

Plasmadynamics and Lasers

Papers Presented at the AIAA SciTech Forum and Exposition
2023

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

ISBN: 978-1-7138-7600-7

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

MEASUREMENTS IN PLASMA AND LASER ENVIRONMENTS

Wavefront Retrieval from Irradiance Measurements Using Inverse Design Methods	1
<i>Christopher Limbach</i>	
Assessment of Classical Theory of Laser Propagation Through Turbulence Using Well-Resolved Direct Numerical Simulations	16
<i>Dillon Motley, Komal Kumari, Diego A. Donzis</i>	
Evaluating the Role of Product Gas Composition in Vibrational Relaxation in Pulsed Microwave Plasma-Enhanced Flames	23
<i>Fynn Reinbacher, Sarang Bidwai, James B. Michael, Ryan J. Thompson, Chloe E. Dedic</i>	
CARS in an Inductively Coupled Plasma Torch, Part 1: High Temperature Nitrogen Thermometry	36
<i>Dan Fries, John S. Murray, Spenser Stark, Noel Clemens, Philip L. Varghese, Rajkumar Bhakta, Elijah Jans, Sean P. Kearney</i>	
CARS in an Inductively Coupled Plasma Torch, Part 2: Temperature and Carbon-Monoxide Measurements in the Reaction Layer of a Graphite Ablator.....	45
<i>Sean P. Kearney, Rajkumar Bhakta, Dan Fries, John S. Murray, Spenser Stark, Noel Clemens, Philip L. Varghese</i>	

PLASMA AND LASER DIAGNOSTICS I: LASER-INDUCED AND TRANSIENT PLASMAS

Angle Optimized Filtered Rayleigh Scattering for the Imaging of Pressure Waves from Laser Generated Surface Sparks at 250,000 Frames Per Second	50
<i>James R. Creel, Boris S. Leonov, Richard Miles</i>	
Quantitative Femtosecond Two-Photon Absorption Laser Induced Fluorescence Measurements of Hydrogen and Nitrogen Atoms in an AC Dielectric Barrier Discharge.....	58
<i>Ning Liu, Timothy Chen, Hongtao Zhong, Christopher Kondratowicz, Yiguang Ju</i>	
Beam Shaping for the Laser Energy Deposition in Air	65
<i>Sagar Pokharel, Junhwi Bak, Albina Tropina, Richard B. Miles</i>	
On the Effect of High-Frequency Plasma Actuator Forcing for Prevention of Dynamic Stall.....	79
<i>Alexander J. Lilley, Subrata Roy, Miguel R. Visbal</i>	

COMPUTATIONAL METHODS FOR PLASMAS AND LASERS

Investigation of Hypersonic Radiative Signatures Through the Use of a Voxelized Photon Monte Carlo Radiation Model	90
<i>Sara Swenson, Brian Argrow</i>	
Semiclassical Analytic Model of Nonadiabatic Energy Transfer in Atomic Collisions.....	105
<i>Igor V. Adamovich, J. William Rich</i>	
Effects of Multiple Pulses on Nanosecond Discharges	114
<i>Alfredo J. Duarte, Nicholas E. Deak, Fabrizio Bisetti</i>	

State-To-State Analysis of a Nitrogen RF Inductively Coupled Plasma.....	127
<i>Sanjeev Kumar, Alessandro Munafò, Sung Min Jo, Marco Panesi</i>	
Numerical Modeling of NS Discharge Development in Inhomogeneous Magnetic Field	141
<i>Andrey Starikovskiy, Nikolay Aleksandrov, Mikhail N. Shneider</i>	

PLASMA-ASSISTED IGNITION AND COMBUSTION I: IGNITION AND CHEMICAL CONVERSION

Numerical Model of the Initiation and Propagation of a Radial Flame Front by NRP Discharge.....	146
<i>Raphaël J. Dijoud, Carmen Guerra-Garcia</i>	
Ignition Enhancement of NH ₃ /Air Mixtures by Non-Equilibrium Excitation in a Nanosecond Pulsed Plasma Discharge.....	159
<i>Xingqian Mao, Hongtao Zhong, Ning Liu, Yiguang Ju</i>	
Numerical Investigation of Ignition Kernel Development with Nanosecond Pulsed Plasma in Quiescent and Flowing Mixtures.....	165
<i>Taareh Sanjeev Taneja, Timothy Ombrello, Joseph Lefkowitz, Suo Yang</i>	
Laser Ignition and Laser-Induced Breakdown Spectroscopy of a Hydrocarbon Flame in an Annular Spray Burner.....	174
<i>Parneeth Lokini, Ciprian Dumitrache, Bret C. Windom, Azer P. Yalin</i>	
Ammonia Generation in Ns Pulse and Ns Pulse / RF Discharges Over a Catalytic Surface.....	185
<i>Xin Yang, Caleb Richards, Igor V. Adamovich</i>	

TOPICS IN PLASMADYNAMICS AND LASERS

Kinetic Studies of Low-Temperature Ammonia Oxidation in a Nanosecond Repetitively-Pulsed Discharge.....	206
<i>Hongtao Zhong, Ning Liu, Xingqian Mao, Ziyu Wang, Yiguang Ju</i>	
Comparison of Plasma Development in a Dielectric Barrier Discharge Actuator Operated Using a Constant and Sinusoidal Applied Voltage.....	212
<i>Aliaksandr Murzionak, Jason Etele</i>	
Low-Temperature Plasma Assisted Kinetics Study of Ethanol	230
<i>Karan Bopaiah, Michael T. Middleton, Nicholas Tsolas</i>	
Relationship Between Power Consumption and Fluid Characteristics in Plasma Aerodynamic Control for High-Reynolds Number Flow.....	242
<i>Koki Asawa, Noritsugu Kubo, Kazuya Nishiyama, Motofumi Tanaka, Takayasu Fujino</i>	

PLASMA AND LASER DIAGNOSTICS II: THOMSON SCATTERING AND OTHERS

Demonstration of Low Angle Thomson Scattering for Background Interference Suppression.....	255
<i>Junhwi Bak, Amirhossein Abbasszadehrad, Anuj Rekhy, Christopher Limbach, Richard B. Miles</i>	
Mapping of an Arbitrarily Oriented Circular Aperture to Determine Solid Angle Broadening Effects on Thomson Scattering.....	261
<i>Amirhossein Abbasszadehrad, Junhwi Bak, James R. Creel, Richard Miles</i>	

Seeded Optical Parametric Oscillator as a Light Source for Slow-Light Imaging Spectroscopy 273
Boris S. Leonov, Robert T. Randolph, Anuj Rekhy, Junhwi Bak, Amirhossein A. Rad, Arthur Dogariu, Richard Miles, Christopher Limbach

Electron Momentum-Transfer Collision Frequency Measurements in Small Plasma Objects Via Phase Information from Constructive Elastic Microwave Scattering 282
Adam Patel, Xingxing Wang, Apoorv Ranjan, Mikhail Slipchenko, Sergey O. Macheret, Mikhail N. Shneider, Alexey Shashurin

Preliminary Krypton Measurements by Two-Photon Absorption Laser Induced Fluorescence (TALIF) in Cold Flow and a Hollow Cathode Plasma 291
Jacob Gottfried, Seth Antozzi, Ciprian Dumitrache, Azer P. Yalin

PLASMA AND LASER PHYSICS I: FILAMENTARY DISCHARGES

Control of Shock Train in Mach 4 Duct-Driven Flow by Filamentary Plasma 303
Philip S. Andrews, Philip Lax, Sergey B. Leonov

Investigating the Effect of Flow Velocity on Jetting Motion Produced by Repetitively Pulsed Discharges 316
Katherine C. Opacich, Joshua Heyne, Stephen Hammack, Timothy Ombrello

Influence of Airflow on Nanosecond Pulsed Discharges 327
Carmen Guerra-Garcia, Colin A. Pavan, Sankarsh Rao, Raphaël J. Dijoud

The Effect of Humidity on Streamer Propagation in Long Air Gaps 335
Andrey Starikovskiy, Eduard Bazelyan, Nickolay Aleksandrov

Kinetics of HO₂ Radical in Ns Pulse O₂-He Plasmas Over a Liquid Water Surface 346
Hamzeh Telfah, Elijah Jans, Sai Raskar, Igor V. Adamovich

HYPERSONICS AND ENTRY FLOW PLASMAS I: EXPERIMENTS

Use of Modified Radar REMPI for Localized Measurement of Temperature in Semiconductors 364
Christopher Grunbok, Richard Miles, Arthur Dogariu

Luminous Efficiency Determination of Spacecraft Materials in Ground Test Facilities 371
David Leiser, Christian A. Dürnhöfer, Stefan Loehle, Jérémie J. Vaubailon, Stefanos Fasoulas

Effect of Transport Coefficients on RAM-C-II Plasma Density 381
Prasanna Thoguluva Rajendran, Bernard Parent

Stabilization Effects in Hydromagnetic Plasma Flows 406
Thomas C. Underwood

PLASMA-ASSISTED IGNITION AND COMBUSTION II: MODELS AND EXPERIMENTS

Modeling Flame Speed Modification by Nanosecond Pulsed Discharges to Inform Experimental Design 416
Colin A. Pavan, Carmen Guerra-Garcia

Laser Induced Fluorescence and High Speed Imaging of Nanosecond-Pulsed Discharges for Application in Plasma Assisted Combustion in a Microchannel 431
Madeline Vorenkamp, Andrey Starikovskiy, Christopher Kliewer, Yiguang Ju

Investigation and Modeling of Equilibrium Plasma for Spherical Flame Initiation and Measurements.....	436
<i>James Shaffer, Omid Askari</i>	
Kinetics of Non-Equilibrium Plasma in Water Vapor- And Hydrocarbon-Containing Gaseous Mixtures	442
<i>Nickolay Aleksandrov, Eduard Bazelyan, Alexander Ponomarev, Andrey Starikovskiy</i>	
Plasma Assisted Emission Control of Hydrocarbon Gas Flares: A 0D Feasibility Study.....	474
<i>Praise Noah Johnson, Taareesh Sanjeev Taneja, Suo Yang</i>	

PLASMA AND LASER DIAGNOSTICS III: NANOSECOND PULSED DISCHARGES AND REACTIVE FLOWS

Electric Field Distribution in a "Hybrid" RF Discharge with Ionization Generated by Ns Discharge Pulses.....	486
<i>Sai Raskar, Keegan Orr, Xin Yang, Igor V. Adamovich</i>	
Measurements of Vibrationally Excited Oxygen Molecules in Preheated O ₂ -Ar Mixtures Excited by a Ns Pulse Discharge	507
<i>Keegan Orr, Dirk Van Den Bekerom, Igor V. Adamovich</i>	
Single-Shot Time-Resolved Thermometry of Atmospheric-Pressure Nanosecond Pulsed Plasma Discharges	528
<i>Karna Patel, Anup Saha, Aman Satija, Terrence R. Meyer, Sally P. Bane</i>	
Optical and Electrical Diagnostics of a High-Voltage Laser-Triggered Switch with Variable Impedance Load	536
<i>Jacob Gottfried, Charles E. Rose, Azer P. Yalin</i>	
High-Fidelity Simulations of Plasma-Assisted Oxidation of Hydrocarbon Fuels Using Nanosecond Pulsed Discharges.....	551
<i>Nicholas E. Deak, Alfredo J. Duarte, Lucas Esclapez, Marc Day, Fabrizio Bisetti</i>	

PLASMA-ASSISTED IGNITION AND COMBUSTION III: STATIC AND DYNAMIC STABILITY

Dynamics of Low-Temperature Filamentary Plasma-Assisted Ignition-Stabilized Combustion	571
<i>Ravi B. Patel, Jeroen Van Oijen, Nico Dam, Sander Nijdam</i>	
Stabilization of Lean Flames with Nanosecond Discharges in a Gas Turbine Model Combustor.....	579
<i>Victorien P. Blanchard, Frédéric Roqué, Philippe Scouflaire, Christophe O. Laux, Sébastien Ducruix</i>	
Electrical Characteristics and Flow Topology of Ring-Type Dielectric Barrier Discharge Plasma Actuator	590
<i>Tom Fridlender, Srikar Yadala Venkata, Nicolas Benard, Eric Moreau</i>	
Mixing Enhancement Downstream of an Active Square Mesh Grid Using Plasma Actuation	605
<i>Tom Fridlender, Nicolas Benard, Jean-Paul Bonnet, Eric Moreau</i>	

HYPERSONICS AND ENTRY FLOW PLASMAS II: SIMULATION

Numerical Analysis of Magnetohydrodynamic Flow Control in Mars Direct and Orbital Entries	626
<i>Kotaro Tabuchi, Ryota Sumitomo, Kaito Tanaka, Takayasu Fujino</i>	
Feasibility of MHD Aerobraking for Use in Martian Atmospheric Entry	641
<i>John C. Ogilvie, David Gildfind, Rowan Gollan, Nicholas N. Gibbons</i>	
Prediction of Communication Blackout and Degradation for a Re-Entry Hypersonic Capsule Through High-Fidelity Numerical Simulations	666
<i>Henry H. Vu, Valerio Viti, Jeff Tharp, Eldon Staggs</i>	
Optimised Magnetic Field Strengths for Venus Atmospheric Entry Using Magnetohydrodynamic Aerobraking.....	681
<i>Sebastiaan B. Van Oeveren, David Gildfind</i>	

SPECIAL SESSION: ATMOSPHERIC AND SPACE PLASMAS

Liquid Plasma Crystals on the ISS	704
<i>Evdokiya G. Kostadinova, Emerson Gehr, Bradley Andrew, Lorin S. Matthews, Truell W. Hyde, Abbie Terrell</i>	
Charging of Irregularly-Shaped Dust Grains Near Surfaces in Space	717
<i>David Lund, Xiaoming He, Daoru Han</i>	
Simulated Propagation of Ion Acoustic Solitary Waves from Orbital Debris Contrasted with Simultaneous Observations of the Ionosphere by an Incoherent Scatter Radar	730
<i>Connor M. Wilson, Christine M. Hartzell</i>	
Addressing the Lightning Protection Needs of Novel Aircraft.....	738
<i>Carmen Guerra-Garcia, Samuel Austin, Jaime Peraire, Cuong Nguyen</i>	
Streamer Discharge Development in Long Air Gaps	746
<i>Andrey Starikovskiy, Eduard Bazelyan, Nickolay Aleksandrov</i>	

Author Index