International Low Temperature Plasma Community

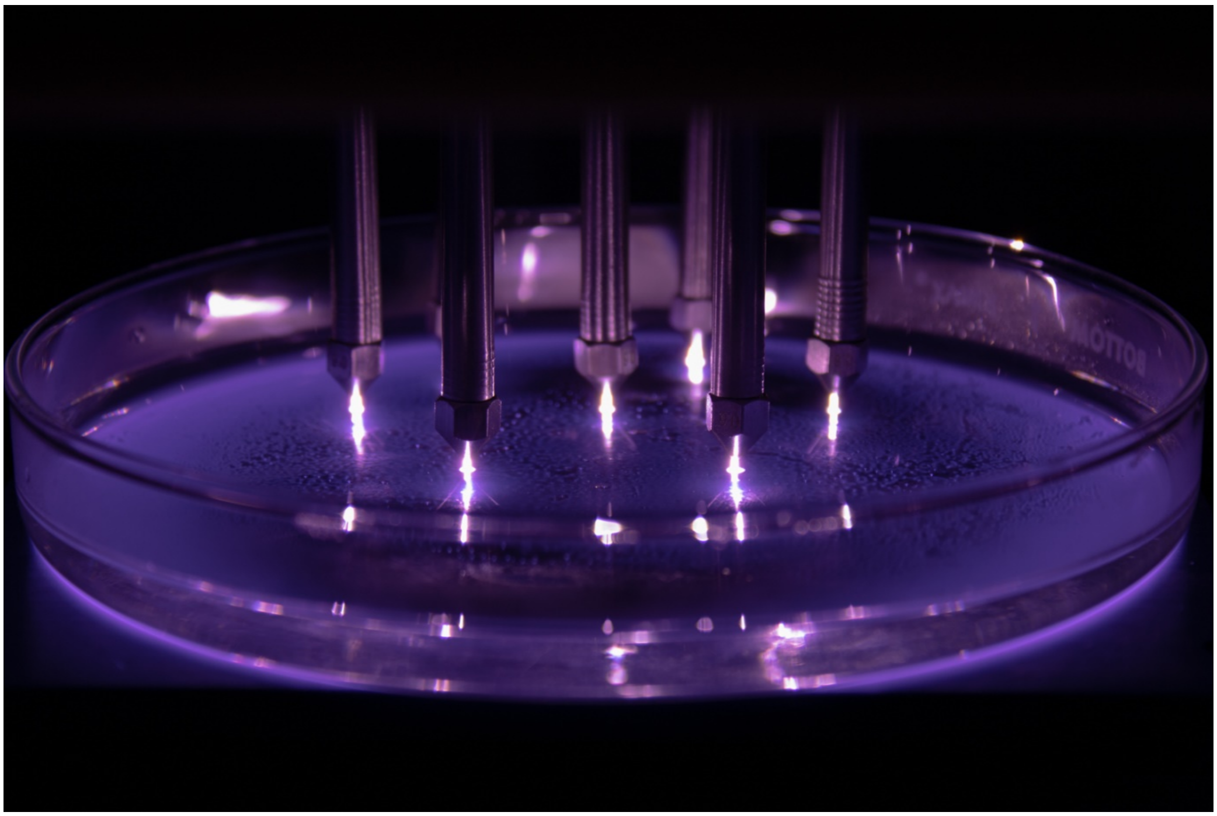
https://mipse.umich.edu/iltpc.php, iltpc-central@umich.edu

Newsletter 11

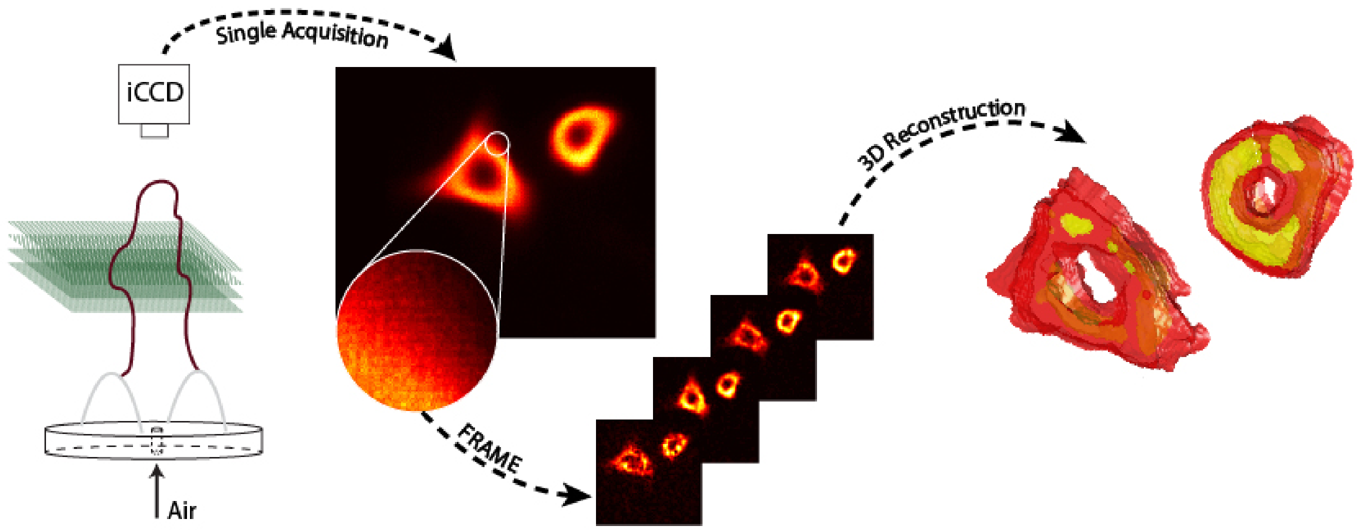
26 February 2021

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.



Scaling of Plasma Treatment of Liquids:
Treatment of distilled water with a hexagonal plasma jet assembly exhibits time dependent stability operating regimes that depend on changing liquid properties such as pH value, conductivity, and chemical composition. The so-called Hex-Jet is based on the single plasma jet described in: Plasma Process Polym. **16**, e1800137 (2019). The Hex-Jet is operated in 1 L/min flow of argon with 10% admixture of Oxygen at 20 kHz and 16kV. Thanks to Sean Watson and Bernard Nisol.
Contact: **Prof. Stephan Reuter,** Plasma Physics and Spectroscopy Lab, Polytechnique Montréal (stephan.reuter@polymtl.ca) and **Prof. Michael R. Wertheimer,** Plasma Physics and Spectroscopy Lab, Polytechnique Montréal (michel.wertheimer@polymtl.ca).



3-Dimensional Laser-Induced Fluorescence in Gliding Arcs: The image shows a strategy for single-shot 3D LIF (Laser-induced Fluorescence) imaging of ground state OH in the vicinity of a gliding arc discharge at atmospheric pressure using structured laser illumination and FRAME (Frequency Recognition Algorithm for Multiple Exposures). An inherent benefit of the FRAME technique is that the plasma-emission background is rejected. More details can be found in our letter cited below, in which we demonstrated how to render cross-sectional 2D distributions of ground state OH LIF, perpendicular to the orientation of the discharge channel.
Contact: **Yupan Bao** (yupan.bao@forbrf.lth.se) and **Dr. Andreas Ehn** (andreas.ehn@forbrf.lth.se), Lund University, Sweden.
Source: Bao *et al*., "Single-shot 3D imaging of hydroxyl radicals in the vicinity of a gliding arc discharge", Plasma Sources Science and Technology (2021), https://iopscience.iop.org/article/10.1088/1361-6595/abda9c/meta.

In this issue:

Call for Contributions

Please submit content for the next issue of the Newsletter. Please send your contributions to iltpc-central@umich.edu by **March 27, 2021**.

Please send contributions as MS-Word files if possible – and avoid sending contributions as PDF files.

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.

LTP Perspectives: Policy, Opportunities, Challenges

Taking Research from a Paper to a Product

As researchers, we have many goals, which are sometimes in concert and sometimes in conflict. These may include finding or remaining in employment, educating younger researchers, writing and presenting papers, and developing useful processes or products. As low-temperature plasma researchers, almost all of our work will have the latter as one of its stated goals. And the world is indeed filled with products that use or rely on plasma processes – semiconductor etching, arc welding, plasma spraying, and corona surface treatment, to name just a few. But in reality, the vast majority of our efforts (at least for those who work in academic and government research institutions) are never commercialized.

How can researchers increase the likelihood that their research leads to a commercial product or process instead of the final 'product' being a scientific paper? Here are a few suggestions.

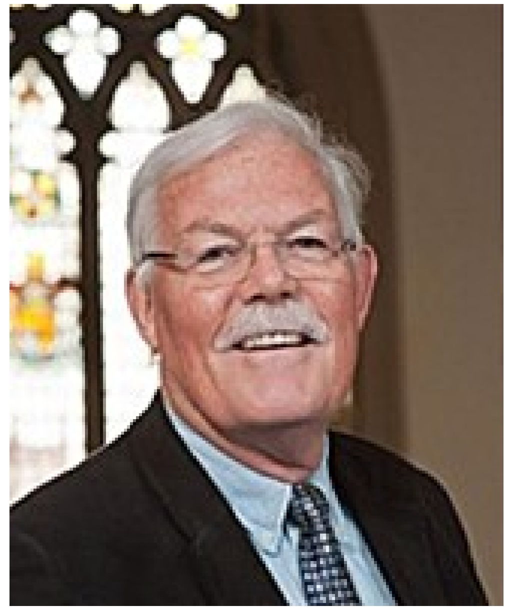
- Spend time to understand the needs of potential users. Don't directly ask them to validate your proposal; instead, ask open-ended questions – for example, what are your problems and needs in the general area addressed by the proposal? For instance, in planning a plasma seed treatment project, we learnt that cotton seed is more expensive and has lower germination rates than most other seed. We also learnt that all cotton seed planted in Australia is distributed to farmers every year, whereas farmers generally save their own wheat seed. We concluded that cotton seed was a more sensible target for plasma treatment.
- Formulate a 'path to impact' for every project. If your research is successful, how will it achieve the economic, environmental or social benefits promised in your grant proposal? Who will you work with on further development, and how will it be funded? Can the process be scaled up, and will it be economically viable?
- Be prepared to make a sustained effort. Writing a scientific paper is much quicker and easier than establishing an industrial process. The adage that development needs ten times as much effort as research, and commercialization needs ten times as much again, is a reasonable guide.

The scientific reward system encourages a focus on novel areas, for which grants and publications in high-impact-factor journals are more likely. It discourages the longer-term R&D required to progress from a laboratory experiment described in a scientific paper to a demonstration system likely to attract investment. Not every academic will wish to spend time on the latter for understandable reasons. Nevertheless, it is worth considering how you can increase the likelihood that your results can make the transition from a paper to a product.

Dr. Anthony B. Murphy
Chief Research Scientist
CSIRO Manufacturing
Lindfield NSW 2070, Australia
tony.murphy@csiro.au

Leaders of the LTP Community: Career Profiles

Professor Bill Graham, Queen's University Belfast



In our current circumstances one of the main things researchers, in particular early career researchers, are missing out on are physical conference environments. These are important in getting to know the 'makers of the community' – and Bill is certainly one of them.

Many will know Bill from previous conferences and/or his former role as Editor in Chief of the IOPP journal *Plasma Sources Science and Technology*.

He leaves a footprint on all of the committees he has chaired and been a member of. One aspect he has always been dedicated to is his support and encouragements of the earlier career generation, not only in conference settings. His generosity, in any terms, is far-reaching. Bill has played a major role over the years shaping our community.

Bill's energy and enthusiasm are truly encouraging. He always has a keen interest in exploring new cultural aspects in international conference settings. Likewise, he also organised the first Gaseous Electronics Conference (GEC 2004) in Europe, choosing a remote ancient Castle in Ireland as the conference venue, as well as the International Conference on Phenomena in Ionized Gases (ICPIG, Belfast, 2011).

Bill has always been at the frontiers of our science with clear foresight. One example where he was well ahead of his time are his famous 'physics of beer' talks – a decade before there was any talk of plasmas in liquids. Unsurprisingly, he then went on to be one of the pioneers of plasmas interfacing liquids. This, including the interface of the plasma-biological sciences are still important topics in his research, being an ambassador for multi-disciplinary science. A second interesting example is his early initiative in the development of web-based learning for online delivery of MSc courses in Plasma and Vacuum Technology – two decades ago!

Bill recently retired as Professor of Physics at Queen's University Belfast (QUB) but is still research-active as Honoury Professor at QUB. Before that he was Director of the QUB Centre for Plasma Physics, Director of the QUB International Research Centre for Experimental Physics and the Internationalisation Leader for the School of Mathematics and Physics.

Bill obtained his BSc and PhD in Physics from QUB, after a period of 5 years as a staff scientist at the Lawrence Berkeley Laboratory, USA, he returned to a Lectureship (Assistant Professorship) at the University of Ulster before returning to QUB. He is an elected member of the Royal Irish Academy and a Fellow of both the American Physical Society and the Institute of Physics. In 2013 he was awarded the ICPIG Franklin - von Engel Prize. His early research career was in atomic collision physics, particularly related to nuclear fusion needs. Bill's work on the production of negative hydrogen ions for neutral beam heating led into work on low pressure plasmas, and then he worked on electronegative plasmas in general which led to work on rf driven plasmas of the type used in semiconductor processing. Recently a main focus of his work has been on atmospheric pressure plasmas and plasmas in liquids, with an increasing interest in their application in medicine and catalysis. These are multidisciplinary projects with Pharmacists, Chemists and Electrical Engineers and companies. Bill has published about 200 articles in international refereed journals.

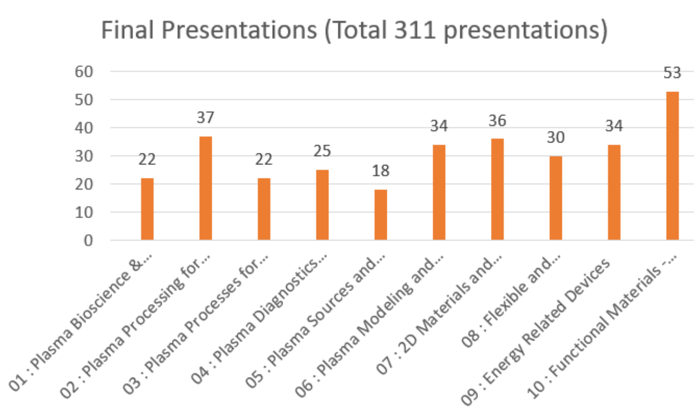
We know he is itching to see everyone again, and also the newcomers to our community, as soon as we safely can again.

Sláinte!

Prof. Deborah O'Connell & **Prof. Timo Gans**
National Centre for Plasma Science and Technology (NCPST), Dublin City University, Ireland
deborah.oconnell@dcu.ie, timo.gans@dcu.ie

Status Report of the 8th International Conference on Microelectronics and Plasma Technology (ICMAP) Held Online in January 2021 in Korea

Official webpage of the International Conference on Microelectronics and Plasma Technology (ICMAP) 2020 held in January 2021.



Number of presentations in each topic of the conference.

ICMAP, a biennial international conference organized by the Korean Vacuum Society, was founded to provide an open forum for the discussion of the current status of scientific and technological achievements in the various fields of plasma applied research and developments including microelectronic devices.

The 8^{th} *International Conference on Microelectronics and Plasma Technology* (ICMAP) was held online jointly with the 9^{th} *International Symposium on Functional Materials* (ISFM) on January 17-20, 2021. The conference was successfully completed with 462 participants from 17 regions (countries). During the conference, main conference sessions (5 plenary lectures, 38 oral sessions including 4 keynote speakers and 40 invited speakers, and poster session), 7 tutorial sessions, and 1 special session were conducted. Even though the conference was limited to the online format due to the COVID-19 pandemic, it turned out to be a very successful conference.

The conference topics were as follows:
1) Plasma Bioscience & Medicine
2) Plasma Processing for Semiconductor and Display Devices
3) Plasma Processes for Nanomaterial Development
4) Plasma Diagnostics and Process Monitoring Technology
5) Plasma Sources and Technology
6) Plasma Modeling and Simulation Techniques
7) 2D Materials and Their Application to Nano/Micro Devices
8) Flexible and Stretchable Displays & Sensors
9) Energy Related Devices
10) Functional Materials - Synthesis, Characterizations, and Application (ISFM session)

Contact:
Prof. Geun Young Yeom
Sungkyunkwan University, Korea
gyyeom@skku.edu

More information:
The 8th ICMAP & The 9th ISFM secretariat
http://www.icmap2020.org

Meetings and Online Seminars

- **Online LTP Seminar (OLTP)**

  The Online Low Temperature Plasma (OLTP) Seminar series schedule for January – June 2021 is available at: https://mipse.umich.edu/ltp_seminars.php. The next seminars in the new series will be presented by Dr. Sedina Tsikata (**March 10, 2021**); and Drs. Igor Kaganovich and Alex Khrabrov (**March 23, 2021**).

- **International Online Plasma Seminar (IOPS)**

  The International Online Plasma Seminar (IOPS) is a non-profit international seminar on low temperature plasma science with bi-weekly sessions via Zoom. The main purpose of the seminar is to make high quality research results in low temperature plasma science available to our community to foster scientific discussion. Based on the speaker's written consent, presentations will be recorded and will be made available for on-demand download. IOPS speakers can be nominated by anybody and are selected by the IOPS committee. The program for IOPS is available at: https://mipse.umich.edu/online_seminars.php. Nominations for speakers for speakers for the July – December 2021 can also be made from this page.

  The next seminars will be given by Prof. Selma Mededovic Thagard (**March 11, 2021**); and Prof. Richard Wirz and Dr. Mikael Tacu (**March 25, 2021**)

  To attend IOPS, use the following Zoom link:
  https://ruhr-uni-bochum.zoom.us/j/93889931395?pwd=bFN5dU14RHRMYU5ySW40V1gvbDJpZz09

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

  The MIPSE seminar series, usually held as an in-person event, is totally virtual this Winter. The seminars during Winter 2021 are 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

- **8th International Plasma Science and Entrepreneurship Workshop – 8 & 9 November 2021, Prague, Czech Republic – Save the Date!**

  The 8th annual International Plasma Science and Interfaces workshop that will take place at Charles University in Prague, Czech Republic, on November 8 & 9 is waiting for your precious contribution. Don't forget to mark this date in your diary!

  Key topics and themes:

  - Plasma medicine, medical and healthcare
  - Plasma Surface modification & thin films
  - Atmospheric pressure plasma @ Micro/Nano scale
  - Atmospheric pressure plasma jet (APPJ)
  - Nanoparticles generation and particle surface treatment
  - Surface diagnostics, energetics, analytics and –metrology
  - Plasma parameterization, diagnostics, simulation
  - Plasma for Emission Abatement & CO2
  - Plasma parameterization, diagnostics, simulation

  Including:

  - 2-day workshop
  - 60+ lectures
  - Max 15 Table top demonstrations
  - Evening dinner / Social event

  International scientists from universities, institutes and firms & scientific entrepreneurs are expected to participate. This invited-only workshop has an admission fee and will be a PhD (student) expert-level workshop focused on the achievements, challenges and opportunities for the scientific- and entrepreneurial-community working in the field.

  We look forward to welcoming you at our workshop in November 2021 in Prague.

  Contact:
  Scientific Chair & Host: **Dr. Ondrej Kylian** (Charles University), ondrej.kylian@gmail.com
  Scientific co-Chair: **Dr. Milan Simek** (IPP)**,** simek@ipp.cas.cz
  Entrepreneurship Chair: **Dr. Hugo de Haan**, Hugo.deHaan@visiondynamics.nl

- **23rd International Conference on Gas Discharges and Their Applications (GD) - September 2022**

  We would like to inform you about the postponement of the *23rd International Conference on Gas Discharges and their Applications* (GD).

  We have been monitoring and anticipating that the next six months will most likely show no major changes in travel restrictions and issues for holding of major events regarding the COVID-19 pandemic. As a result, the Executive Management Committee of the conference has decided that a shift of the 23rd GD to 2022 is the reasonable course of action in order to be able to hold this conference as an in person event.

  The 23rd GD will be held on **28th August to 2nd September 2022** in Greifswald, Germany. Please find the updated deadlines and further information on our website: https://www.gd2021.org.

  We are looking forward to welcoming you in Greifswald next year!

  Contact:
  Prof. K.-D. Weltmann on behalf of the Local Organizing Committee
  Do not hesitate to contact us for any questions.
  gd2020@inp-greifswald.de
  Tel.: +49 3834 - 554 313

Community Initiatives and Special Issues

- **2021 Special Issue *'Plasma Propulsions'* to be published in *Aerospace***

  We are living in a key period in the development and commercialization of plasma or electric propulsion (EP) for space missions. Recent progress ranges from the continuous improvement of the performance, lifetime, and cost of existing technologies to the development of new disruptive technologies that promise to stir our field. The availability of these propulsion systems is opening novel possibilities in the space sector, where new and exciting space missions can greatly benefit from the capabilities of EP. At the same time, multiple research challenges remain open in EP. On the one hand, we need to improve the physical understanding of the various processes and mechanisms that participate in the thruster's operation in order to improve their efficiency, lifetime, and operational envelope of the most mature technologies. Additionally, there is room for research and development of new EP technologies that improve the actual durability, simplicity, and operational flexibility, among other characteristics.

  This Special Issue on Plasma Space Propulsion in the journal *Aerospace* has the objective of reviewing the state-of-the-art of EP and the latest research advances, as well as describing the direction in which the future plasma propulsion developments are heading. Works on current and emerging technologies, plasma modeling (theory and simulations), ground testing of EP, and technological developments for its specialization are encouraged from researchers across the plasma propulsion sector. The deadline for submissions is **15 September 2021.**

  More information: https://www.mdpi.com/journal/aerospace/special_issues/Plasma_Propulsion

  Guest Editors:
  Prof. Dr. Pablo Fajardo, pfajardo@ing.uc3m.es
  Prof. Dr. Mario Merino, mario.merino@uc3m.es
  Prof. Dr. Jaume Navarro, jaume.navarro@uc3m.es
  Universidad Carlos III de Madrid

Electrical Characteristics of the Sparks Produced by Electrosurgical Devices

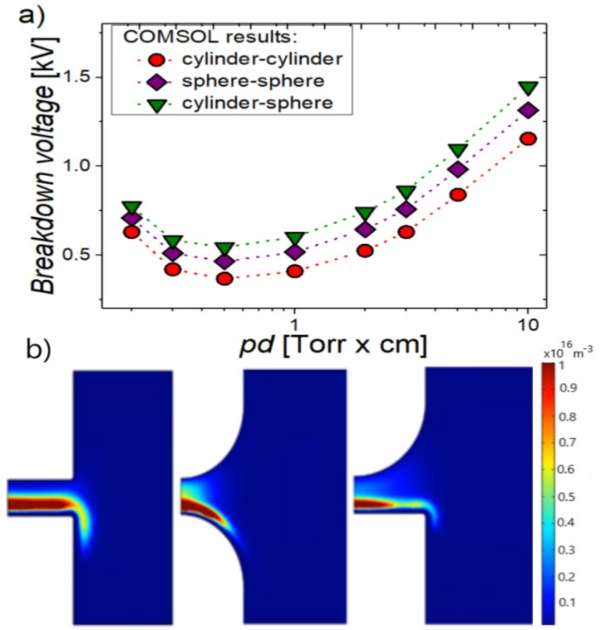


Figure 1. a) The breakdown voltage and b) the electron density between cylinder-cylinder, sphere-sphere, and cylinder-sphere electrodes.

Figure 2. Effect of cathode radius on the electron density between cylinder-cylinder, sphere-sphere, and cylinder-sphere electrodes.

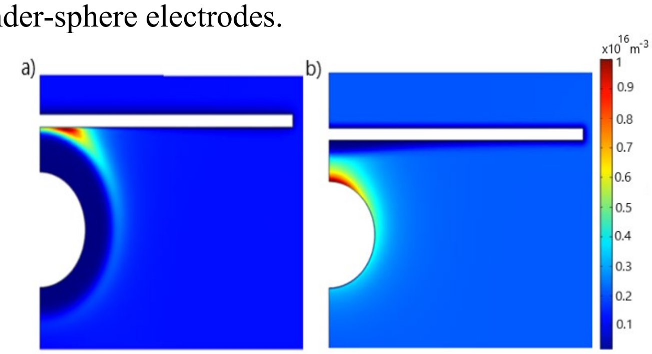


Figure 3. The electron density at the onset of breakdown between the spherical electrode and metal plate: a) positive and b) negative polarity.

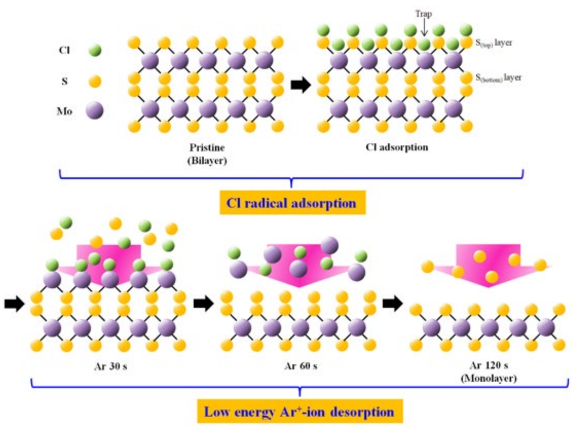
The electrical characteristics of the sparks produced between the active electrode and the biological tissue during electrosurgical procedures have been studied by using the COMSOL simulation package based on a multicomponent fluid model. According to the literature (Dias *et al.* 2019), the presence of an organic tissue does not significantly affect the breakdown mechanism. Therefore, studying the breakdown between electrodes can be useful in better understanding the sparking formation during electrosurgery. The obtained results have shown that the minimum voltage required to initiate a spark depends on the electrode configuration and the applied voltage polarity resulting in electrosurgical voltage asymmetry.

Figure 1 shows a) the breakdown voltage curves and b) the electron density distributions at the onset of breakdown for various electrode arrangements (cylinder-cylinder, sphere-sphere, cylinder-sphere). The breakdown occurs most easily when both electrodes are cylindrical. With decreasing the radius of the cathode it is easier to achieve the breakdown as illustrated in Figure 2. Electrical breakdown does not occur equally in both directions between positive and negative polarizations of the sphere-metal plate arrangement due to asymmetry (see Figure 3). The results presented here could be very useful for the design of surgical electrodes to prevent potential complications during electrosurgical procedures.

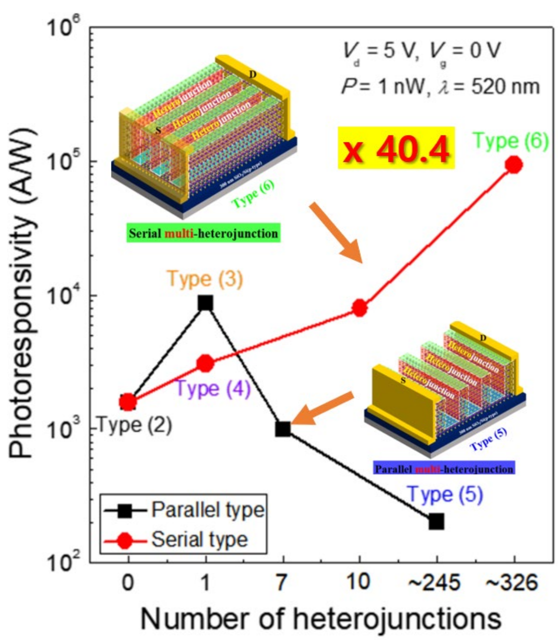
Contact:
Dr. Marija Radmilović-Radjenović
Institute of Physics, University of Belgrade
marija@ipb.ac.rs

Source:
Computer Methods in Biomechanics and Biomedical Engineering (2021).

Significant Improvement of 2D MoS_2 Photodetector Performance by Using Plasma-based Atomic Layer Etching Technique



a) MoS_2 ALE sequence.



b) Photoresponsivity enhancement by forming multiple heterojunctions on MoS_2 FET using ALE.

Two dimensional metal dichalcogenide (TMD) materials are widely investigated as next generation semiconductor materials for logic devices, optoelectronics, solar cells, biosensors, etc. One important phenomenon of TMD materials is the change of bandgap energy and direct/indirect bandgap depending on the layers of the TMD. Therefore, for the various applications, the control of TMD layers from monolayer to multilayer is important. However, the precise control of TMD layers on wafers is difficult, especially for heterojunction TMD layers of different thickness.

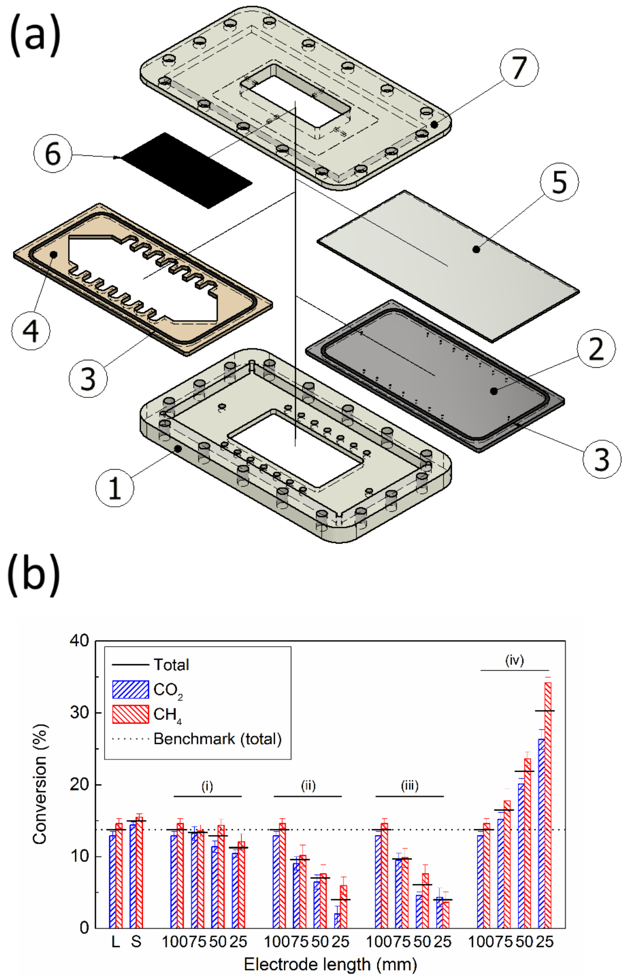
We are investigating an important TMD material, MoS_2, which changes its bandgap from 1.2 eV (multilayer, indirect) to 1.9 eV (monolayer, direct). We performed atomic layer etching (ALE) of MoS_2 multilayer material. We formed a single-multilayer heterojunction MoS_2 from the multilayer MoS_2 by partially masking the multilayer MoS_2 using photoresist. For ALE of MoS_2, Cl radical adsorption was performed using a remote ICP. The desorption of chemisorbed S-Cl, Mo-Cl, etc. on the MoS_2 surface was carried out using an Ar^+ ion beam which enables more precise control of ion energy compared to conventional etching systems.

Forming a single-multilayer MoS_2 FET by the ALE method not only improves photoresponsivity by a factor of 40 but also decreases the photoresponse time by a factor of 280. Previously, single-multilayer heterojunctions of 2D materials were randomly produced by flake exfoliation/transfer and searching by optical microscopy. Using this ALE technique, a way to fabricate single-multilayer 2D materials junctions at intended locations and on a wafer-scale could be established using multilayer MoS_2 layer grown on wafers by CVD or ALD. Further applications of the ALE technique on other 2D materials are currently under way.

Contact:
Prof. Geun Young Yeom
Sungkyunkwan University, Korea
gyyeom@skku.edu

Source: https://doi.org/10.1038/s41467-019-12592-w
More information: http://spl.skku.ac.kr

How Gas Flow Design Can Influence the Performance of a DBD Plasma Reactor for Dry Reforming of Methane



(a) Expanded view of the novel parallel plate DBD reactor design, comprised of PMMA holders (1 and 7), a grounded aluminium electrode (2), O-rings (3), POM spacer (4), borosilicate glass dielectric (5), and high voltage stainless steel mesh electrode (6).

(b) CO_2, CH_4, and total conversion for DRM, plotted for different reactor geometries.

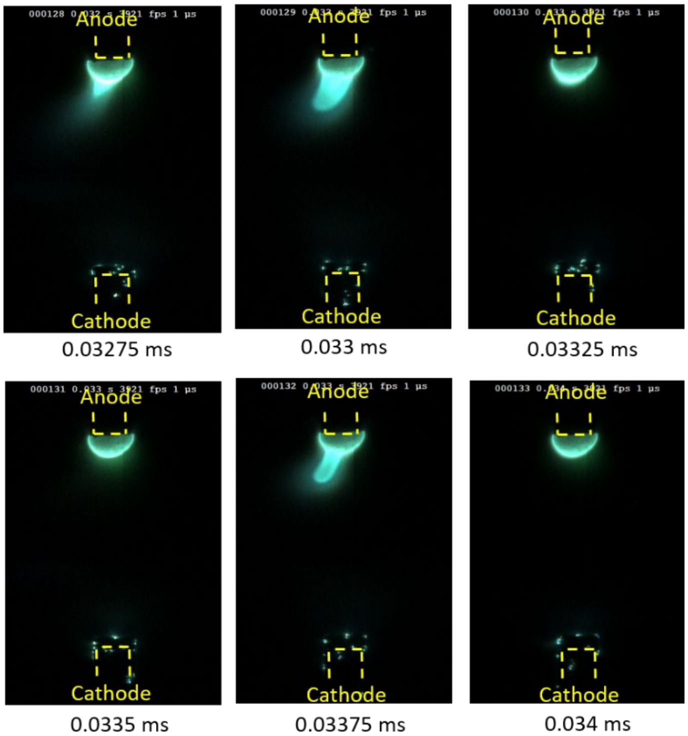
DBD plasma reactors are commonly used in static 'one inlet – one outlet' design that goes against reactor design principles for multi-component reactions, such as dry reforming of methane (DRM). We have developed a novel reactor design, and investigated how the shape and size of the reaction zone, as well as gradual gas addition, and the method of mixing CO_2 and CH_4 can influence the conversion and product composition of DRM. Even in the standard 'one inlet – one outlet' design, the direction of the gas flow (i.e., short or long path through the reactor, which defines the gas velocity at fixed residence time), as well as the dimensions of the reaction zone and the power delivery to the reactor, largely affect the performance. Using gradual gas addition and separate plasma activation zones for the individual gases give increased conversions, by optimizing mixing ratios and kinetics. The choice of the main (pre-activated) gas and the direction of gas flow largely affect the conversion and energy cost, while the gas inlet position during separate addition only influences the product distribution.

This study is published in: Chem. Eng. J., **405** 126618 (2021).

Contact:
Prof. Dr. Annemie Bogaerts
annemie.bogaerts@uantwerpen.be

More information:
https://doi.org/10.1016/j.cej.2020.126618

Oscillations of an Anodic Plasma Plume in High Current Vacuum Arcs



Anodic plume oscillating phenomena by high current vacuum arcs.

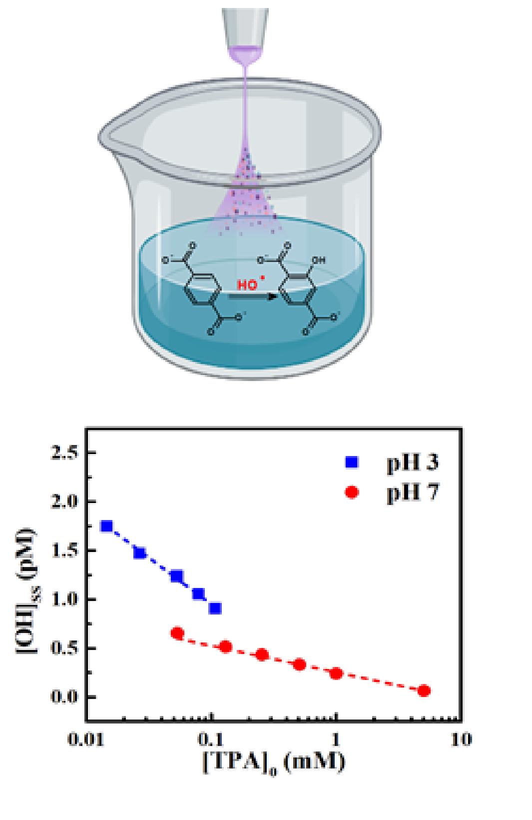
The impact of current density on arc attachment characteristics at the anode of high current vacuum arcs was investigated using high-speed imaging techniques and spectroscopy. Current density affects the occurrence of different arc attachment modes, e.g. anode spot type 2. Sometimes anode spot type 2 is followed by several anodic plasma plumes. It is known that an overheating of anode surface, which depends on the instantaneous power delivered to the anode, determines the formation of the plasma region in front of the anode. High-speed imaging indicates that this region interacts actively with the cathodic plasma jets. Recently, we observed that under certain conditions, the anode spot type 2 is accompanied by an oscillating anodic plasma plume. This can be deduced from high-speed videos as a subsequent expansion and collapse of an anodic plasma plume. Moreover, the observed plasma plume oscillations seem to be correlated with high frequency contents in the measured voltage signals. Interpretation of the results is ongoing.

Contact:
Dr. D. Gonzalez, diego.gonzalez@inp-greifswald.de
Dr. St. Franke, steffen.franke@inp-greifswald.de
INP Greifswald, Germany

Source: https://www.inp-greifswald.de/en/research/materials-and-energy/welding-and-switching/

More information:
https://www.inp-greifswald.de

Quantifying Plasma-Produced Hydroxyl Radicals in Solution and Their Dependence on the pH



Lifetime, formation rate and steady-state concentration of plasma-generated OH· in water were quantified under different pH conditions.

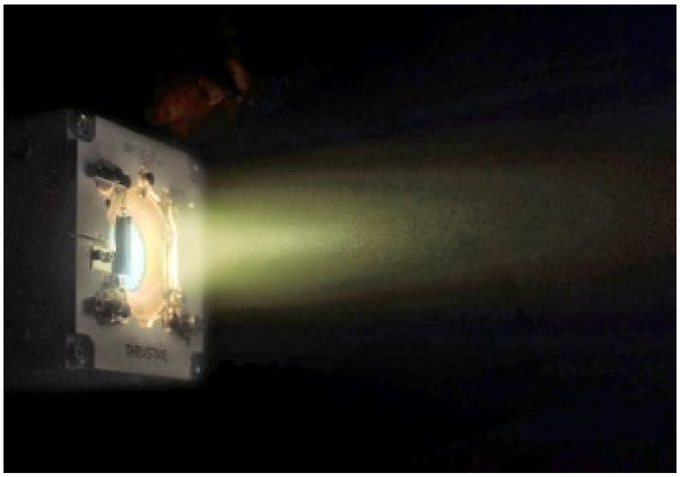
OH radicals are the most important reactive species generated during water treatment by non-thermal plasma devices. Several works during the last few years reported suspiciously high concentrations of these radicals in solutions, not taking into account for their high reactivity and short lifetime.

In our recently published letter, we discuss the different approaches required to detect and quantify long- and short-lived reactive species. We report on the accurate quantification of the steady-state concentration and lifetime of plasma-produced hydroxyl radicals in water solutions at pH 3 and 7. We also discuss the differences based on their reactivity with other plasma-generated species. Finally, we show to what extent the use of chemical probes to quantify short-lived reactive species has an influence on the results and that these effects should be taken into account.

Contact:
Dr. Francesco Tampieri and **Prof. Cristina Canal**
Universitat Politècnica de Catalunya, Barcelona, Spain
francesco.tampieri@upc.edu
cristina.canal@upc.edu

Source: Anal. Chem. (2021).
https://pubs.acs.org/doi/10.1021/acs.analchem.0c04906

First Iodine Plasma Used to Maneuver a Satellite in Space



Iodine ion thruster firing.

During December 2020, the world's first iodine electric propulsion system, the NPT30-I2-1U developed by the French company **ThrustMe**, was successfully fired in space onboard the Beihangkongshi-1 satellite (launched on 6 November 2020). Two 90-minute burns resulted in a total altitude change of 700 m and provided the first ever demonstration of iodine as a propellant for plasma-based propulsion systems.

The use of iodine as a propellant is ground-breaking for the satellite industry because it not only provides cost benefits over traditional propellants such as xenon, but also offers improved efficiency and is significantly more abundant. Iodine, which is a solid at room temperature, allows a trade-off between two important performance criteria for space propulsion systems: thrust-to-power ratio and total impulse.

Since the early 2000s, several space agencies, companies and research institutions, including NASA, Ecole Polytechnique, and Busek, have been racing towards the development of an iodine plasma thruster. This effort has been complicated by a lack of fundamental knowledge of iodine plasmas, corrosion issues, and difficulties in controlling sublimating solid propellants. ThrustMe, a startup that spun out from the LPP (CNRS and Ecole Polytechnique), has managed to achieve this ambitious goal, kick-starting a new era in space propulsion.

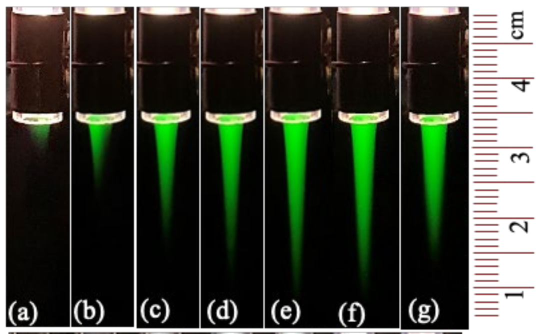
Contact:
Dr. Dmytro Rafalskyi
Thrustme, Verrières-le-Buisson, France
dmytro.rafalskyi@thrustme.fr

Source:
https://www.esa.int/Applications/Telecommunications_Integrated_Applications/Iodine_thruster_could_slow_space_junk_accumulation

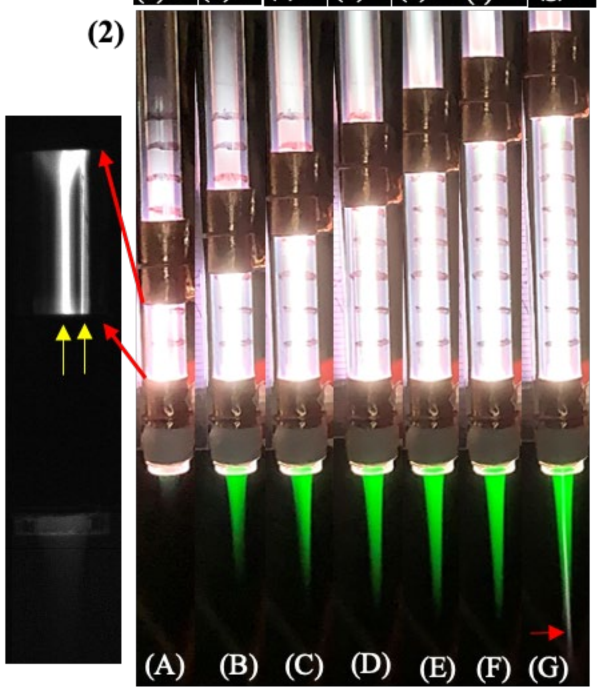
More information:
https://spacenews.com/french-startup-demonstrates-iodine-propulsion-in-potential-boost-for-space-debris-mitigation-efforts/

Emission of the "Auroral" Green Line in Atmospheric Pressure Plasma Jet

(1)



(2)



(1) Typical snapshots of the plasma jet at (a) 2 sL/min (b) 3 sL/min (c) 4 sL/min (d) 5 sL/min (e) 6 sL/min (f) 7 sL/min and (g) 8 sL/min.

(2) Photograph of the APPJ at electrode gap (A) 10 mm, (B) 15 mm, (C) 20 mm, (D) 25 mm, (E) 30 mm, (F) 35 mm, (G) 40 mm. The b/w image represents the filaments formed between the electrodes for a gap of 10 mm.

The emission of the "auroral" green line was studied in an argon kHz atmospheric pressure plasma jet. Observation of the green line is uncommon in atmospheric pressure sources because of the high quenching rates with N_2 and O_2. The line shape at 557.7 nm established that the emission was from the $O(^1S)N_2$ excimer. The plasma jet also produced other reactive species such as excited nitrogen, atomic oxygen, and OH.

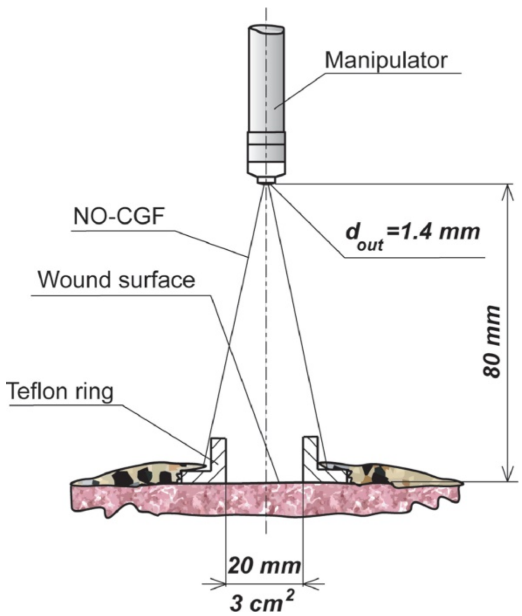
The formation of the $O(^1S)N_2$ excimer in our work does not require additional gases such as N_2 or O_2. The $O(^1S)$ emission persists for all operating parameters that were varied including: gas flow rate, applied voltage, and linear electrode gap. The $O(^1S)$ state persists even though the plasma jet changes behavior from the diffusive to filamentary mode at higher electric fields. An upper limit on the atomic oxygen density was determined to be 1 x 10^{16} cm^{-3}.

Based on these results, the plasma system described in this work is likely to be useful for a variety of applications. The $O(^1S)$ state has been determined to be effective for cleaning and sterilization. We tested the efficacy of this system for wastewater treatment by degrading a solution of methylene blue dye. The treatment was effective and a more detailed study on this matter is forthcoming.

Contact:
Dr. Surabhi Jaiswal
Princeton University
jaiswal@princeton.edu

Source:
S. Jaiswal, **E. M. Aguirre**, and G. V. Prakash, *Sci. Rep.* **11**, 1893 (2021). https://doi.org/10.1038/s41598-021-81488-x

Dose-dependent Effect of Plasma-chemical NO-containing Gas Flow on Wound Healing: An Experimental Study



Schematic diagram of NO-containing gas flow effect on the surface of the experimental wound.

Exogenous NO-therapy is used for the treatment of wound and inflammatory processes. It occurs through the delivery of NO-containing gas flow (NO-CGF) to the area of disease. The exposure to NO-CGF allows a deep penetration of wound tissues with NO, which was previously shown. NO-CGF can be characterized with certain physical, chemical and physicochemical parameters: temperature t, velocity v, nitric oxide concentration C_{NO} and nitrogen dioxide concentration C_{NO2}, mass flow rate of nitric oxide m_{NO} and mass flow rate of nitrogen dioxide m_{NO2}.

The purpose of this research was to determine the effect of the mass dose of NO in the NO-CGF on the inflammatory and reparative processes during wound healing, using histological, semi-quantitative and morphometric analyses. The experiment was performed in 36 white Wistar rats with full-thickness skin wounds with an area size of 3 cm^2. The results of histological, semi-quantitative and morphometric analyses indicated that NO-CGF has the most beneficial effect on wound healing at treatment time 120 and 360 seconds corresponding to integral mass doses of NO on the wound surfaces of 240 mg and 720 mg and relative mass doses of NO per wound areas of 80 mg/cm^2 and 240 mg/cm^2. These results will be useful for the further improvements and effective application of NO-CGF producing devices in clinical practice.

Contact:
Dr. Victor N. Vasilets
N. N. Semenov Federal Research Center of Chemical Physics, Russian Academy of Sciences.
vnvasilets@yandex.ru

Source:
A. B. Shekhter *et al*, Clinical Plasma Medicine **19–20**, 100101 (2020).
https://doi.org/10.1016/j.cpme.2020.100101

New Resources

Please submit your notices for new resources (e.g., newly published special issues, new databases, new reviews) to iltpc-central@umich.edu.

Career Opportunities

- **Postdoctoral Fellow in Computational Modelling of Wire-Arc Additive Manufacturing at CSIRO, Sydney, Australia**

  CSIRO, Australia's largest government research organisation, is offering a three-year postdoctoral fellowship. The successful candidate will join a large team with expertise in computational modelling of metal and plasma processes, with a focus on metal additive manufacturing. You will draw on existing tools for modelling of plasma and liquid flows and metal properties, to develop advanced simulations of the wire-arc additive manufacturing process. The goal is to develop a model that reliably predicts all stages of part production, including flow in the arc plasma and the melt pool, and the evolving temperature distributions in the part.

  Details can be found at https://jobs.csiro.au/job/Sydney%2C-NSW-CSIRO-Postdoctoral-Fellowship-in-Modelling-of-Wire-Arc-Additive-Manufacturing/714445400/.

  Unfortunately, because of the border restrictions that Australia has imposed due to the Covid-19 pandemic, the position is only open to Australian citizens or permanent residents, and/or to those who are currently in Australia. Applications close on Monday **15 March**.

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

- **Plasma Modeling at Lam Research, Tualatin, Oregon, USA**

  Lam Research is looking for a computational plasma scientist to employ cutting edge methods to model and simulate our complex plasma reactor systems and to provide innovative solutions to our design challenges.

  Job Responsibilities:

  - Formulate models of plasma reactor systems for wafer fabrication
  - Work with process and hardware design engineers to model and simulate Multiphysics problems involving plasmas, heat and mass transfer, electromagnetics in the reactor level as well as wafer level
  - Find root-causes, optimize process and hardware design with the aid of a combination of simulation and modeling tools
  - Simplify complex phenomena into solvable models that capture the essence of the physics
  - Take the initiative to address the limitations in full scale plasma simulation when needed, and adopt numerical methods that speed up/augment the physics based models
  - Communicate findings to a larger multidisciplinary audience
  - Provide innovative, impactful and scalable solutions to hardware and process challenges with the aid of simulations
  - Put in place modeling and simulation methods and guidelines for plasmas to reduce throughput time and increase modeling impact

Minimum Qualifications:
Graduate studies in Electrical or Mechanical Engineering with focus on computational plasmas:

- MS with 4+ years' experience
- PhD with 0+ years' experience

Skills:

- Plasma simulations on commercial packages and plasma codes
- EM simulations on commercial packages
- Experience with particle formulation of plasmas
- Expertise in fluid formulation of plasmas
- Exposure to Multiphysics modeling
- Coding in Python

Contact:
Dr. Meenakshi Mamunuru, Meenakshi.Mamunuru@lamresearch.com
Manager – Reactor Modeling Program
Lam Research Corporation, 11155 SW Leveton Drive, Tualatin, OR 97224 USA
www.lamresearch.com

- **Postdoctoral Position in Commercial Development of Electrospray Ion Thrusters, Astronautics Group, University of Southampton, UK**

Applications are invited for a Post-Doctoral Research Assistant (Research Fellow) position, for a duration of 18 months with possible extension for an additional 6 months. The position is within the Astronautics Group, within the Department of Aeronautics and Astronautics at the University of Southampton, UK. The salary is £31,866 per annum. The start of the position is March 2021, however that start date is flexible.

The post will work on the development of electrospray ion thrusters for CubeSat propulsion, pushing the commercial development of the technology. The project, in collaboration with two small companies, AVS UK and RHP Technology Austria, and with funding from Innovate UK, will work to develop an electrospray thruster based upon the previous work completed at Southampton on this novel CubeSat propulsion technology. Work at Southampton will focus on the design and testing of the electrospray thruster, with the manufacturing of the thruster components completed at the commercial collaborators.

It is desirable that the person has experience in designing and testing ion thruster technology, preferably electrospray thrusters, a closely related technology such as ion beam experience, or a demonstrated aptitude for learning new fields of research. The person should have a PhD in aerospace engineering or a closely related discipline, preferably within the field space propulsion, or experimental beam physics. It is desirable that the person has experience of operating large vacuum chamber facilities. Additionally, a strong track record of high-quality journal publications is an advantage.

More information: https://jobs.soton.ac.uk/Vacancy.aspx?id=24608&forced=2

Contact:
Dr. Charlie Ryan, Assistant Professor in Astronautics
University of Southampton, UK
c.n.ryan@soton.ac.uk

- **Postdoctoral Position in Electrospray Ion Thrusters, Astronautics Group, University of Southampton, UK**

  Applications are invited for a Post-Doctoral Research Assistant (Research Fellow) position, for a duration of one year with a possible extension for an additional year. The position is within the Astronautics Group, within the Department of Aeronautics and Astronautics, at the University of Southampton, UK. The salary is £31,866 per annum. The start of the position is March 2021, however that start date is flexible.

  The post will work on the development of a novel propulsion system for spacecraft that can use the same propellant for chemical as well as electric propulsion. The project, in collaboration with University of Illinois at Urbana–Champaign, will work to develop an electrospray ion thruster and chemical propulsion system that can utilise the same propellant. Work at Southampton will focus on the development of an electrospray ion thruster, including its design (based upon our previous work), and the experimental testing of the thruster. Some work will also be completed on the experimental testing of a chemical thruster.

  It is desirable that the person has experience in designing and testing ion thruster technology, preferably electrospray thrusters, a closely related technology such as ion beam experience, or a demonstrated aptitude for learning new fields of research. The person should have a PhD in aerospace engineering or a closely related discipline, preferably within the field space propulsion, or experimental beam physics. It is desirable that the person has experience of operating large vacuum chamber facilities. Additionally, a strong track record of high-quality journal publications is an advantage.

  More information: https://jobs.soton.ac.uk/Vacancy.aspx?id=24599&forced=2

  Contact:
  Dr. Charlie Ryan, Assistant Professor in Astronautics
  University of Southampton, UK
  c.n.ryan@soton.ac.uk

- **Program Director in the Convergence Accelerator Office of the US National Science Foundation, Washington, DC, USA**

  The Convergence Accelerator Office (CAO) within the Office of Integrative Activities (OIA) under the Office of the Director, of the National Science Foundation announces a Nationwide Search to Fill Multiple Program Director Positions for the Convergence Accelerator Program. OIA works across disciplinary boundaries to lead and coordinate strategic programs and opportunities that: advance research excellence and innovation; develop human and infrastructure capacity critical to the U.S. science and engineering enterprise; and promote engagement of scientists and engineers at all career stages.

  The detailed job description and application process are available at:
  https://beta.nsf.gov/careers/openings/oia/oia-2021-2003

  Contact:
  Dr. Lara A. Campbell
  Program Director, NSF Convergence Accelerator
  National Science Foundation
  LCampbel@nsf.gov
  https://www.nsf.gov/od/oia/convergence-accelerator/index.jsp

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Please submit your notices for collaborative opportunities to iltpc-central@umich.edu.

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