim and Cule [J. Appl. Phys 85, 1560 (1999)]. In fact, conventional numerical techniques do not accurately capture the local fields especially for the contact points between two pixels of the same phase for reasonable grid resolution.

The results of the analyses are discussed and compared with test data collected during experimental activities carried on during the development of FEEP thruster.