International Low Temperature Plasma Community

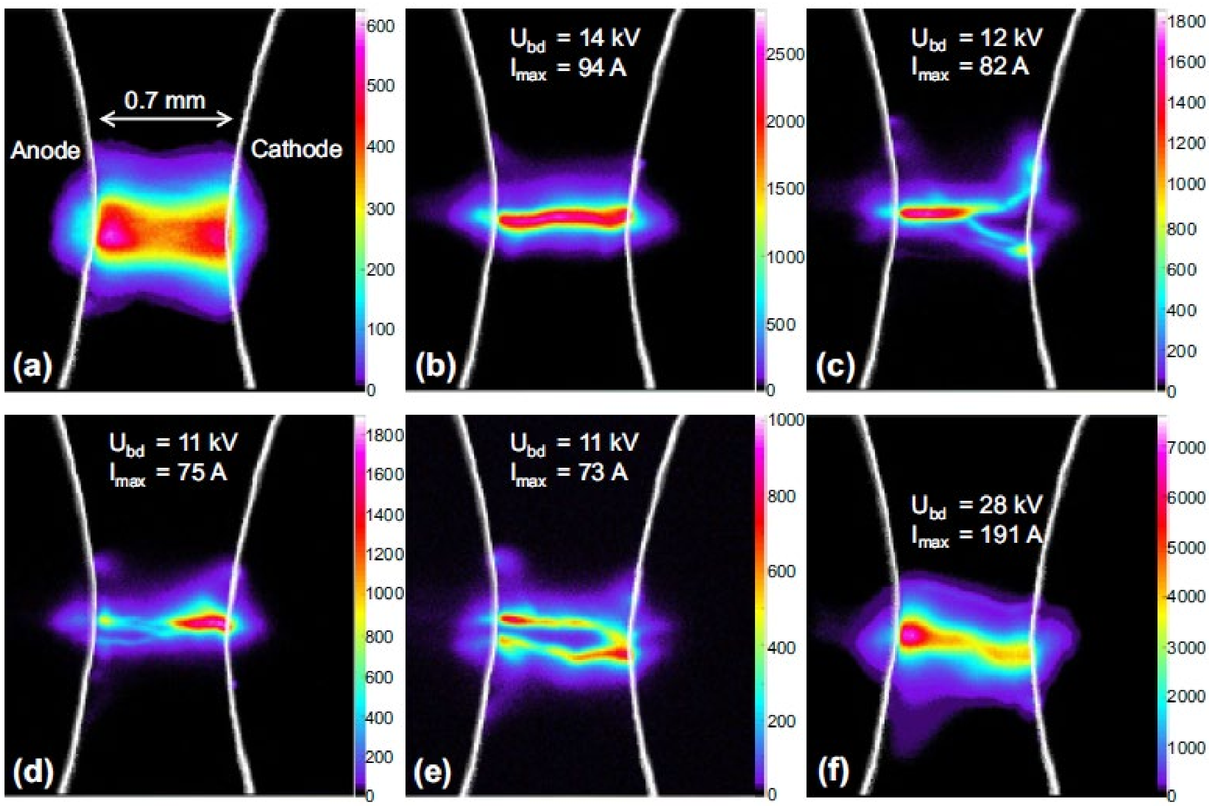
https://mipse.umich.edu/iltpc.php, iltpc-central@umich.edu

Newsletter 05 (updated)

7 August 2020

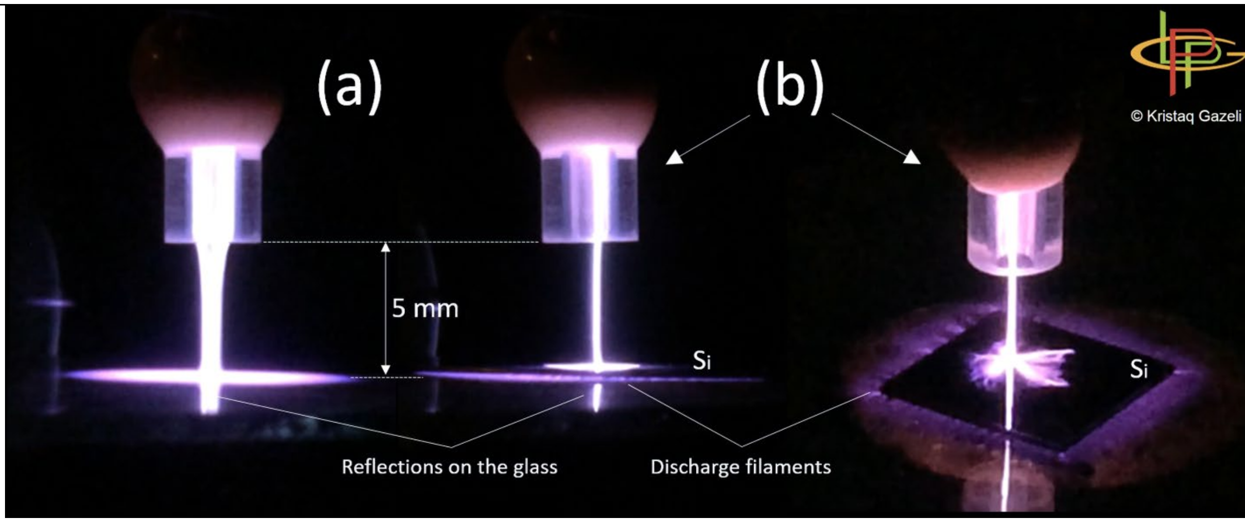
Images to Excite and Inspire!

Thank you for submitting your images, some of which are shown here. Those images already submitted will appear in later Newsletters. Please do send your images (with a short description or source) to iltpc-central@umich.edu.



Spark discharge emission structures for the same applied voltage (U = 37 kV) for d_{gap} = 0.7 mm in air with an iCCD gate of 100 µs for different breakdown voltage Ubd. (a) Averaged iCCD image using 200 single discharges, (b) straight discharge channel with homogeneous emission, (c) branching with major spot on anode, (d) branching with major spot on cathode, (e) double channel, (f) thicker channel for higher Ubd and Imax. Breakdown voltage and maximum current are indicated in the images (intensity scale in pseudo color) and electrode surfaces are indicated by white lines. The direction of the gas flow is from top to bottom. (https://epjd.epj.org/articles/epjd/abs/2018/12/d180505/d180505.html)

Dr. rer. nat. Hans Höft, Leibniz-Institut für Plasmaforschung und Technologie e.V. (INP), hans.hoeft@inp-greifswald.de



Emission patterns of a ns-pulsed Ar plasma jet impinging (a) on a grounded glass plate and (b) on a silicon (Si) wafer placed on top of a grounded glass plate.
(https://doi.org/10.1088/1361-6595/aac5b3, https://doi.org/10.1002/ppap.201800080).
Dr. Kristaq Gazeli, Université Paris-Saclay, CNRS, Laboratoire de Physique des Gaz et des Plasmas (LPGP), kristaq.gazeli@gmail.com.

In this issue:

- Images
- Call for Contributions
- General Interest Announcements
- Meetings and Online seminars
- Community Initiatives and Special Issues (updated)
- Research Highlights and Breakthroughs
- New Resources
- Career Opportunities
- Collaborative Opportunities

Call for Contributions

Please submit content for the next issue of the Newsletter. Please send your contributions to iltpc-central@umich.edu by **August 31, 2020**.

In particular, please send **Research Highlights and Breakthroughs** using this ***template*** (https://mipse.umich.edu/iltpc/highlight_template_v03.docx). The highlight consists of an image and up to 200 words of text. The topic can be anything you want - a recently published work, a new unpublished result, a proposed new area of research, company successes, anything LTP-related. Please see the *Research Highlights and Breakthroughs* for examples.

General Interest Announcements

- The ILTPC is maintaining a list of LTP conferences. With many meetings being canceled and rescheduled, we thought this would be useful for minimizing conflicts and planning future trips. The data may not be 100% accurate, so please let us know of changes in conference scheduling. View-only link to the schedule: https://docs.google.com/spreadsheets/d/1XoD6Fn7AP0HFTQJpPCETrRIQhx8IDisz4XUMyv9X7zo/edit?usp=sharing.

  Contact:
  ILTPC
  iltpc-central@umich.edu

Meetings and Online Seminars

- **Online LTP Seminar**

  Reminder!! Upcoming seminars: **August 18, September 1, September 15.** More information on the Online LTP Seminar: https://mipse.umich.edu/ltp_seminars.php

- **International Online Plasma Seminar**

  Reminder!! Upcoming seminars: **August 13, August 27, September 10.** More information on the International Online Plasma Seminar (IOPS): https://mipse.umich.edu/online_seminars.php

Community Initiatives and Special Issues

- **Special Issue in *Frontiers in Physics* on *Applications of LTP in Biomedicine, Agriculture and Food Processing***

  Low-temperature plasmas (LTP) at atmospheric gas pressure play an increasing role in biomedical applications. The experimentally observed benefits of LTP for these applications are attributed to the controllable fluxes of chemically active species that can be produced in air at near room temperatures and delivered to bio-matter to induce desired effects. Recent research on the biomedical applications of LTP has generated new scientific knowledge regarding the interaction of plasma with soft matter including cells, tissues, seeds, and plants. The relative importance of different factors on plasma-induced bio-effects remains poorly understood. For example, cold plasma jets exhibit large electric fields that can play a synergistic role by causing cellular electroporation and thus allowing ROS and RNS (RONS) to enter the cell. The effects described above have already led to the development of many medical and therapeutic applications of LTP including wound healing, dentistry, the destruction of cancer cells and tumors. However, in order to fully utilize the potential of LTP in biomedicine, a better understanding of fundamental physio-chemical processes is required, and novel methods of precise control LTP sources need to be developed. This Special Issue aims to assemble a collection of papers on:

  - Advances in understanding the ignition, generation, and maintenance of LTP at atmospheric gas pressures
  - Characterization of the chemical processes which play crucial roles in the generation of RONS
  - New methods for the active control of these processes for biomedical, food processing, and agriculture applications

Experimental studies, theoretical models, computer simulations, and practical applications are of particular interest. These advances can be related to the development of specific plasma-based therapies or reporting on new fundamental understanding of the physical and biochemical pathways whereby LTP affects cells and tissues.

More information:
https://www.frontiersin.org/research-topics/12731/low-temperature-plasma-for-biomedical-applications

Guest Editors:
Prof. Mounir Laroussi
Prof. Michael Keidar
Dr. Vladimir Kolobov

- **Special Issue in *Frontiers in Physics* on *Ion Beams from Plasmas: Space to Nanotechnology***

Ion beams derived from plasmas have revolutionized many areas of physics and applications. This special issue research topic will host a collection of exciting research articles on the physics of generation and use of ion beams originating from plasmas. More information about the overview and scope of the research topic may be obtained from:
https://www.frontiersin.org/research-topics/14932/ion-beams-from-plasmas-space-to-nanotechnology

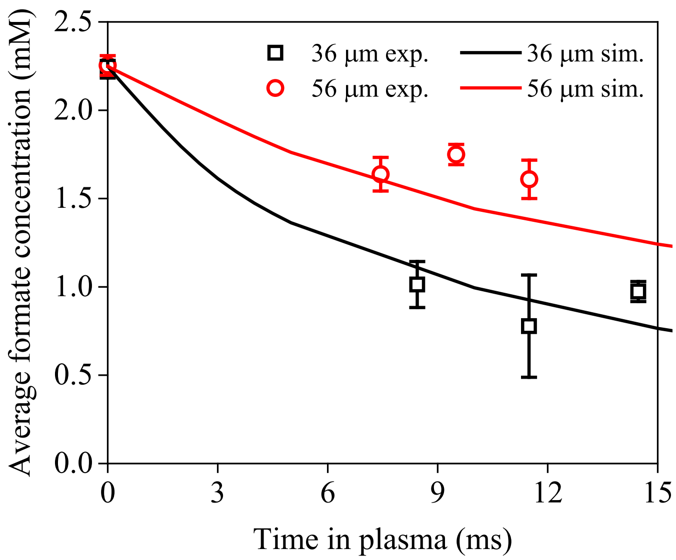
We cordially invite potential authors to submit high quality research papers in experimental, theoretical, and computational areas, or their combination, belonging to the broad research theme of ion beams from plasmas and their applications from space to nanotechnology. The scope may not be limited to the topics mentioned on the website alone, so long as the topic of the submitted article falls within the scope of the title.

We welcome the submission of Original Research, Review, Brief Research Report, and Perspective articles.

Submission deadline: Abstract: August 22, 2020. Manuscript: December 20, 2020.

Guest Editors:
Prof. Sudeep Bhattacharjee, Indian Institute of Technology Kanpur, sudeepb@iitk.ac.in
Prof. Roderick William Boswell, Australian National University, Rod.Boswell@anu.edu.au
Prof. Pascal Brault, Centre National de la Recherche Scientifique CNRS, pascal.brault@univ-orleans.fr

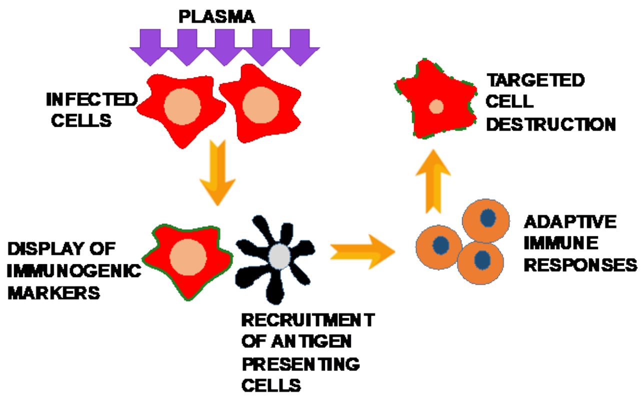
Controlled Plasma-Droplet Interactions for the Quantitative Study of Multiphase Reactivity Transfer



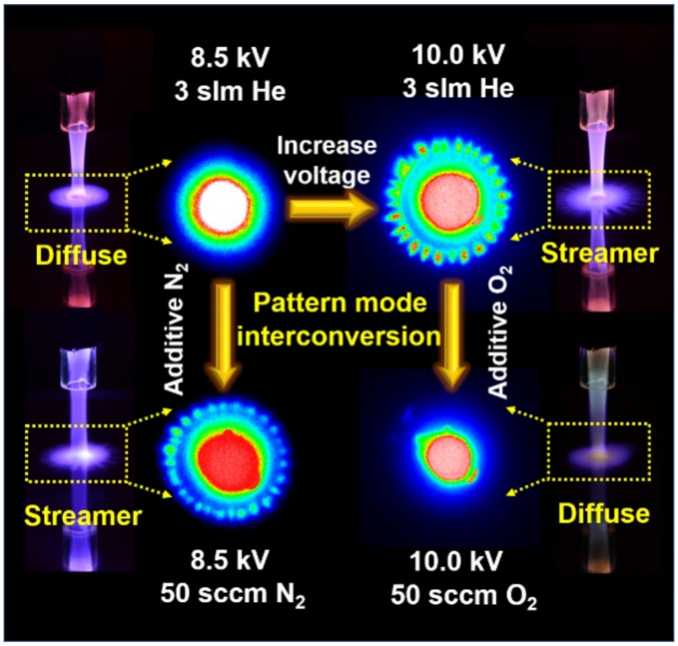
Formate decomposition as a function of droplet residence time in the plasma.

Plasma-liquid interaction at atmospheric pressure is a complex multiphase phenomenon with inherent transport limitations of highly reactive short-lived species, such as OH radicals, from the gas phase plasma to the bulk liquid phase. In this work, we report on a highly controlled plasma-micro-droplet reactor enabling detailed and quantitative plasma-liquid interaction studies. On demand water micro-droplets containing formate are injected into a diffuse homogeneous RF glow discharge and the plasma-treated droplets are collected after passing through the plasma for *ex situ* analysis of the reduction in formate concentration. The setup enables a 50% decomposition of formate in the micro-droplets for a short droplet residence time of ~10 ms, with minimum droplet evaporation. A 1D reaction-diffusion model, with the measured bulk gas phase OH radical density as input, is able to predict the formate decomposition without any fitting parameters. The model shows the importance of near-interfacial reactions of formate with OH radicals and the resulting diffusion limited decomposition process.

Contact: **Prof. Peter Bruggeman**, pbruggem@umn.edu
More information:
https://iopscience.iop.org/article/10.1088/1361-6595/aba988

Non-Thermal Plasma as Part of a Novel Strategy for Vaccination	
 Non-thermal plasma triggered protective immune response against infectious diseases.	Vaccination has been one of the most effective public health interventions for reducing morbidity and mortality associated with infectious diseases. Vaccines stimulate the body's protective immune responses through controlled exposure to modified versions of pathogens that establish immunological memory. The biological effects of non-thermal plasma (NTP) on cells suggest that plasma could play an important role in improving efficacy of existing vaccines and overcoming some of the limitations and challenges of current vaccination strategies. In an immunotherapeutic strategy featuring *ex vivo* application of NTP, immunomodulation caused by NTP will stimulate the emission of DAMPs (damage-associated molecular patterns) from cells exposed to NTP, promote the display of new antigens, and induce *de novo* immune responses not triggered by the antigen alone. Therapeutic vaccination strategies involving NTP-mediated immunomodulation may also reverse or compensate for deficiencies in immune functions characteristic of some infectious diseases. Because of its capacity to modulate innate and adaptive immune responses, NTP has the potential to synergize with existing vaccination strategies. *Contact:* **Dr. Vandana Miller and Dr. Fred Krebs** Drexel University College of Medicine vam54@drexel.edu, fck23@drexel.edu *Source:* https://doi.org/10.1002/ppap.202000051

Interfacial Pattern Between APPJ and ITO Glass Substrate



The plasma–surface interaction (PSI) is a complex process and plays a prominent and fundamental role in biological applications, organic film deposition, and surface hydrophilic treatment. However, knowledge about PSI is severely limited. In particular, little is known about the mechanism of mode conversion of interfacial patterns during a PSI process. This knowledge gap is critical to plasma science, greatly hindering the future design and optimization of plasma sources for their intended applications.

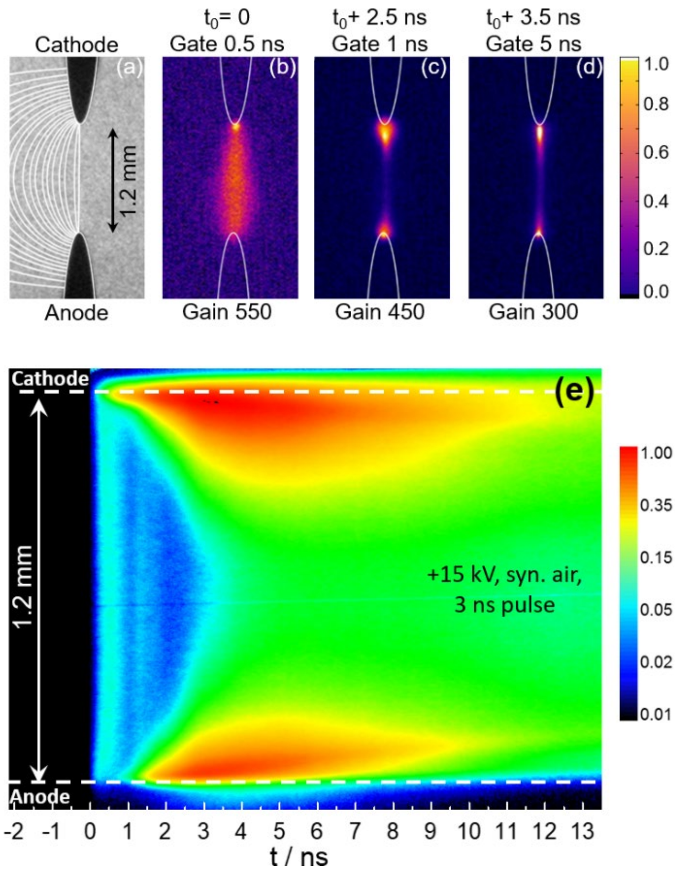
Here we focus on the behavior of mode conversion of interfacial patterns during an APPJ interacting with an ITO glass substrate. By regulating the pulse voltage, the results reveal that the interfacial patterns display two modes – a diffuse pattern and a streamer pattern. These two modes are not independent and can be transformed into each other by introducing additives such as N_2 and O_2. The reason is mainly attributed to the difference of N_2^+(B)/O(3p) ratio and local electric field distribution.

These trends for operational modes and conversion between them provide deep insights into the nature of physico-chemistry during PSI processes. These transitions may find potential applications in biological tissue and material treatment. However, there is still a great deal of work that needs to be done to further understand the nature of PSI in the future.

Contact: **Dr. Zhijie Liu and Dr. Dingxin Liu**
liuzhijie@mail.xjtu.edu.cn, liudingxin@mail.xjtu.edu.cn

Source: Process Polym. **16**, e1900108 (2019),
https://doi.org/10.1002/ppap.201900108

Tracking of Fast Streamer Breakdown in Pin-to-Pin Spark Discharges Driven by Pulsed HV with 200-ps Rise Time



(top) (left) Electrode shape and position overlaid with calculated electric field lines. (right) Single shots of discharge emission structures during initial and secondary breakdown phase, and major emission of 15 kV pulse with 200 ps rise time. (bottom) Spatio-temporal development of the discharge emission along the gap axis obtained by a streak camera in a 15 ns time window in logarithmic intensity scale (accumulation of 100 jitter-corrected streak camera single shots).

Spark discharges ignited by unipolar positive rectangular HV pulses with 200 ps rise time and (15±2) kV amplitude with 3 ns duration (FWHM) in synthetic air in a 1.2 mm pin-to-pin gap at atmospheric pressure were investigated. The discharge development was recorded by synchronized ICCD and streak camera measurements with sub-ns resolution in single-shot operation revealing a particular two-stage propagation mode. The discharge started with a fast initial breakdown across the entire gap (~10 mm/ns) during the HV slope followed by a much slower (~0.1 mm/ns) propagation originating from both electrodes towards the gap centre. The combination of high-resolution diagnostics with numerical modelling indicated that the initial breakdown phase is caused by the rapid increase of electric field strength during the steep HV slope, which leads to the simultaneous fast propagation of a positive and a negative streamer.

This work was a fruitful collaboration of the Electrical Engineering Department at Eindhoven University of Technology (The Netherlands) and the Plasma Diagnostics and Modelling at INP Greifswald (Germany).

Contact:
Dr. Hans Höft, Leibniz Institute for Plasma Science and Technology (INP Greifswald), hans.hoeft@inp-greifswald.de

Source:
H. Höft, M. M. Becker, J. F. Kolb, T. Huiskamp "Double-propagation mode in short-gap spark discharges driven by HV pulses with sub-ns rise time", PSST (2020) (Open Access)
https://doi.org/10.1088/1361-6595/aba112

New Resources

Please submit new resources to: iltpc-central@umich.edu.

Career Opportunities

- **Postdoctoral Positions at the University of Delaware: Computational and Experimental Plasma-Surface and Plasma-Liquid Interactions**

  Two postdoctoral research positions are available at the University of Delaware in the group of Professor Dion Vlachos. The **first** will be associated with *computational* work on plasma-surface interactions, plasma chemistry and plasma catalysis. The candidate should possess solid knowledge in the field of non-equilibrium plasma processing and proven record of accomplishment in plasma modelling and simulation. The **second** will be associated with *experimental* work in the field of plasma-liquid interaction for chemical conversion in the context of circular economy. The postdoctoral researcher should have strong experimental skills in plasma chemistry and plasma processing and prior experience with plasma engineering and diagnostic techniques. Additional experience in liquid chemistry and analytical methods will be considered an asset.

  For more information about the post-doctoral positions, the candidates should contact **Prof. Dionisios Vlachos**, vlachos@udel.edu. Our key catalysis and reaction engineering programs are described here: https://ccei.udel.edu/ and https://dei.udel.edu/rapid under the Energy Institute umbrella, https://dei.udel.edu.

Collaborative Opportunities

Please submit your Collaborative Opportunities to: iltpc-central@umich.edu.

Disclaimer

Newsletter is supported by:

US National Science Foundation

US Department of Energy Office of Science

University of Michigan Institute for Plasma Science and Engineering