Evidence for Low-energy Ions Influencing Plasma-assisted Atomic Layer Deposition of SiO2: Impact on the Growth per Cycle and Wet Etch Rate

International Low Temperature Plasma Community

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

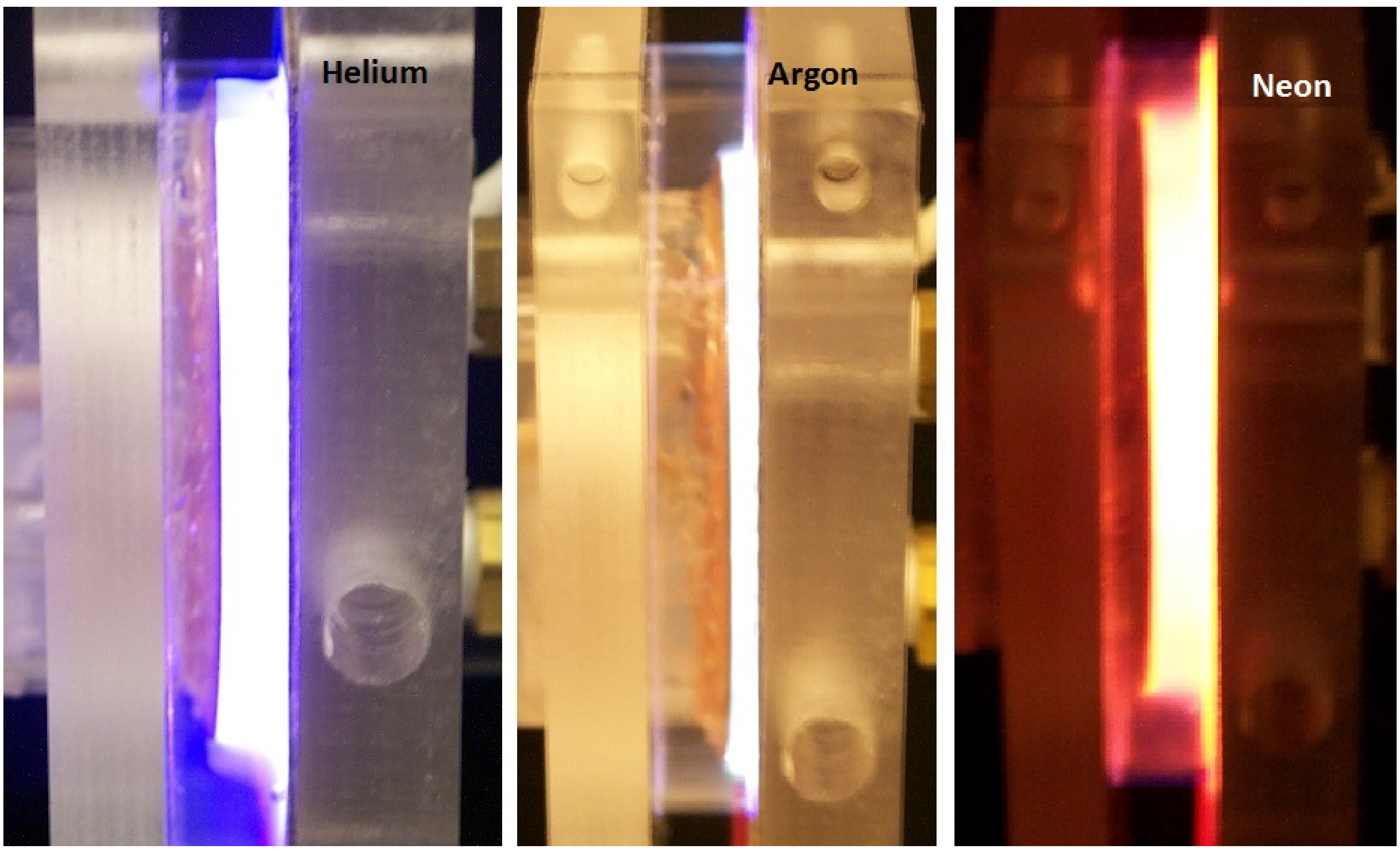
Newsletter 06

(with correction to Research Highlights)

14 September 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. The recommended image format is JPG or PNG; the minimum file width is 800 px.



Pulsed dielectric barrier discharge in helium, argon, and neon showing uniformly diffuse plasma. The operating conditions are: Voltage = 6 kV, Pulse width = 500 ns, Repetition rate = 5 kHz. The gap distance for helium and neon is 5 mm, and 2 mm for argon.

Contact: **Prof. Mounir Laroussi**, Applied Plasma Technology Laboratory, Old Dominion University, mlarouss@odu.edu.

Arc-free Argon atmospheric pressure cold plasma jet developed at Plasma Processing Laboratory, IIT Tirupati, India. A 25 mm length was achieved with an outward flow of 5.0 SLM. The jet is designed to serve as an ionizing source for the characterization of infected tissues using mass spectrometry.

Contact:
Prof. Reetesh Kumar Gangwar,
Indian Institute of Technology Tirupati,
reetesh@iittp.ac.in.

In this issue:

- Images
- Call for Contributions
- General Interest Announcements
- Meetings and Online seminars
- Community Initiatives and Special Issues
- 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 **September 30, 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 The topic can be anything you want - a recently published work, a new unpublished result, a proposed new area of research, company successes, anything LTP-related.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

- **US National Science Foundation: Funding and Engagement Opportunities**

  In addition to its core Plasma Physics program, the US National Science Foundation (NSF) has several funding and engagement opportunities that may be of interest to the LTP community.

  - Dear Colleague Letter: Seeking Community Input for Topic Ideas for Emerging Frontiers in Research and Innovation (EFRI) Program: https://www.nsf.gov/pubs/2020/nsf20121/nsf20121.jsp with the deadline for topic idea submissions of **October 30, 2020**.
  - International Research Experience for Students (IRES) solicitation with FY21 submission deadlines of **November 09, 2020** for Advanced Studies Institutes and **November 12, 2020** for IRES Sites Tracks within the program.
  - The annual solicitation for applications to the NSF Graduate Research Fellowship Program with due dates during the **week of October 19, 2020.**
  - The NSF Cyberinfrastructure for Sustained Scientific Innovation (CSSI) program with FY21 submission deadline of **October 28, 2020**. There will be a webinar to discuss the CSSI program on September 16, 2020 at 2:00 PM Eastern Time (US and Canada). Register in advance for this webinar at https://nsf.zoomgov.com/webinar/register/WN_hzqixnS1SRakQOWnLYosPQ
  - A new round of NSF Artificial Intelligence (AI) Institutes solicitation: FY21 National Artificial Intelligence (AI) Research Institutes solicitation NSF 20-604. Note, in particular, Theme 5: **AI Institute in Dynamic Systems:**

    "An AI Institute in Dynamic Systems supports research and education in fundamental AI and ML theory, algorithms, and use-inspired engineering and science for real-time sensing, learning, decision making and predictions that lead the way towards safe, reliable, efficient, and ethical data-enabled engineering and science systems. Many natural and human-built systems are described by complex physical dynamics, and the combination of data-driven approaches with physics-based models and experiments can enhance understanding of these systems and facilitate intelligent decision-making."

Contact:
Dr. Vyacheslav (Slava) Lukin
Program Director, Plasma Physics, National Science Foundation
vlukin@nsf.gov

Meetings and Online Seminars

- **Online LTP Seminar**

  Reminder!! Upcoming seminars: **September 15, September 29, October 13.** More information on the Online LTP Seminar: https://mipse.umich.edu/ltp_seminars.php

- **International Online Plasma Seminar**

  Reminder!! Upcoming seminars: **September 24, October 22, November 5.** More information on the International Online Plasma Seminar (IOPS): https://mipse.umich.edu/online_seminars.php

- **MIPSE (Michigan Institute for Plasma Science and Engineering) Seminar Series**

  The MIPSE seminar series, usually held as an in-person event, will be totally virtual this Fall. There will be five seminars during Fall 2020 covering the full range of plasma topics (not only LTP). The seminars are held on Wednesdays at 3:30 pm (US East Coast Time). The schedule and abstracts can be viewed at https://mipse.umich.edu/seminars_2021.php. Please send a request for the Zoom link to view the seminars to mipse-central@umich.edu. Seminars will be recorded and posted (with slides) at the same website.

  Past MIPSE seminars (recordings and slides) can be viewed from: https://mipse.umich.edu/seminars.php.

  Interviews of past seminar speakers can be viewed from: https://mipse.umich.edu/life_overview.php

  Contact:
  MIPSE Central
  mipse-central@umich.edu

- **Gordon Research Conference (GRC) and Gordon Research Seminar (GRS) on Plasma Processing Science, July 23-29, 2022**

  The dates for the GRC on Plasma Processing Science (https://www.grc.org/plasma-processing-science-conference/2022/) have been announced. The conference will be held on July 24-29, 2022 at Proctor Academy, Andover, NH, USA.

  The GRC will be preceded by the GRS on Plasma Processing Science (https://www.grc.org/plasma-processing-science-grs-conference/2022/) on July 23-24 at the same venue.

  Contact:
  Dr. Tony Murphy
  CSIRO, Australia
  tony.murphy@csiro.au

- **QPTDat FAIR Research Data in Plasma Medicine Workshop**

  On October 28 to 29, 2020, the BMBF-funded joint project *Quality assurance and linking of research data in plasma technology* - QPTDat (https://www.forschungsdaten.org/index.php/QPTDat) hosts the virtual workshop*: FAIR Research Data in Plasma Medicine*.

  The goal of the workshop is to bring together researchers in the field of plasma medicine with research data management experts to discuss requirements and possibilities for research data management in accordance with the FAIR principles. Experts will provide an overview over existing procedures and ideas for the provision and usage of quality assured research data, e.g. as a basis for data-driven science. On this basis, approaches for the further development of an ontology, metadata standards, and quality criteria supporting a simplified publication and re-use of data in the field of plasma medicine will be worked out in the course of the workshop. The collected ideas will be incorporated into the services to be developed in the framework of QPTDat and thus be made available to the community.

  Participation in the workshop is only possible with prior registration. Upon registration, a short presentation (max. 5 minutes) on current practices and/or challenges in sharing/publishing research data in plasma medicine or related topics can be submitted. Registered persons will receive further information about participation in the virtual event a few days before the workshop starts.

  Link to the registration form: https://forms.gle/fytU1hzVTmnC1r3r9

  Contact:
  Dr. Markus Becker,
  Leibniz Institute for Plasma Science and Technology (INP)
  markus.becker@inp-greifswald.de

Community Initiatives and Special Issues

- **Special Issue *Advances in Plasma Oncology toward Clinical Translation* in the journal *Cancers***

  IWPCT 2020 (International Workshop on Plasma Cancer Treatment) was canceled due to the Covid-19 pandemic. However, the Special Issue associated with the IWPCT in the journal *Cancers* will continue! It is our pleasure to invite you to submit an article to the Special Issue "Advances in Plasma Oncology toward Clinical Translation".

  In the past decade, cold atmospheric plasmas (CAPs) have been under investigation for their potential for cancer treatment, thus opening the young, multidisciplinary field of plasma oncology. CAPs are tunable sources for the production and delivery of reactive oxygen and nitrogen species (RONS), which positions them as a unique tool to study intracellular redox pathways and for development as a novel redox therapy.

  As new research tools and more sophisticated 3D in vitro cancer models are emerging, the role of the tumor microenvironment is attracting greater attention among plasma-cancer researchers. Strategies for combination therapy, e.g., immunotherapy, are also of great importance and are currently under development. There is a clear need for a better understanding of the underlying mechanisms, but at the same time, we should start thinking about the move toward clinical translation of this promising technology.

  In this Special Issue, we will publish original research papers that provide fundamental understanding into the mechanisms of CAPs in cancer treatment, ranging from computer modeling to in vitro and in vivo experiments and clinical trials. New insights should preferably be considered and discussed in the context of clinical translation or application.

The deadline for manuscript submission is **January 1, 2021**. If you are interested in contributing to the Special Issue, please send us a tentative title by **September 15**. More information about the scope, the journal (IF: 6.126), and submission guidelines can be found here:
https://www.mdpi.com/journal/cancers/special_issues/Workshop_Plasma

Guest Editors:
Prof. Katharina Stapelmann, North Carolina State University, katharina_stapelmann@ncsu.edu
Dr. Abraham Lin, University of Antwerp
Prof. Annemie Bogaerts, University of Antwerp

- **Special Issue "*High Temperature Statistical Thermodynamics of Molecules in Gases and Plasmas*" in the journal *Entropy***

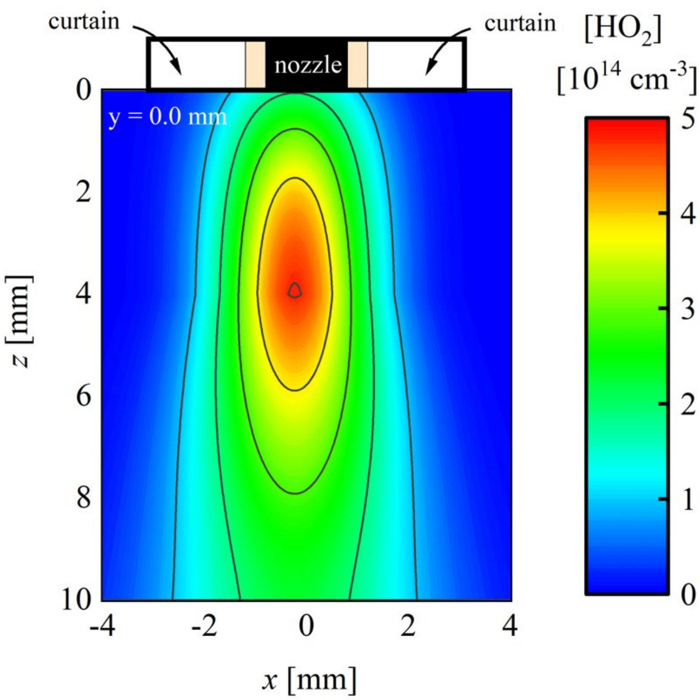
  This special issue is devoted to the fundamentals of high temperature statistical thermodynamics of small molecules and applications of partition functions and thermodynamic properties. High temperatures are understood to be broadly ranging from 1000 K to tens of thousands K. Applications of high temperature statistical thermodynamics are scattered over several areas of research – general chemical physics/physical chemistry, combustion (temperatures of thousands of K are of interest), plasma science (full range of temperatures mentioned can be of interest), hypersonic flows (also shock waves and aerothermodynamics; temperatures of tens of thousands of K are often of interest) and equations of state. In plasmas and flows non-equilibrium conditions often arise and translational, rotational and vibrational of molecules are often characterized by different temperatures. Kinetic theory is then needed to connect external conditions with thermodynamic quantities.

  The main scope of the special issue is theoretical studies of various gas and plasma systems but experimental studies are also welcomed.

  The deadline for manuscript submissions is **31 March 2021**. For more information, please see:
  https://www.mdpi.com/journal/entropy/special_issues/Gases_and_Plasmas

  Contact:
  Prof. Marcin Buchowiecki
  Institute of Physics, University of Szczecin, Poland
  marcin.buchowiecki@usz.edu.pl

The Spatial Distribution of HO_2 in an Atmospheric Pressure Plasma Jet Investigated by Cavity Ring-down Spectroscopy



Localised density of HO_2 illustrated in a plane cut along the symmetry axis of the plasma jet.

The small diameter of cold atmospheric pressure plasma jets makes diagnostics challenging. A promising approach to obtain absolute number densities is the utilisation of cavity-enhanced absorption spectroscopy methods, by which line-of-sight averaged densities are determined.

Here, first measurements are presented, on how the spatial distribution of HO_2 in the effluent of a cold atmospheric pressure plasma jet can be obtained by cavity ring-down spectroscopy in an efficient way. Instead of recording fully wavelength resolved spectra, it is demonstrated that it is sufficient to measure the absorption coefficient at two wavelengths, corresponding to the laser being on and off the molecular resonance.

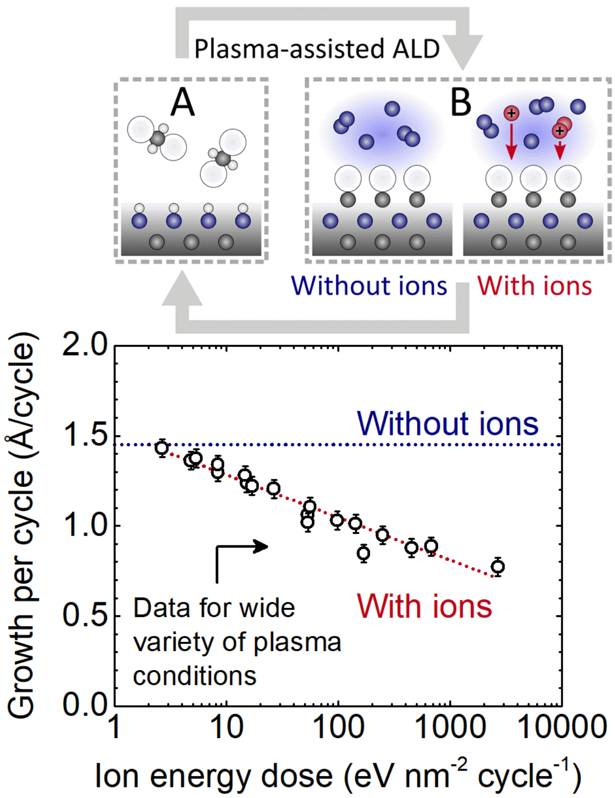
By sampling the effluent from the 1.6 mm diameter nozzle in the radial direction at various axial positions, the distances over which the HO_2 density was distributed were determined to be (3.9 ± 0.5) mm and (6.7 ± 0.1) mm at a distance of 2 mm and 10 mm below the nozzle of the plasma jet, respectively. By performing an Abel inversion, the localised density distribution of HO_2 was obtained, which is presented along the symmetry axis of the effluent.

It is pointed out that the plasma zone plays an important role on the formation of HO_2.

Contact:
Sarah-Johanna Klose
Leibniz Institute for Plasma Science and Technology (INP)
sarah-johanna.klose@inp-greifswald.de

Source:
S.-J. Klose, K. M. Manfred, H. C. Norman, G. A. D. Ritchie, J. H. van Helden, Plasma Sources Sci. Technol. https://doi.org/10.1088/1361-6595/aba206 (Open Access)

Evidence for Low-energy Ions Influencing Plasma-assisted Atomic Layer Deposition of SiO_2: Impact on the Growth per Cycle and Wet Etch Rate



Top: Conceptual image illustrating plasma ALD with and without exposure to ions.

Bottom: Experimental results showing a strong influence of the supplied ion energy dose on the growth of SiO_2 by plasma ALD, which is universally observed for a wide variety of plasma conditions.

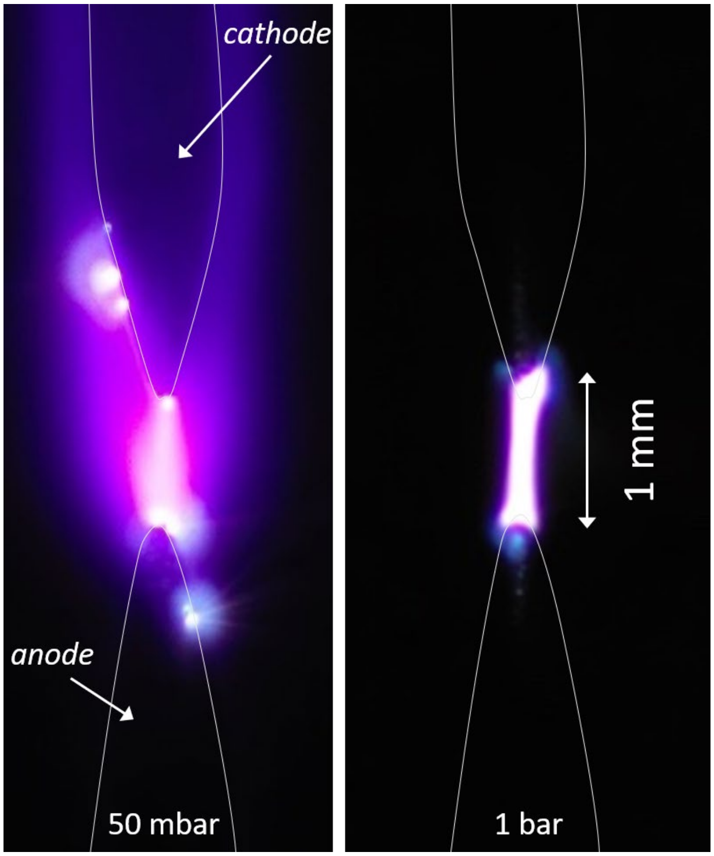
Plasma-assisted atomic layer deposition (ALD) of SiO_2 has become one of the most important ALD processes in the semiconductor industry, particularly for nanopatterning and gap-filling. The oxygen plasma used in the process facilitates the growth of high quality SiO_2 nanolayers even at low temperatures.

In our recent article in Applied Physics Letters, [1] it is demonstrated that ions have a much stronger impact on plasma ALD of SiO_2 than generally considered. From studies based on two distinctly different experimental approaches, it is shown that ions (including low-energy ions) can significantly decrease the growth per cycle and at the same time improve the film quality. The magnitude of this effect depends on the used plasma conditions, where the supplied ion energy dose (i.e., the plasma time × ion flux × mean ion energy) is demonstrated to be a key parameter. Using this parameter, a universal map is provided by which the growth can be predicted and tailored for any plasma ALD setup. These insights are valuable for current and future applications of plasma ALD of SiO_2 and expectedly also other materials prepared by plasma ALD.

Contact:
Prof. W.M.M. (Erwin) Kessels, w.m.m.kessels@tue.nl

Source:
[1] K. Arts *et al*., Appl. Phys. Lett. **117**, 031602 (2020)
https://doi.org/10.1063/5.0015379

Fully Ionized Nanosecond Discharges in Air: The Thermal Spark



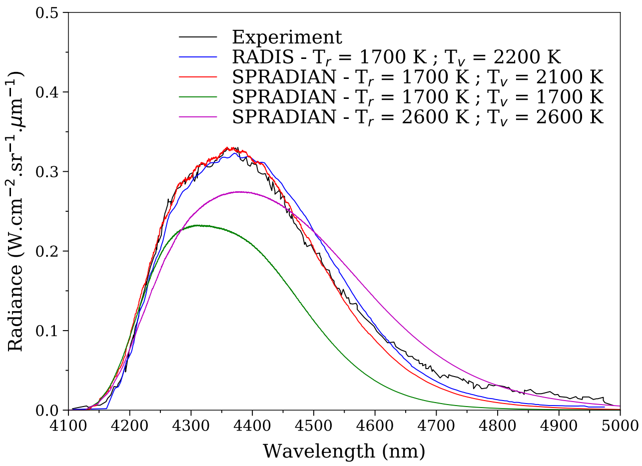
Photographs of single ns-discharges in real colors at 50 mbar and 1 bar in air. The non-thermal spark emission at 50 mbar is mainly composed of N_2(C-B) (purple), while the thermal spark emission is due to N^+ lines and continuum radiation (white).

This work presents new findings concerning the formation and decay of the thermal spark, *i.e.* a fully ionized plasma generated by a single nanosecond high-voltage pulse. The spark thermalization consists of five steps studied at air pressures ranging from 50 mbar to 1 bar. The electron number density is measured with spatial and temporal resolution from the Stark broadening of the H_α, N^+, and O^+ lines. The subtraction of other broadening mechanisms is extensively detailed in the appendix and extended to other species commonly used in spectroscopy. The electron temperature is also determined from the relative emission intensity of N^+ excited states. In the present case, a 10-ns pulse of 6 kV generates a fully ionized plasma at 48,000 K. During at least 100 ns, the plasma remains at chemical equilibrium. Thus, the decay of the electron number density is driven by an isentropic expansion of the plasma column. Our findings apply to measurements performed by other teams in nanosecond plasmas. It is also shown that the thermal spark is indeed the early phase of longer duration sparks typically used for ignition in automotive engines.

Contact:
Prof. Christophe Laux
christophe.laux@centralesupelec.fr

Source:
N. Minesi *et al.,* Plasma Sources Sci. Technol. **29**, 085003 (2020).
https://doi.org/10.1088/1361-6595/ab94d3

Simulations of CO_2-CO Infrared Radiation Measurements in Shock and Expansion-Tubes (Correction of editorial error)



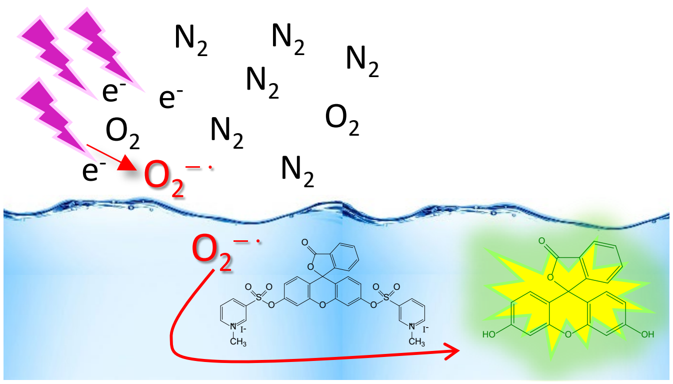
Fit of 5.3 km/s shock in JAXA expansion-tube using nonequilibrium 2-temperature models.

Atmospheric entries on Mars have long been studied, but large uncertainties remain regarding the afterbody radiation. This work presents measurements and simulations of CO_2 and CO infrared radiation behind shock waves and expansion flows. The JAXA (Japan Aerospace Exploration Agency) shock-tube was operated for flow velocities ranging from 2.8 to 7.3 km/s. The emission spectra, measured between 4.0 and 5.4 µm, compare well with previous measurements at the NASA Electric-Arc Shock-Tube (EAST). A CO_2 non-equilibrium radiation model is described for the JAXA in-house radiation code SPRADIAN. The model was compared to literature data, and then is used to fit the free-flow spectra of the JAXA expansion-tube measurement at 5.3 km/s. Comparisons with another two-temperature radiation code (RADIS) were also performed.

Contact:
Prof. Dr. Kazuhisa Fujita
fujita.kazuhisa@jaxa.jp

Source:
U. Dubuet *et al*., Journal of Thermophysics and Heat Transfers (2020)
https://doi.org/10.2514/1.T5853

Quantification of Plasma-produced Superoxide in Water Solution



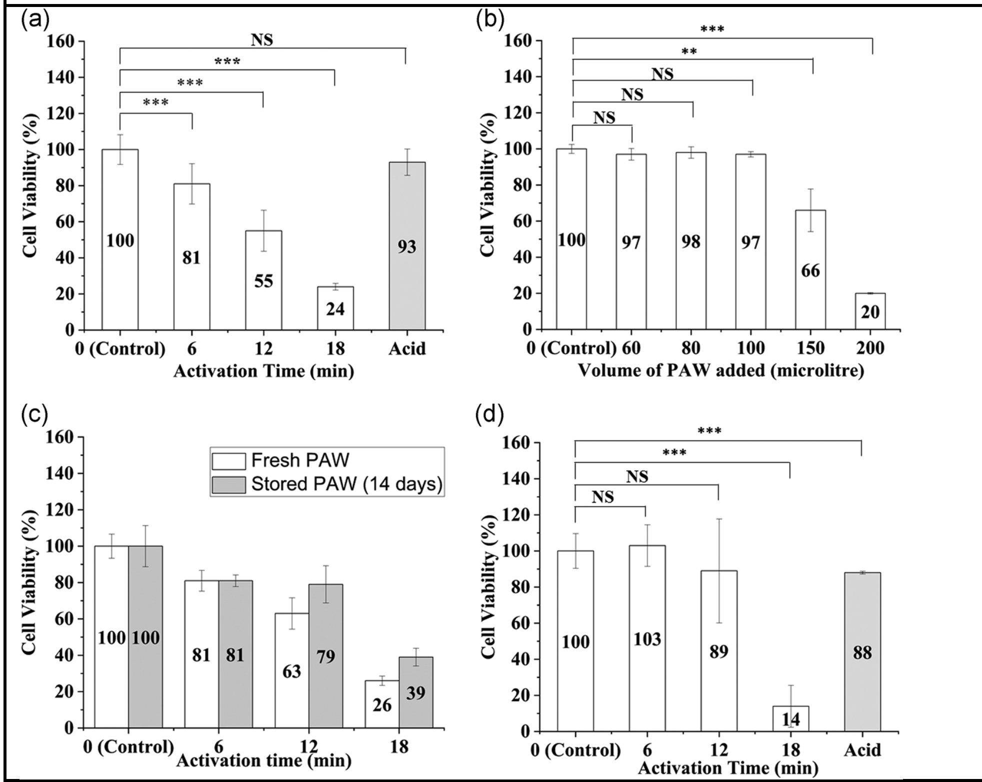
Superoxide is one among the reactive oxygen species (ROS) in non-thermal plasmas generated by electrical discharges in air at room temperature and atmospheric pressure. When in contact with aqueous media, ROS and notably superoxide can react at the plasma/liquid interface or transfer and react into the liquid. While the detection of superoxide in plasma treated water has been reported in the literature, to the best of our knowledge, quantitative determinations were lacking.

In our recently published paper, we report the determination of superoxide lifetime, formation rate and steady-state concentration in water at neutral pH subjected to air non-thermal plasma in a streamer discharge reactor. After detecting the presence of superoxide by spin-trapping and EPR analysis, we applied superoxide-selective fluorescent probes to carry out quantitative determinations. Under typical plasma operating conditions, the rate of superoxide formation and its steady state concentration were (0.27 ± 0.15) $\mu M\ s^{-1}$ and (0.007 ± 0.004) nM, respectively. The procedure outlined here can be usefully applied to detect and quantify superoxide in water treated by different plasma sources.

Contact:
Prof. Ester Marotta, ester.marotta@unipd.it
Dr. Francesco Tampieri,
francesco.tampieri@upc.edu

Source:
https://pubs.acs.org/doi/10.1021/acssensors.0c01042

Plasma-Activated Water from a Dielectric Barrier Discharge Plasma Source for the Selective Treatment of Cancer Cells



MTT assay results showing cell viability upon PAW addition on (a) MDA-MB-231 with activation time, (b) MDA-MB-231 with volume, (c) MDA-MB-231 upon 14-day PAW storage, (d) MMF with activation time. Significance was determined between each of the test conditions and parameters using Student's t-test or Welch's t-test. MMF, murine muscle-derived fibroblast; MTT, 3-(4,5-dimethylthiazol-2-yl) -2,5-diphenyltetrazolium bromide; PAW, plasma-activated water. NS, not significant for $p > .05$, $*p < .05$, $**p < .01$, $***p < .001$.

In this study, cold plasma was used to prepare plasma-activated water (PAW) from a dielectric barrier discharge plasma source, with ambient air as the plasma-forming gas. The PAW prepared was characterized for its physicochemical parameters, some of which followed a strong linear correlation with activation time (t_a). The effects of PAW addition on the cell viability of human breast cancer cells (MDA-MB-231) and healthy murine muscle-derived fibroblast cells were investigated using the MTT assay. The volume of PAW added and t_a of PAW showed a significant impact. The PAW prepared was selective toward killing cancer cells at specific t_a. PAW retains its potency against cancer cells after 14 days of refrigerated storage.

Contact: **Dr. Lakshminarayana Rao,** Indian Institute of Science, narayana@iisc.ac.in

Source: https://doi.org/10.1002/ppap.201900260

New Resources

- **Journal of Physics D – *The 2020 Plasma Catalysis Roadmap***

  Plasma catalysis is gaining increasing interest in environmental pollution control and the synthesis of fuels and chemicals. Recently, the Journal of Physics D: Applied Physics has published the *2020 Plasma Catalysis Roadmap* to highlight the state-of-the-art, the current and future challenges, as well as the advances in science and technology needed to meet these challenges. The *Plasma Catalysis Roadmap* is available from: https://iopscience.iop.org/article/10.1088/1361-6463/ab9048

  Contact:
  Prof. Xin Tu
  University of Liverpool
  xin.tu@liverpool.ac.uk

Career Opportunities

- **Postdoctoral Position: Spectroscopy on Atmospheric Pressure Plasmas for Medicine at Polytechnique Montréal and the TransMedTech Institute**

  Plasma Physics and Spectroscopy Laboratory (PPSL, www.polymtl.ca/plasma) of Stephan Reuter, TransMedTech Chair for Plasma Medicine, within the Department of Physics Engineering at Polytechnique Montréal and the TransMedTech Institute offers a Postdoctoral Fellow position. Successful applicants should have hands-on experience in spectroscopy of plasmas and/or plasma liquid systems, plasma source design, and/or laser spectroscopy. They should have an interest or experience in plasmas for medicine.

  You will work on an interdisciplinary project involving aspects of physics, biophysics, chemistry, and medicine. In this position, you are expected to contribute to proposal and report writing, and to preparation of presentations and publications.

  You will be employed at Polytechnique Montréal, a francophone engineering University in the heart of Montréal. You will interact with colleagues within Engineering Physics Department and the Institut Biomédicale of Polytechnique Montréal and Université de Montréal and the Institute TransMedTech and its collaborating research hospitals.

  Please send your application in a first application stage as a single PDF file including a full CV, a cover letter describing research interests and goals (max. 2 pages), full list of publications highlighting your most relevant peer reviewed works, as well as the names and contact information of three references. Applications should be sent to **Prof. Stephan Reuter** (stephan.reuter@polymtl.ca) using the **subject line "*PPSL-Postdoctoral Fellow*".** The successful candidate of the first stage must send a full application including a research project to the Institute TransMedTech de Montréal (fall competition deadline: 1st stage **10th of Sept. 2020**, full application 21st of Sept. 2020; spring competition deadline: to be announced).

- **Post-Doctoral Scholar/Research Associate in Experimental Low-Temperature Plasma at the University of Alabama at Huntsville**

  Applications are invited for a Post-Doctoral Scholar/Research Associate position at the University of Alabama in Huntsville (UAH) starting on or around January 2021.

  The successful applicant will be joining a collaborative project between UAH and Sandia National Laboratories (SNL) to study low-temperature plasmas at solid and liquid interfaces. The project is funded for a 3-year duration. This position primarily focuses on experimental measurements of plasmas from vacuum to atmospheric pressures. Periodic travel to SNL is required to collaborate with SNL researchers and use their diagnostics and facilities. The applicant will also participate in the NSF EPSCoR project in plasma science and engineering, CPU2AL (https://www.uah.edu/cpu2al). CPU2AL is a collaboration between 9 Alabama universities and industry partners to conduct research in different areas of low-temperature plasma science and engineering from astrophysics to material science. Multi- disciplinary collaborations across campus are encouraged.

  Successful applicants will have a background in experimental plasma research with a Ph.D. or equivalent qualifications in physics, engineering, or related fields. U.S. citizenship is required. Demonstrated experience in plasma diagnostics, especially optical diagnostics such as LIF, absorption spectroscopy, and emission spectroscopy is highly desired. Applications from candidate who are nearing the completion of a relevant Ph.D. degree will be considered. Applications from female, minority, and underrepresented groups are strongly encouraged.

General inquiries and applications should be sent to **Dr. Gabe Xu** (gabe.xu@uah.edu). Applications should include a statement of interest, CV, and contact information for 2-3 professional references.

- **Internship with Intel: Dry Etch Technology Development Process**

At Intel, we optimize storage and memory from device physics to platform architecture to system level solutions while collaborating with industry leaders to help our customers. We continue to invest in two core technologies: Intel Optane technology that delivers industry-leading low latency (it's super-fast!) and Intel 3D NAND technology that delivers high density at low cost. F11x in Rio Rancho, New Mexico is Intel's new Non-Volatile Memory Solutions Group (NSG) Technology Development site and will focus on Optane Technology Development and NAND Technology Research and Pathfinding.

To deliver the silicon technology, the Intel NSG Rio Rancho Technology Development (RTD) group is looking for talented and enthusiastic Dry Etch Technology Development Process Interns to help support ongoing technology development projects in Dry Etch. As a Dry Etch Intern, you will be integrated with the main Dry Etch team and will be involved in one or more Dry Etch process development projects, as well as having exposure to daily fab operations in Dry Etch. These projects will provide you with the opportunity to learn Dry Etch as well as demonstrate and build capability with problem solving, innovation, experimental design, and data analysis. Internships will involve support and/or interactions across shifts and collaboration with cross-functional/cross-company teams to meet challenging program goals.

Safety is a core Intel value. Therefore, due to COVID-19 health and safety restrictions, internships will be conducted remotely. Internships will be for a minimum of 3 months, with an option for 6 months.

Minimum Requirements:

- The candidate must be pursuing a Master’s and/or PhD in Electrical Engineering, Chemical Engineering, Mechanical Engineering, Material Science, Physics, or Chemistry.
- Minimum 3+ months of experience or equivalent coursework in the following areas:
    - Semiconductor device fabrication (any process area)
    - Experimental design and structured problem solving

Preferred Requirements:

- Master’s and/or PhD thesis work in the area of plasma physics, plasma diagnostics, plasma etch or plasma deposition.
- Coursework in or experience with Design of Experiments DOE principles
- Analytical/ inspection/ metrology/ quality control experience (any industrial setting)

Contact:
Dr. Catherine Labelle
Intel NSG RTD Dry Etch Director
catherine.labelle@intel.com

- **Postdoctoral Position in Plasma Laser Diagnostics, Max Planck Institute for Plasma Physics (IPP), Garching, Germany**

  We are looking for interested candidates for a postdoc vacancy that will become available at Max Planck Institute for Plasma Physics, in the group of Plasma for Gas Conversion. Currently the focus of the group is on CO_2 conversion in the field of energy storage, and chemical energy carriers. However, we are looking forward to expand our activities and manpower. The plasmas are operated up to atmospheric pressure and are equipped with several diagnostics. Among them is a laser diagnostics available, hence we are looking for an interested Postdoc candidate with experience in low temperature plasma physics and plasma laser diagnostics. The candidate will be responsible for continuation of existing TALIF on O and CO in the available pressure range. It is expected that candidate expands the possible laser diagnostics experiments (CARS, and Raman scattering envisaged). Tasks of the candidate will include execution, evaluation and dissemination of the test results with respect to implications for optimization of efficiency of the plasma CO_2 conversion. It is also expected that the candidate takes over the responsibilities for laser-safe environment in the laboratory. The candidate should have completed doctoral thesis, preferably in the field of plasma physics, experience with laser diagnostics techniques (e.g. LIF, TALIF). The experience in laser diagnostics of molecular plasmas at low and atmospheric pressure is preferred. Strong ability to interpret experimental data and very good communication skills and ability to present scientific results are required.

  This is a position for 3 years; it is intended to be available from 1st January 2021 or as soon as possible thereafter. Applicants should send a cover letter (including date applicant is available), CV, and reprints of representative publications to **Prof. Ursel Fantz** (ursel.fantz@ipp.mpg.de).

Collaborative Opportunities

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

Disclaimer

The content of this Newsletter comes from the contributions of members of the ILTPC. The Newsletter editors are attempting to provide as inclusive a communication as possible. However, inclusion of items in the Newsletter should not be interpreted as an endorsement by the editors nor as advertisement for commercial purposes. The content of this newsletter should also not be interpreted as an endorsement by our sponsors – the US National Science Foundation, the US Department of Energy, or the University of Michigan. The Newsletter editors may do some light editing of the original submissions, to maintain a consistent tone and style.

Newsletter is supported by:

US National Science Foundation

US Department of Energy Office of Science

University of Michigan Institute for Plasma Science and Engineering