

# **Electric Propulsion**

Papers Presented at the AIAA SciTech Forum and Exposition  
2023

National Harbor, Maryland, USA and Online  
23-27 January 2023

ISBN: 978-1-7138-7574-1

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 34922 Uwytkug'Xcmg{'Ftkxg.'Uwky'422, Reston, VA 20191, USA.

# TABLE OF CONTENTS

## **ELECTRIC PROPULSION MODELING**

Array-Scale Modeling of Electrospray Ion Plumes Within AFRL Plume Simulation Tool TURF.....	1
<i>Adler Smith, Elaine Petro</i>	
The Dispersion of Lower-Hybrid Instabilities and Comparisons with Measurements Near the Front Pole of a Magnetically Shielded Hall Thruster.....	16
<i>Ioannis G. Mikellides, Alejandro Lopez Ortega, Robert B. Lobbia, Vernon H. Chaplin</i>	
Numerical Investigation of Carbon Sputtering and Transport for the Ion Thruster Testing in the Ground Facility.....	32
<i>Keita Nishii, Deborah A. Levin</i>	
Optimal Experimental Design to Learn Reduced-Fidelity Models for Porous Electrospays .....	48
<i>Joshua Eckels, Collin B. Whittaker, Benjamin Jorns, Alex Gorodetsky</i>	
Evaluation of Several First-Principles Closure Models for Hall Thruster Anomalous Transport.....	67
<i>Thomas A. Marks, Benjamin Jorns</i>	

## **MICROPROPULSION I**

Electrospray Emitter Geometry Characterization Through Surface Profilometry and Parameter Estimation.....	82
<i>Collin B. Whittaker, Benjamin Jorns</i>	
Additive Manufacturing and Characterization of Porous Ceramic Electrospray Emitters .....	95
<i>Suhail Chamieh, Elaine Petro, Sadaf Sobhani</i>	
Designing and Commercialization of Porous Emitter Electrospray Thruster for Space Applications.....	102
<i>Arsad Quraishi, Szymon Dworski, Chengyu Ma, Charles N. Ryan, Alessandro Ferreri, Guillaume Vincent, Hugo Larsen, Emmanuelle Rosati Azevedo, Emily Dingle, Alberto Garbayo, Maria Vozarova, Erich Neubauer</i>	
A Brief Review of Diagnostics for Electrospray Propulsion .....	118
<i>Christopher T. Lyne, Miron F. Liu, Joshua Rovey</i>	

## **ADVANCED CONCEPTS**

A Linear Magnetic Reconnection Based Plasma Thruster for Spacecraft Propulsion .....	138
<i>Christopher N. Everett, Charles N. Ryan</i>	
Performance Predictions for CW-Mode Operation of an RMF Thruster.....	168
<i>Christopher L. Sercel, Tate Gill, Benjamin Jorns</i>	
Research on Efficient Heat Transfer for Air Breathing Electric Propulsion .....	186
<i>Masanori Harada, Hideki Moriai</i>	
Simulations of Alternative Propellants for Inductive Pulsed Plasma Thrusters.....	200
<i>Tate Gill, Christopher L. Sercel, Benjamin Jorns</i>	

Characterization of an Air-Breathing Deflagration Thruster .....	216
<i>Keshav P. Prathivadi, Jackson S. Dye, Thomas C. Underwood</i>	

## **HALL THRUSTERS AND HOLLOW CATHODES**

Design of an Air-Core Circuit for a Hall Thruster.....	229
<i>William Hurley, Thomas A. Marks, Benjamin Jorns</i>	
Operation and Performance of a Magnetically Shielded Hall Thruster at Ultrahigh Current Densities on Xenon and Krypton.....	238
<i>Leanne L. Su, Parker J. Roberts, Tate Gill, William Hurley, Thomas A. Marks, Christopher L. Sercel, Madison Allen, Collin B. Whittaker, Matthew Byrne, Zachariah Brown, Eric Viges, Benjamin Jorns</i>	
Characterization of Electron Mach Number in a Hollow Cathode with Thomson Scattering.....	270
<i>Parker J. Roberts, Benjamin Jorns</i>	
Theory of RF Plasma Cathodes and Supporting Experiments for Electric Propulsion Applications .....	283
<i>Marcel P. Georjin, Michael S. McDonald, John W. Brooks</i>	
100 A-500 a High-Current Hollow Cathode Development .....	299
<i>Wayne L. Ohlinger, Bernard Vancil</i>	

## **TOPICS IN ELECTRIC PROPULSION I**

Computational Simulation and Performance Investigation of 8-GHz Microwave Electrothermal Thrusters (MET) with Helium.....	304
<i>Juyeon Lee, Laxminarayan L. Raja</i>	
A Comparison Between Laser Beamed Thruster and Solar Thermal Thruster .....	320
<i>Maged A. Soliman</i>	
Edge Wear of the Advanced Electric Propulsion System Pole Covers .....	331
<i>Jason D. Frieman, Hani Kamhawi, Jon Mackey, George Soulas, Peter Y. Peterson, James H. Gilland</i>	

## **MICROPROPULSION II**

Experimental Study of a Low-Voltage Pulsed Plasma Thruster for Nanosatellites .....	343
<i>Brian F. Jeffers, Patrick Gresham, Alexey Shashurin</i>	
Investigating the Chemical Stability of Electrospray Plumes During Particle Collisions .....	352
<i>Abderrahim R. Bendimerad, Abu Taqui M. Tahsin, Adam Yonas, Caleb Colucci, Elaine Petro</i>	
Plume-Material Interactions of Metallic Surfaces Bombarded by an [EMIM][BF <sub>4</sub> ] Electrospray Source.....	359
<i>Avinash Rao, Tanapat Bhakyaipaul, Joshua Rovey, Deborah A. Levin, Huck Chew</i>	
Angular Properties of Ionic Liquid Electrospray Emitters .....	375
<i>Madeleine Schroeder, Ximo Gallud Cidoncha, Amelia Bruno, Oliver Jia-Richards, Paulo Lozano</i>	

Optical Emission Characterization of a Single Emitter Electrospray Thruster Interacting with Surfaces .....	386
<i>Nazli Turan, Chengyu Ma, Charles N. Ryan</i>	

## **ADVANCED CONCEPTS II**

A Two-Stage $\mu$ CAT-MPD Thruster.....	397
<i>Denis B. Zolotukhin, Michael Keidar</i>	

Physical Insight into Microwave Electrothermal Thruster Startup Via Multi-Objective Design Optimization and Plasma Simulation .....	403
<i>Tsubasa Ozawa, Suk Hyun Yeo, Hideaki Ogawa</i>	

Study on the Laser Induced Plasma Applying for Laser Propulsion .....	420
<i>Ryota Yasuda, Hideki Moriai</i>	

Novel Methods to Detect Trace Quantities of 1-Ethyl-3-methylimidazolium Tetrafluoroborate .....	441
<i>Stefan Bell, Carl Geiger, Benjamin Inbar, Mark Pfeifer, Elaine Petro</i>	

## **TOPICS IN ELECTRIC PROPULSION II**

Development of MSR-ERO Electric Propulsion Subsystem: Thruster Power and Control Features .....	453
<i>Dominique Nicolas, Paul Kirch, Guillaume Bonnery, Christian Lebranchu, Howard Gray, Luis Alonso-Gomez, Cheryl Collingwood, Tim Watterton, Orson Sutherland</i>	

Charge-Exchange Plasma Effects of the SPT-100 Hall Thruster at Heliocentric Distances from 0.044 AU to 1 AU .....	470
<i>Tejaswi Shinde, Iver Cairns, Jason Held</i>	

Student Design and Analysis of a Hall Effect Thruster .....	484
<i>James Wetherbee, Daniel Torres, Sara Hering, Sebastian Padilla, Gabriel Gustavson, Kai Korte-Wormley, Oweis Mokatish, Sankrit Mhaske, Natalie Cruz, Garrett Ostrander, Han V. Nguyen</i>	

## **Author Index**