

ICPSA 2024

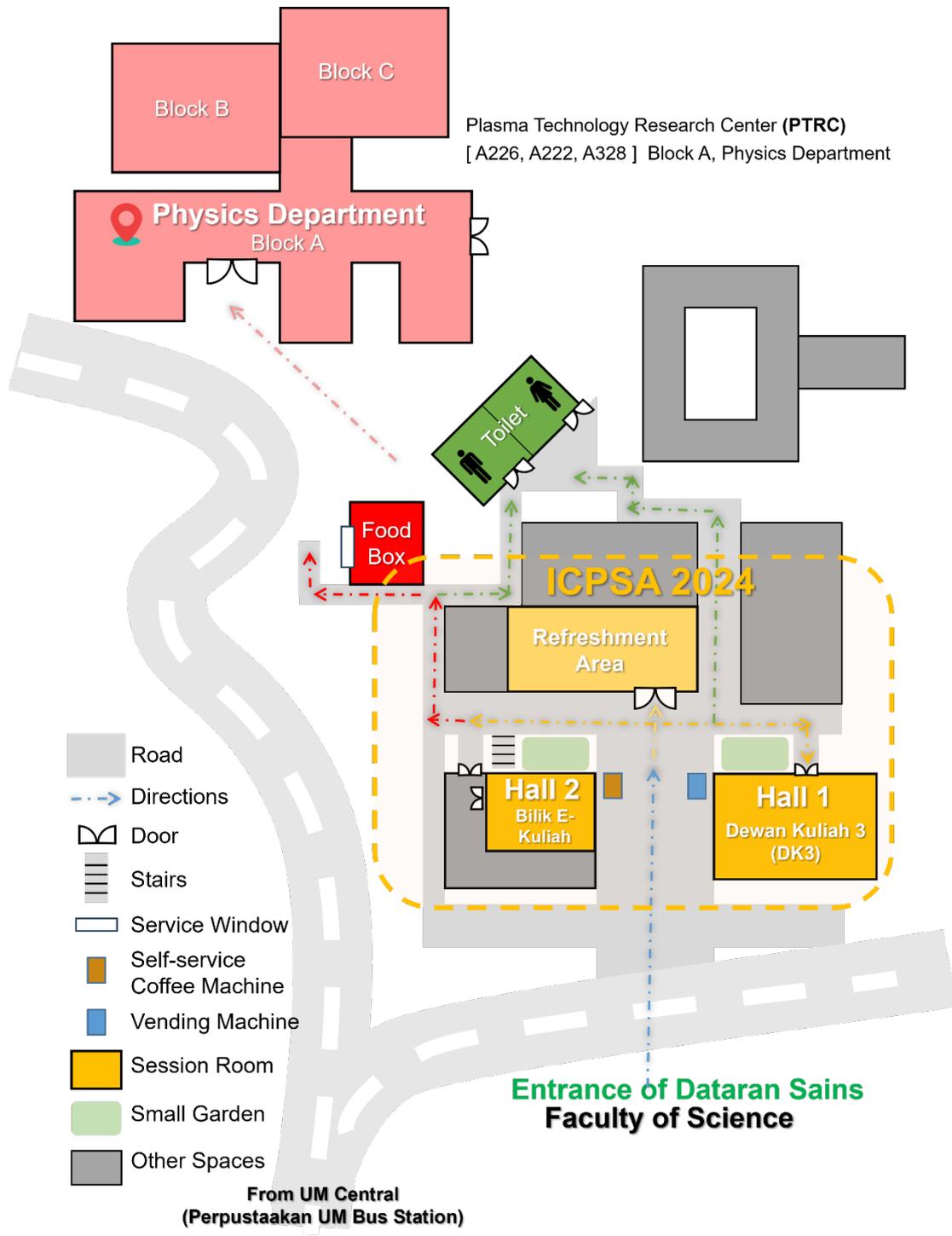
**17th INTERNATIONAL CONFERENCE
ON PLASMA SCIENCE AND APPLICATIONS**

PROGRAM BOOK

10 - 13 November 2024

Universiti Malaya, Kuala Lumpur, Malaysia





Location Map

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Program at a glance

Time	10 Nov 2024 (Sun)	11 Nov 2024 (Mon)	12 Nov 2024 (Tues)	13 Nov 2024 (Wed)
Morning Session (09:00 - 13:00)		Registration	Plenary	Plenary
		Opening Ceremony (AAAPT Introduction)		
		Break		
		Plenary	Parallel Sessions	Closing Ceremony (ICPSA Organisator)
		Parallel Sessions		
(13:00 - 14:00)	Break	Poster Session & Break	Break	
Afternoon Session (14:00 - 18:00)	Early Registration & Networking Reception & Council Meeting	Plenary	Plenary	Visitation (13:30-16:30)
		Break	Parallel Sessions	
		Parallel Sessions		
			Dinner (18:00-21:00)	





ID card for the 17th ICPSA 2024

Your ID card for the 17th ICPSA conference is specially designed with the conference information, on an exclusive Touch 'n Go (TNG) card equipped with NFC technology.



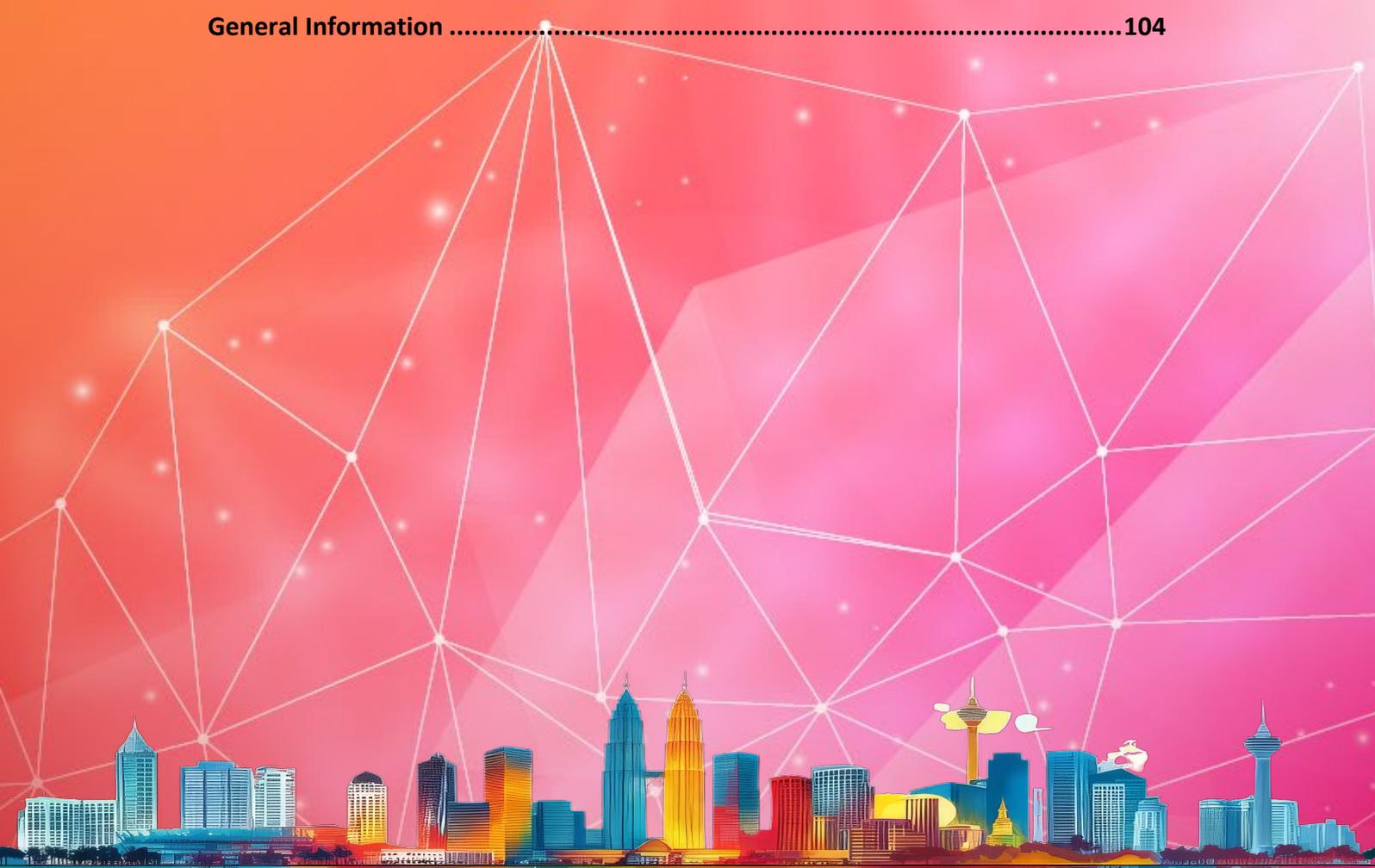
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Welcoming Letter

The 17th International Conference on Plasma Science and Applications (ICPSA 2024) is hosted by Universiti Malaya Plasma Technology Research Centre from 10 to 13 November, 2024, at the Universiti Malaya, Kuala Lumpur, Malaysia

ICPSA 2024 is a continuation of the annual meetings organized by the member institutes of AAAPT (Asian African Association for Plasma Training). On behalf of the organizing committee, I warmly welcome researchers and enthusiasts from around the globe. We will have 61 presentations, 15 plenary talks by world renowned plasma scientists and 36 invited talks covering a broad scope on the fundamentals of plasma science, plasma fusion and transdisciplinary application of plasma. We will be celebrating the many advancements in plasma agriculture and plasma medicine through scientific discussions and expert exchange on the diverse fields of research. The active participation of young researchers in this conference plays a vital role to future development impacting the communities.

In this short conference, we have participants coming from over 18 countries, including AAAPT members and speakers from Australia, China, Japan, Malaysia, Philippines, Russia, Singapore, Slovenia, South Korea, Thailand, United Kingdom and United States. They are prominent speakers from well-recognized research institutions and universities from these countries. The effort in contributing to the scientific talk has warmly touched our heart, and will always be remembered by all the participants. We also welcome local participants from Universiti Kebangsaan Malaysia, Universiti Tun Hussein-Onn Malaysia, Universiti Malaysia Perlis, Heriot-Watt University, Sunway University, Tunku Abdul Rahman University of Management and Technology, Malaysia Nuclear Agency and Infineon Technologies.

I wish to express my heartfelt appreciation to all that have collaborated to make this conference possible; the international scientific committees, local organizing committees from different research centers and the Dean of Faculty of Science and the Head of Physics Department. Thank you for your support, together we are a strong community to produce breakthroughs into the scientific basis for plasma fusion and develop rich insights into the nature and uses of plasma in diverse fields.



Seong Ling Yap
Chair, 17th ICPSA 2024 Local Organizing Committee
Professor, Plasma Technology Research Centre, Universiti Malaya



Scientific Program 10 - 13 Nov 2024

ICPSA 2024 10 November 2024		
02:30	03:30	Networking and Early Registration
03:30	05:30	AAAPT Meetings

ICPSA 2024 11 November 2024			
08:30	09:00	Registration (<i>Venue: Dataran Science, Faculty of Science</i>)	
Opening Sessions			
09:00	10:00	Opening Ceremony	
10:00	10:15	Group Photo Break (<i>Hall 3</i>)	
Session 1 : Plenary (Chair: Rajdeep Singh Rawat)			
10:15	10:55	Plenary	Heping Li <i>Tsinghua University, China</i> Non-equilibrium Transport Mechanisms and Active Control of Key Parameters in Arc Plasmas
10:55	11:35	Plenary	Tomoyuki Murakami <i>Seikei University, Japan</i> Complexity Analysis on the Chemical Reaction Network of Low-temperature Plasmas
11:35	12:15	Plenary	Yong Chia Francis Thio <i>ShanghaiTech University, China</i> Magneto-Inertial Fusion and Magnetized High Energy Density Laboratory Plasma
Session 2 : Parallel Sessions			
		<i>Hall 1</i> Chair: Renwu Zhou	<i>Hall 2</i> Chair : Dheerawan Boonyawan
12:20	12:40	Invited	Seong Ling Yap <i>Universiti Malaya, Malaysia</i> Research Activities and Recent Results from UMPTRC
			Size Yang <i>Chinese Academy of Sciences, China</i> Low-Temperature Plasma for Algal Treatment and Water Quality Improvement
12:40	13:00	Invited	Eric J. Lerner <i>LPP Fusion Inc, USA</i> Initial Proton-Boron Tests With FF-2B Dense Plasma Focus
			Feng Huang <i>China Agricultural University, China</i> Effect of Plasma on Arabidopsis Senescence and its Multi-omics Analysis



ICPSA 2024 11 November 2024				
13:00	14:00	Lunch Break (<i>Hall 3</i>)		
Session 3 : Plenary (Chair: Tao Shao)				
14:00	14:40	<i>Plenary</i>	Hyyong Suk <i>Gwangju Institute of Science and Technology, Korea</i> In Search of Extremely High Intensity Light: A New Way Based On Plasma	
14:40	15:20	<i>Plenary</i>	Xinpei Lu <i>Huazhong University of Science and Technology, China</i> Atmospheric Pressure Air Plasma for Nitrogen Fixation	
15:20	16:00	<i>Plenary</i>	Kazunori Koga <i>Kyushu University, Japan</i> Quantitative Analysis of Reactive Species Generated by Non-thermal Air Plasma for Seed Treatment	
16:00	16:10	Break (<i>Hall 3</i>)		
Session 4 : Parallel Sessions				
		<i>Hall 1</i> Chair : Kazunori Koga		<i>Hall 2</i> Chair : Hyyong Suk
16:10	16:30	<i>Invited</i>	Xuekai Pei <i>Wuhan University, China</i> NOx Production for Nitrogen Fixation through DC Glow Discharge	Mudtorlep Nisoa <i>Walailak University, Thailand</i> Characteristics of 10 kW RF High-density Helicon Plasma Source for PMI Experiments
16:30	16:50	<i>Invited</i>	Ruonan Ma <i>Zhengzhou University, China</i> Potential Use of Plasma-activated Water as Green Fungicides for Wheat FHB Control	Mohan Jacob <i>James Cook University, Australia</i> RF and Microwave Plasma Assisted Synthesis of Nanomaterials
16:50	17:10	<i>Invited</i>	Kittisak Jantanasakulwong <i>Chiang Mai University, Thailand</i> Effect of Cold Plasma on Degree of Substitution and Physicochemical Properties of Fatty Acid-Starch Ester	Paul Lee <i>Nanyang Technological University, Singapore</i> Development of a Simple Particle-in-Cell Code to Study Coulomb Explosion of a Hot Spot
17:10	17:30	<i>Invited</i>	Dongjie Cui <i>Zhengzhou University, China</i> Effects of Atmospheric Low-temperature Plasma on Blueberry Quality and Surface Fungal Diversity	Choncharoen Sawangrat <i>Chiang Mai University, Thailand</i> Enhanced Methane Dry Reforming via Microwave Plasma-Catalysis Using Mesoporous Ni/Al₂O₃ Catalysts Derived from MIL-53(Al)



ICPSA 2024 11 November 2024

17:30	17:50	Invited	Vikas Rathore <i>Walailak University, Thailand</i> Comparative Study of Dielectric Barrier Discharge and Microwave Plasma-Activated Water for Food Preservation and Agricultural Applications	Liyang Zhang <i>Tsinghua University, China</i> Modelling of Plasma-bioaerosol Interactions
17:50	18:10	Invited	Kim Shyong Siow <i>Universiti Kebangsaan Malaysia, Malaysia</i> Agri-plasma Applications in Seed Germination (Pre-harvest) and Related Patents	Pankaj Attri <i>Kyushu University, Japan</i> Sustainable CO₂ Conversion: The Role of Nonthermal Plasma

ICPSA 2024 Day 2, 12 November 2024

Session 5 : Plenary (Chair: Mohan Jacob)

08:30	09:10	Plenary	Tao Shao <i>Chinese Academy of Sciences, China</i> High Voltage and Plasma Technology: Electrification of Chemical Industry
09:10	09:50	Plenary	Koichi Sasaki <i>Hokkaido University, Japan</i> Effective Species in Plasma-Aided Ammonia Syntheses at Low-pressure and Atmospheric-pressure Conditions
09:50	10:30	Plenary	Renwu Zhou <i>Xi'an Jiaotong University, China</i> Plasmas in Advancing Nitrogen Chemistry
10:30	10:40	Break (Hall 3)	

Session 6 : Parallel Sessions

			Hall 1 Chair : Seong Ling Yap	Hall 2 Chair : Mudtorlep Nisoa
10:40	11:00	Invited	Rajdeep Singh Rawat <i>Nanyang Technological University, Singapore</i> Ultra-fast and Ultra-thin High sp3 Content Carbon Coating Using High Energy Density Plasma	Miran Mozetic <i>Jozef Stefan Institute, Slovenia</i> Cold Plasma Within a Stable Supercavitation Bubble - A Breakthrough Technology for Efficient Inactivation of Viruses in Water
11:00	11:20	Invited	Hang Wang <i>Chinese Academy of Sciences, China</i> The gas production characteristics and mechanism of mineral transformer oil decomposition under discharge plasma	Magdaleno Jr. Vasquez <i>University of the Philippines Diliman, Philippines.</i> Transformative Benefits of Plasma Techniques in Value-Adding Processes



ICPSA 2024 Day 2, 12 November 2024				
11:20	11:40	Invited	<p>Rusen Zhou <i>Xi'an Jiaotong University, China</i> Gas-liquid Discharge Plasma for CO₂ Reduction into Oxalic Acid</p>	<p>Ying Wang <i>Nanjing University of Science and Technology, China</i> Nanostructures Fabricated and Processed by Plasma Electrochemistry</p>
11:40	12:00	Invited	<p>Ram Prakash <i>Indian Institute of Technology Jodhpur, India</i> DBD Plasma-based UV-C Excimer Light Sources for Health and Environmental Applications</p>	<p>Pradoong Suanpoot <i>Maejo University Phrae Campus, Thailand</i> Investigating Electron Temperature and Plasma Density Using a Propagation Speed Model for Ar Plasma in Atmospheric Pressure Micro-DBD</p>
12:00	12:20	Invited	<p>Stuart V. Springham <i>Nanyang Technological University, Singapore</i> High Count-Rate Neutron Detectors for Plasma Fusion Studies Using Lithium-6 Scintillators</p>	<p>Haruna Peter Wante <i>Universiti Malaya, Malaysia</i> Enhanced Adsorption of Malachite Green (MG) Dye using RF Glow Oxygen Plasma-Modified Coconut Carbon Shell: A Sustainable Approach for Water Treatment</p>
12:20	12:40	Invited	<p>Lian Kuang Lim <i>Universiti Malaya, Malaysia</i> Insight from Characterising Pulsed Ion Beam Emissions in Hot and Dense Plasma</p>	<p>Choe Earn Choong <i>Kwangwoon University, Republic of Korea</i> Jet-plasma Catalysis System Development for PFAS Removal: Mechanism Studies via In-situ Raman Spectroscopy Analysis</p>
12:40	13:40	<p>Session 6A : Poster Session (Hall 2) Lunch Break (Hall 3)</p>		
Session 7 : Plenary (Chair : Koichi Sasaki)				
13:40	14:20	Plenary	<p>Kenji Ishikawa <i>Nagoya University, Japan</i> Plasma-Driven Sciences: Exploring Complex Interactions at Plasma Boundaries</p>	
14:20	15:00	Plenary	<p>Dheerawan Boonyawan <i>Chiang Mai University, Thailand</i> The Art and Science of Plasma Medicine: Crafting the Perfect Cellular Cocktail</p>	
15:00	15:40	Plenary	<p>Qiuyue Nie <i>Harbin Institute of Technology, China</i> A Big Science Project, SESRI-SPERF: Research and Development</p>	
15:40	15:45	Break (Hall 3)		



ICPSA 2024 Day 2, 12 November 2024					
Session 8 : Parallel Sessions					
		<i>Hall 1</i> Chair : Xinpei Lu		<i>Hall 2</i> Chair : Paul Lee	
15:45	16:05	<i>Invited</i>	Peiyu Wang <i>Xiamen University, China</i> Dissecting the Molecular Mechanisms of Potential Cold Atmospheric Plasma-Based Pathogen Defense	Jiangqi Niu <i>Zhejiang University, China</i> Correlation Between Reaction Field Diagnostics and Carbon Products in Solution Plasma Synthesis	
16:05	16:25	<i>Invited</i>	Pipath Poramapijitwat <i>Department of Physics and Materials Science, Thailand</i> Optimizing Therapeutic Efficacy of Nightingale® Plasma-Activated Ringer's Lactate with Cannabidiol Nanoemulsion for Targeted Lung Cancer Cytotoxicity	Yiheng Li <i>Wuhan University, China</i> Efficient Absorption and Sterilization of Nitrogen Fixation Products Using Air Plasma	
16:25	16:45	<i>Invited</i>	Natpaphan Yawut <i>Chiang Mai University, Thailand</i> Enhancing Myoblast Cell Proliferation through Cold Plasma Jet Stimulation as a Foundational Approach for Alternative Protein Production	Nafarizal Nayan <i>Universiti Tun Hussein Onn, Malaysia</i> Deposition of Smooth AlGaN Thin Film on Silicon Substrate Using Magnetron Sputtering Plasma Technique	
16:45	17:05	<i>Invited</i>	Mi Tian <i>University of Exeter, United Kingdom</i> Plasma Cracking of Methane for Carbons	Zala Arunsinh Bakulsinh <i>Nanyang Technological University, Singapore</i> Advancements in Aluminide Coatings via Plasma-Based Techniques	
18:00	21:00		Conference Dinner		



ICPSA 2024 Day 3, 13 November 2024

Session 9 : Plenary (Chair : Mohan Jacob)

09:00	09:40	Plenary	Ricky Ang Lay Kee <i>Singapore University of Technology and Design, Singapore</i> Electron Emission and Quantum Transport: 2D Materials and Fractional Modeling
09:40	10:20	Plenary	Zhitong Chen <i>Chinese Academy of Sciences, China</i> Plasma Immunotherapy
10:20	10:50	Plenary	Yangyang Fu <i>Tsinghua University, China</i> The Physics of Microscale Breakdown: A Review of Recent Progress
10:50	11:50	Award Presentation & Closing Ceremony	
11:50	12:10	Lunch Break (<i>Hall 3</i>)	

ICPSA 2024 Day 3, 13 November 2024

Session 10 : Oral Session (Chair: Paul Lee) *Hall 2*

08:30	08:45	Contributed	Sachin Sharma <i>Indian Institute of Technology Jammu, India</i> Observation of Kolmogorov Turbulence due to Multiscale Vortices in Dusty Plasma Experiments
08:45	09:00	Contributed	Rauoof Wani <i>Indian Institute of Technology Jammu, India</i> Turbulence in Many-particle System
09:00	09:15	Contributed	Dongheyu Zhang <i>Tsinghua University, China</i> Mechanism of Periodic Convective Oscillations in Laser-sustained Plasmas
09:15	09:30	Contributed	Yuting Gao <i>Xi'an Jiaotong University, China</i> Synergistic Plasma-Catalyst Approach for CO₂ Decomposition: Optimizing Energy Efficiency with NiCo-CuO Catalysts
09:30	09:45	Contributed	Zhuo Li <i>Xi'an Jiaotong University, China</i> Evaluation of Gas-liquid Discharge Plasma for Inactivation of Microorganisms in Pond Sewage
09:45	10:00	Contributed	Rubie Mavelil Sam <i>James Cook University, Australia</i> RF Plasma Treatment on Carrageenan-Based Food Packaging Materials





ICPSA 2024 Day 3, 13 November 2024			
12:15		Depart from Dataran Sains (By Bus)	Depart from Dataran Sains (By Van and Cars)
		Session 11 Chair : Haruna Peter Wante	Session 12 Chair : Lian Kuang Lim
13:30	16:40	Visit to Malaysia Nuclear Agency	Pre-arranged Meeting at Xiamen University Malaysia



International Scientific Committee



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Former Director of Center for Low-temperature Plasma Sciences (cLPS)
Japan



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Taiwan



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Head, Plasma Technology Research Centre
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A A A P T
Asian African Association for Plasma Training



Plenary Speakers & Abstract



Non-equilibrium Transport Mechanisms and Active Control of Key Parameters in Arc Plasmas

He-Ping Li

Professor

*Department of Engineering Physics
Tsinghua University, Beijing China*

Biography:

Professor He-Ping Li is the tenured Full Professor of Tsinghua University, Fellows of the Institute of Physics (FInstP), the Institution of Engineering and Technology (FIET) and the Chinese Institute of Electronics (Fellow of CIE), Senior Members of IEEE of USA, China Electrotechnical Society and Chinese Nuclear Society. He has also served as the Editorial Board Members of the journal “Plasma Science & Technology” and “Applied Sciences-Basel”, the Associate Editor of the journal “High Voltage”. He focuses on the fundamental and applied research of non-equilibrium synergistic transports in plasmas. He is the co-author of over 460 journal papers and 57 invited talks in conferences. His research has received over 3900 citations from Google Scholar with H-index of 32. He has been selected as the 2020~2023 “Most Cited Chinese Researchers” by Elsevier. His research has been rewarded the University Science and Technology Award – Second Prize of Natural Science, Ministry of Education of China in 2008, the Gold Medal in the 45th International Exhibition of Inventions of Geneva and the Best International Invention by the National Research Council of Thailand in 2017, and the Technological Invention Prize (First Prize) of China National Light Industry Council in 2019. He has mentored 26 doctoral and master students, and 10 of them have won the Outstanding Degree Thesis Award of Tsinghua University.

Plenary Talk (11 Nov 2024 | 10:15 ~ 10:55)



Non-equilibrium Transport Mechanisms and Active Control of Key Parameters in Arc Plasmas

He-Ping Li, Zi-Ming Zhang, Yun-Hai Zeng

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Abstract:

Arc plasmas, characterized by high temperatures / enthalpies, high species number densities, large spatial gradients of temperatures and species concentrations, have wide applications in the fields of welding, cutting, spraying, synthesis of micro- and nano-structured materials, hazardous waste treatment, ground simulation of high-speed spacecraft re-entry process, and so on. Oriented by numerous actual applications, a dramatic development of theoretical and applied research on arc plasmas has been obtained in the past few decades. In recent years, on the one hand, a free-burning arc plasma has been regarded as a model system of collision-dominated plasmas (CDPs) for theoretically investigating the non-equilibrium synergistic mass, momentum and energy transport mechanisms; while on the other hand, an active control of the key parameters of arc plasmas has also gradually become one of the hot research topics facing various novel applications like low-dimensional materials synthesis, biomedicine, etc. In this paper, a comprehensive review concerning theoretical and numerical investigations on the characteristics of arc plasmas is presented firstly, including the fluid model with the local thermodynamic equilibrium (LTE) and local chemical equilibrium (LCE) assumptions [1], the two-temperature fluid model with significant difference in the heavy-particle temperature (T_h) and electron temperature (T_e) with still in the LCE state [2], and the non-LTE-LCE fluid model for the arc column region, as well as various coupled models with considering both the arc column region, the electrode sheath or boundary layer regions and the solid electrodes [3]. In the second part of this paper, some recent progress on the active control of the key plasma parameters, e.g., the electron and heavy-particle temperatures, electron number density, volume of non-equilibrium plasma region, is discussed based on the analyses of the synergistic non-equilibrium transport mechanisms with the aid of the concept of “Energy Tree” [4-6]. And in particular, a recent preliminary study has further shown that this theoretical analysis approach is a powerful tool in physical design of novel CDP plasma sources [7] for promoting or even creating new plasma applications.

Keywords: Arc plasma, energy tree, non-equilibrium effect, synergistic transport, active control of plasma parameters

Acknowledgement: This work has been supported by the National Natural Science Foundation of China (No. 12075132).

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Complexity Analysis on the Chemical Reaction Network of Low-Temperature Plasmas

Tomoyuki Murakami

Professor

*Department of Science and Engineering
Seikei University, Japan*

Biography:

Tomoyuki Murakami is Professor of Science and Engineering at Seikei University, Tokyo, Japan. He is also Visiting Professor at the Department of Mathematics and Physics, Queen's University, Belfast, NI, UK. He received the B.E. degree from the Tokyo Science University, Chiba, Japan in 1993 and M.E. and Ph.D. degrees from the Tokyo Institute of Technology, Yokohama, Japan, in 1995 and 1998, respectively. His current research interests include theoretical and numerical modeling on multi-phase plasma physics and chemistry and computational biology.

Plenary Talk (11 Nov 2024 | 10:55 ~ 11:35)



Complexity Analysis on the Chemical Reaction Network of Low-Temperature Plasmas

Tomoyuki Murakami

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Abstract:

Network analysis based on mathematical graph theory has been applied in various fields, including physics, chemistry, biology, computer science, geography, economics and sociology [1-3]. The graphical and theoretical analysis can capture not only the unique characteristics of a particular network, but also the statistical characteristics common to a wide range of networks. Low-temperature plasmas have been used in interdisciplinary research fields spreading over physics, chemistry and biology. Understanding and predicting a variety of plasma-induced reacting-chemistry are becoming increasingly important. Recently, we discovered that graph theory approaches can be applied for rapid and approximate understanding, visualization and classification of complex plasma-enhanced chemistry when reaction networks are complex enough to form web-like structures [4-8]. This talk covers the basics of graph theory and introduces different kinds of networks in the real world. We then investigate the fundamental properties of the complex networks that appear in plasma chemistry to extract inherent information from the reaction data. Finally, we propose a method for rescaling the reaction network and quantify the effect of rescaling the network with numerical simulations.

Keyword: Modeling, network analysis, plasma chemistry, low-temperature plasmas

Acknowledgement: This work was partially supported by JSPS KAKENHI JP20KK0089, JP23H01404 and 24H00036.

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Magneto-Inertial Fusion and Magnetized High Energy Density Laboratory Plasma

Francis Thio

Professor

Chief Scientist, Deputy Director

Center for Ultimate Energy

ShanghaiTech University, Shanghai, China

Biography:

Professor Y. C. Francis Thio is presently the Deputy Director and Chief Scientist of the Center for Ultimate Energy (CUE) of ShanghaiTech University. Prior to joining ShanghaiTech in December 2019, Professor Zhao was a Program Manager at the U.S. Department of Energy Office of Fusion Energy Sciences, the Leader for Advanced Plasma and Fusion Propulsion at the U.S. NASA Marshall Space Flight Center, Associate Professor of Physics at the University of Miami, Florida, Scientific Affiliate at the U.S. Los Alamos National Laboratory, Senior Research Engineer at the U.S. Westinghouse R&D Center, and Research Scientist at the Australian Defence Science and Technology Materials Research Laboratory. He was the originator of the Plasma-Jet driven Magneto-Inertial Fusion approach (PJMIF). As the Chief Scientist of CUE, he is leading the development of six major laboratories devoted to the pursuit of PJMIF. Previously, he has led the development of five megajoule-class pulsed power laboratories for research for various applications of magnetized high energy density laboratory plasma. He was the first scientist who demonstrated the acceleration of a solid projectile with a mass of 1 gram to the orbital velocity of 8.2 km/s using a dense plasma in a railgun. He was the Senior Scientific Advisor to the U.S. NavAir Engineering in Lakehurst, New Jersey during the early phase of the development of EMALS (Electromagnetic Aircraft Launch System) for launching aircrafts from aircraft carriers. While at NASA, he led a NASA-wide system design of a fusion propulsion system to propel a human mission to Callisto, a moon of Jupiter. At the U.S. DOE, he played a major role in the U.S. program in innovative fusion approaches including magneto-inertial fusion, fast ignition and shock ignition for inertial fusion energy application. He was the Executive Secretary of the Task Force commissioned by the U.S. Presidential Scientific Advisory Council of the Office of Science and Technology Office in formulating a nation-wide program in High Energy Density Physics in 2007.

Plenary Talk (11 Nov 2024 | 11:35 ~ 12:15)



Magneto-Inertial Fusion and Magnetized High Energy Density Laboratory Plasma

Y. C. Francis Thio

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Abstract:

The successful attainment of ignition at the National Ignition Facility at the U.S. Lawrence Livermore National Laboratory draws attention to the question how to package inertial fusion energy (IFE) for commercial generation of electricity. Substantial scientific and technological challenges remain to be overcome. Economically practical targets and drivers remain to be developed. Targets must be fabricated at high repetition rate on the fly and must produce sufficiently high fusion gain to overcome the low wall-plug efficiency of conventional inertial fusion drivers. They must be injected from a sufficiently large distance from the center of the fusion reactor and placed at the center of the reactor with sufficiently high precision at several hertz. The drivers must be rep-ratable and of reasonable cost. Magneto-inertial fusion (MIF) provides an additional knob in addressing all these challenges.

The essential ideas behind MIF have existed for a long time since the 1980's. The concept involves freezing magnetic flux in the hot spot of an inertial fusion target or embedding magnetic flux in a target plasma bounded by a conducting shell serving as a magnetic flux conserver. In a manner similar to conventional inertial fusion, the hot spot or the conducting shell is imploded. As the shell or the hot spot implodes, the magnetic flux is compressed with it, increasing the intensity of the magnetic field. The intense magnetic field suppresses cross-field thermal diffusivity in the plasma during the compression, and thus facilitates the compressional heating of the plasma to thermonuclear fusion temperatures. The extremely high magnetic field created in the hot spot or the target plasma enhances alpha energy deposition in the fusing plasma, further enhances self-heating of the target plasma.

There are two main classes of MIF, the class of high gain MIF and the class of low-to-intermediate gain MIF. Both classes of MIF attempt to make use of a strong magnetic field in the target to suppress electron thermal transport in the target and thus rely upon the same scientific knowledge base of the underlying plasma physics. However, their strategies for addressing the above challenges of IFE, suitable targets and drivers, are different.

Exceedingly strong magnetic fields are also present in astrophysical situations, and present theories suggest that their interactions with plasmas play an important role in many astrophysical processes including gamma ray bursts (GRBs), accretion disks, and astrophysical jets. Experimental facilities, theoretical and computational capabilities developed for Magneto-inertial fusion (MIF) also provide opportunities to create and study dense plasmas in ultrahigh magnetic fields of interest to astrophysics.

In this talk, we begin by discussing the research opportunities in high-gain MIF which is an evolution from conventional inertial confinement fusion (ICF). This is followed by a discussion of the extension of the MIF concept to the low and intermediate gain regime using pulsed power drivers with far higher driver wall-plug efficiency than conventional ICF drivers based on lasers or particle beams. In these approaches, the target plasmas may be produced on the fly economically.





In Search of Extremely High Intensity Light: A New Way Based On Plasma

Hyyong Suk

Professor

Department of Physics and Photon Science

Gwangju Institute of Science and Technology, Korea

Biography:

Professor Hyyong Suk received a Ph.D. degree in 1996 from the University of Maryland at College Park, where his main work was focused on space-charge-dominated electron beam dynamics. Then he went to UCLA to work as a postdoctoral researcher and a staff scientist. Here his work was in laser-plasma interactions. After returning back to Korea in 2001, he established a research laboratory for laser-plasma acceleration, THz generation and plasma diagnostics. Recently he published a paper in Nature Photonics and it was about a new idea for laser pulse compression using a density gradient plasma. Now he is working as a professor in Dept. of Physics and Photon Science at GIST (Gwangju Institute of Science and Technology) which is a strong research-oriented university in Korea.

Plenary Talk (11 Nov 2024 | 14:00 ~ 14:40)



In Search of Extremely High Intensity Light: A New Way Based on Plasma

Hyyong SUK

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Abstract:

High peak power lasers can provide very bright light and they are based on the CPA (chirped-pulse amplification) technique [1]. The highest peak power laser in the world can provide an intensity level of 10^{23} W/cm² nowadays, but some physicists want much higher intensities to explore a new science regime. Especially the so-called Schwinger limit is very interesting, where electron-positron pair production can occur in vacuum (vacuum breakdown). However, such an extremely high intensity laser can not be realized by using the present CPA technique due to the limited damage threshold in compressor gratings. Therefore, a revolutionary new idea is required for that purpose. Recently we proposed a completely new way to realize it by using a plasma [2], of which the damage threshold is unlimited. In this talk, let me give a review for efforts to achieve laser pulse compressions which have been done so far, and then I will introduce the new way we found recently.

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Atmospheric Pressure Air Plasma for Nitrogen Fixation

XinPei Lu

Professor

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Biography:

Professor XinPei Lu, Ph.D., has been working with non-thermal plasma for 30 years. His expertise spans the development of novel plasma sources, plasma diagnostics, and applications of plasma in medicine and energy transfer. Dr. Lu has authored or co-authored over 200 peer-reviewed scientific articles, including two invited papers in Physics Reports, with a total of over 17,500 citations and an H-index of 65. He is also the inventor of twenty patents. As a recognized expert in his field, he has been invited to speak at more than 50 international conferences across the globe, including in the USA, Australia, Germany, South Korea, and other countries. Dr. Lu has received several prestigious awards, including the Early Career Award of Plasma Medicine from the International Plasma Medicine Society (IPMS), the ChangJiang Scholar Award from China's Department of Education, and the Outstanding Young Investigator Award from the National Natural Science Foundation of China. He is recognized as a Highly Cited Researcher in the field of non-thermal plasma in China, according to Elsevier. His work has been featured in prominent publications such as Science, Nature, the American Institute of Physics, and the Institute of Physics of the UK.

Plenary Talk (11 Nov 2024 | 14:40 ~15:20)



Atmospheric Pressure Air Plasma for Nitrogen Fixation

XinPei Lu

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Abstract:

Traditional air volume discharge methods include plate-to-plate dielectric barrier discharge (DBD), needle corona discharge, gliding arc discharge, and more. This presentation is divided into two sections. The first section provides an overview of our group's research on air discharge plasma sources, covering: (1) DC-driven air plasma that is safe to touch and the development of the plasma flashlight [1, 2]; (2) A magnetic field-induced air plasma jet [3]; (3) A rotating electrode air plasma jet [4, 5]; (4) Non-uniform gap air discharges, such as wedge-plane, cone-cylinder, and conical-plane electrode discharges [6-8]; (5) Magnetically stabilized air discharge [9, 10]; (6) Short-gap ignition for large-gap homogeneous air discharge [11]; (7) Three-electrode large-gap homogeneous air discharge [12]; (8) Air discharge ignition triggered by falling water droplets [13].

The second section focuses on our laboratory's research into nitrogen fixation. This includes examining the effects of magnetic field strength, gas flow rate, voltage, current, and gas composition on plasma parameters such as gas temperature, vibrational temperature, reduced electric field, and nitrogen fixation energy consumption. We will also analyze the two-dimensional distribution of nitrogen (N), oxygen (O), and nitric oxide (NO), and their impacts on nitrogen fixation energy efficiency. Finally, we will explore how cooling the plasma affects nitrogen fixation energy consumption and the underlying mechanisms.

Acknowledgement: This work was supported by National Key Research and Development Program of China (Grant No. 2021YFE0114700) and the National Natural Science Foundation of China (Grant Nos. 52130701, 52277150, and 12005076)

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**Quantitative Analysis of Reactive Species
Generated by Non-thermal Air Plasma for Seed
Treatment**

Kazunori Koga

Professor

*Faculty of Information Science and Electrical Engineering
Kyushu University, Japan*

Biography:

Professor Kazunori Koga has been engaged in research into the generation and growth mechanisms of fine particles in plasma at Kyushu University. In particular, he has been involved in developing methods to detect fine particles smaller than a nanometer. In particular, he has achieved the following: He developed a "cluster-suppressed plasma CVD method" and succeeded in producing ultra-high quality amorphous silicon thin films at an unprecedented level. For these research results, he received the 10th Applied Physics Society Lecture Encouragement Award in May 2001 and the 3rd Applied Physics Society Plasma Electronics Award in 2005.

Plenary Talk (11 Nov 2024 | 15:20 ~ 16:00)



Quantitative Analysis of Reactive Species Generated by Non-thermal Air Plasma for Seed Treatment

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Abstract:

The control of plant responses through plasma irradiation to seeds has garnered significant attention [1-3]. So far, our previous studies have reported enhancements in seed germination and growth [4-6], alterations in the phytohormonal balance of gibberellic acid and abscisic acid [7,8], and improvements in harvest yield [5]. To fully understand the effects of plasma irradiation, it is crucial to investigate the underlying molecular mechanisms [9]. Plasma generates reactive oxygen and nitrogen species (RONS), which influence various processes such as germination and subsequent growth, though quantitative study of these effects is still in its early stages. Conventional methods, such as colorimetric quantification, lack the sensitivity required for precise measurements.

Nitrate ions (NO_3^-) in seeds are known to regulate signal transduction and gene expression, particularly through the binding of NLP8 to the CYP707A2 promoter. While numerous studies have focused on the omics and phenotypic responses to NO_3^- administration, quantitative studies on plant responses to the amount of NO_3^- introduced into plant cells are scarce [10]. In this study, we examined the impact of NO_3^- on seed germination. We present a quantitative analysis of NO_3^- introduction into lettuce seeds (*Lactuca sativa* L.) following scalable dielectric barrier discharge plasma irradiation [5]. Seeds irradiated with air plasma for 5 minutes were analyzed using electrospray ionization mass spectrometry (ESI QMS), revealing the introduction of ions with a mass of 62 m/z, corresponding to NO_3^- . These ions were further confirmed as NO_3^- using liquid chromatography (LC), a multiple wavelength detector (MWD), and LC-ESI QMS. Scanning electron microscopy (SEM) showed no changes in seed surface morphology post-irradiation. These results demonstrate that plasma irradiation effectively introduces NO_3^- in a dry process, without causing damage to the seeds.

Keywords: Plasma agriculture, Seed science, Non-thermal plasma, Nitrate ion

Acknowledgement: This work was supported by JST COI-NEXT JPMJPF2302, JSPS KAKENHI JP24H02250, JP23K22483, and JP22K03586.

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High Voltage and Plasma Technology: Electrification of Chemical Industry

Tao Shao

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Biography:

Professor Tao Shao received his Ph.D. degree in electrical engineering from the Graduate University, Chinese Academy of Sciences (CAS), Beijing, China, in 2006. After graduation, he joined the Institute of Electrical Engineering (IEE) at CAS, becoming a professor in 2013. He was also a visiting scholar at the University of New Mexico, USA, from 2011 to 2012. Since August 2024, he has led the Department of High Voltage and Plasma Technology at IEE, CAS. His research focuses on atmospheric-pressure gas discharges and plasma applications driven by pulsed power. He has been an IEEE member since 2010, now a Senior Member, and is a Fellow of the Institution of Engineering and Technology (IET). He has published over 300 papers, including 150+ in international journals. He regularly contributes to major IEEE conferences and serves on editorial boards, including as Associate Editor of IEEE Transactions on Dielectrics and Electrical Insulation. In 2018, he received the William G. Dunbar Award for his contributions to high voltage technology and electrical breakdown phenomena. He has also played a key role in promoting plasma science in China, co-founding the IEEE NPSS Beijing Chapter in 2023, where he served as Vice-Chair. He also chaired the 2024 IEEE International Conference on Plasma Science.

Plenary Talk (12 Nov 2024 | 08:30 ~ 09:10)



High Voltage and Plasma Technology: Electrification of Chemical Industry

Tao Shao

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Abstract:

Decarbonizing the chemical industry is essential for both economic development and environmental sustainability. However, traditional chemical processes often rely heavily on fossil fuels, contributing significantly to global carbon emissions. There is an urgency to develop sustainable chemical production pathways. Non-thermal plasma, generated by high-voltage electricity, offers unique advantages, such as rapid response and instant on/off capabilities, making it highly adaptable to fluctuating renewable energy sources. It generates a large number of reactive species and is characterized by a high degree of non-equilibrium, which can be exploited to overcome the thermodynamic limitations of traditional thermal processes. Plasma is an efficient means of molecular activation and has been applied in diverse fields, including materials science, pollution control, disinfection, and energy conversion, all with high efficiency and cleanliness. We believe that plasma-enabled electrification, driven by renewable and low-carbon electricity, offers a promising and scalable route to achieving the crucial goal of decarbonizing the chemical industry.





Effective Species in Plasma-Aided Ammonia Syntheses at Low-Pressure and Atmospheric-Pressure Conditions

Koichi Sasaki

Professor

*Division of Applied Quantum Science and Engineering
Hokkaido University, Japan*

Biography:

Professor Koichi Sasaki received his PhD degree in 1991 from Nagoya University, Japan, where he worked on the development of infrared and far-infrared lasers with the intention of applying them to fusion plasma diagnostics. After being hired as an assistant professor at Nagoya University in 1991, he changed his research field to basic aspects of low-temperature reactive plasmas. Since becoming a full professor at Hokkaido University in 2010, he has continued his research on low-temperature plasmas. His current research interests include plasma-assisted gas conversion, plasma-liquid interaction, development of plasma diagnostics, and molecular processes in plasmas. He also held the position of program officer at the Japan Society for the Promotion of Science for a time.

Plenary Talk (12 Nov 2024 | 09:10 ~ 09:50)



Effective Species in Plasma-Aided Ammonia Syntheses at Low-Pressure and Atmospheric-Pressure Conditions

Koichi Sasaki

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Abstract:

The Haber–Bosch method, which is predominantly employed in industrial production of ammonia, needs plant-level equipment, but some industrial fields require an alternative production method that is suitable to the power grid with small-scale renewable energy sources. We expect that plasma-aided synthesis is a candidate for the small-scale production method of ammonia.

To date, the effective species in plasma-aided syntheses of ammonia has not been clarified. It is widely understood that atomic nitrogen has higher adsorption probabilities than molecular nitrogen on solid surfaces, but some papers in the field of fundamental surface science report the enhanced probabilities of dissociative adsorption of molecular nitrogen if they are excited vibrationally. In this work, we compared the contributions of atomic nitrogen and vibrational excited molecular nitrogen in plasma-aided syntheses of ammonia.

We employed two plasma sources. One was an atmospheric-pressure dielectric barrier discharge and the other was a low-pressure (<10 Pa) electron cyclotron resonance plasma. The vibrational temperature of molecular nitrogen in the atmospheric-pressure discharge was 1600 K at the maximum, resulting in a flux of 10^{21} s^{-1} of vibrational excited ($v \geq 1$) molecular nitrogen toward a catalyst (5%Ru- Al_2O_3 pellets). The flux of atomic nitrogen was close to 10^{16} s^{-1} . In this case, we observed the dominant contribution of vibrational excited molecular nitrogen to the synthesis of ammonia [1]. On the other hand, the fluxes of vibrational excited molecular nitrogen and atomic nitrogen were 10^{20} and 10^{17} s^{-1} in the low-pressure electron cyclotron resonance plasma, respectively, and in this case, we observed the dominant contribution of atomic nitrogen [2]. Considering the two results, we may conclude that the surface adsorption probability of vibrational excited molecular nitrogen is much lower than that of atomic nitrogen, but it can work in the ammonia synthesis dominantly if its flux is more than four orders of magnitude higher than that of atomic nitrogen.

Keywords: plasma-aided ammonia syntheses, atomic nitrogen, vibrational excited molecular nitrogen

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Plasmas in Advancing Nitrogen Chemistry

Renwu Zhou

Professor
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Xi'an Jiaotong University, China

Biography:

Renwu Zhou is currently a professor at Xi'an Jiaotong University, China. His main research background lies in the area of plasma physics and chemistry, and plasma-enabled applications for sustainable production and green processing. He has published over 100 peer-reviewed articles (50 as first-author and/or corresponding author) and many of them are published on high-impacted journals (e.g., Journal of the American Chemical Society, Energy & Environmental Science, Applied Catalysis B: Environment and Energy and Carbon Energy, with more than 5000 citations in Google Scholar. 10 of them are accessed as ESI highly cited papers. He also serves as an associate editor of Modern Low Temperature Plasma and is selected in Top 2% of Scientists on Stanford List from 2022-2024.

Plenary Talk (12 Nov 2024 | 09:50 ~ 10:30)



Plasmas in Advancing Nitrogen Chemistry

R. Zhou^{1,*}, J. Sun¹ and P. J. Cullen²

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Abstract:

Plasma technology offers a transformative approach to nitrogen chemistry, enabling processes to operate under ambient conditions which significantly reduces energy consumption and enhances efficiency. It supports environmental sustainability by minimizing harmful emissions and utilizing renewable energy sources, aligning with green chemistry principles. Our research highlights the effectiveness of air plasma bubbles in nitrogen oxidation to produce liquid fertilizers, emphasizing the enhanced solubility of higher oxidation state NO_x, which can be optimized by catalysts such as TiO₂, alongside the fine-tuning of the nitrogen to oxygen ratio [1]. In nitrogen reduction, the study explores two primary pathways: the reaction of N₂ with H₂ facilitated by plasma catalysis, and the interaction between N₂ and water. We address selectivity issues in direct air-water plasma reactions, favoring NO_x over ammonia, by introducing a hybrid plasma-electrochemical strategy [2,3]. This method boosts N₂ activation by plasma and enhances ammonia yield and selectivity by electrocatalysis. Our findings illuminate the potential of plasma technology as a versatile tool in nitrogen chemistry, enabling efficient and environmentally friendly synthesis routes for both nitrogen oxidation and reduction. By optimizing process parameters and integrating complementary techniques, plasma technology paves the way for advanced nitrogen management and utilization, promising significant contributions to environmental protection and resource recovery initiatives.

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Plasma-Driven Sciences: Exploring Complex Interactions at Plasma Boundaries

Kenji Ishikawa

Professor

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Nagoya University, Japan*

Biography:

Kenji Ishikawa is a Professor of Center for low temperature plasma science (clps), Nagoya University, Japan. His scientific research interests involve plasma-surface interactions in semiconductor processes and cover plasma effects on liquids and living organisms. He holds his Ph.D. in engineering from Tohoku University. He did his research at the plasma laboratory and environmentally benign etching laboratory of the association of super electronics technologies (ASET) (1999-2004). He joined the Nagoya University in 2009 and was promoted to an adjunct professor of the plasma nanotechnology research center (PLANT) of the Nagoya University in 2012. From 2019 to 2020, he was an adjunct professor of the center of plasma nano-interface engineering (CPNE), Kyushu University. Since 2021, he is currently working on plasma science and technology and graduating PhD and MS students. He received the 11th Plasma Electronics Award (2013) and the 37th Outstanding Paper Award (2015), of the Japan Society of Applied Physics for work related to the in situ real time analysis of electron spin resonance (ESR) allowing to detection of free radicals on materials and living organisms. He is now engaged also in plasma medicine and plasma agriculture studies. He has published more than 300 papers in refereed international journals and his works cited over 3000 times with h-index of 32. He has also given more than 60 invited talks and holds more than 50 patents. He has served as program chairman of the international symposium of advanced plasma science and its applications for nitrides and nanomaterials and the international conference on plasma nanotechnology and science (ISPlasma/IC-PLANTS).

Plenary Talk (12 Nov 2024 | 13:40 ~ 14:20)



Plasma-Driven Sciences: Exploring Complex Interactions at Plasma Boundaries

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Abstract:

Plasma-driven science is defined as the artificial control of physical plasma-driven phenomena based on complex interactions between nonequilibrium open systems. Recently, peculiar phenomena related to physical plasma have been discovered in plasma boundary regions, either naturally or artificially. Because laboratory plasma can be produced under nominal conditions around atmospheric pressure and room temperature, phenomena related to the interaction of plasma with liquid solutions and living organisms at the plasma boundaries are emerging. Currently, the relationships between these complex interactions should be solved using science-based data-driven approaches; these approaches require a reliable and comprehensive database of dynamic changes in the chemical networks of elementary reactions. Consequently, the elucidation of the mechanisms governing plasma-driven phenomena and the discovery of the latent actions behind these plasma-driven phenomena will be realized through plasma-driven science.

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The Art and Science of Plasma Medicine: Crafting the Perfect Cellular Cocktail

Dheerawan Boonyawan

Professor

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Biography:

Professor Dheerawan is former Principal investigator of Plasma & Beam Physics Research Facility (PBP) and TKRCC, Sci & Tech Park (STeP), and former director of Science & Technology Service Center (STSC-CMU), Chiang Mai University, THAILAND. Currently, Dr. Dheerawan is a Chiang Mai University staff. He got his PhD. in Physics (Plasma Physics) in 2001 with certifications in interfacing in Nuclear Experiments 1989, Electron Beam Irradiation Technology 1991, Plasma Physics 1998 and Radiation Engineering and Accelerator Technology 2006. His research interests and activities are mainly in plasma processes and applications to biomaterials. His formerly research center was the Fast Neutron Research Facility which had joint nuclear data for fusion neutronics with Prof. Akito Takahashi, Oktavian intense neutron source facility, Osaka University. He also represents a committee member of Asian Joint Committee for Applied Plasma Science and Engineering (AJC-APSE) and the Asian African Association for Plasma Training (AAATP), associate member of the European Joint Committee (EJC) on Plasma & Ion Surface Engineering (EJC-PISE) and a senior editor of AAPPS Bulletin. His facility members now support internship program for students from France and others. Most of the research work intend to support graduate students for innovation and startup in life science area.

Plenary Talk (12 Nov 2024 | 14:20 ~15:00)



The Art and Science of Plasma Medicine: Crafting the Perfect Cellular Cocktail

Dheerawan Boonyawan

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Abstract:

Non-thermal plasmas (NTP) possess a wide range of biomedical applications owing to their distinctive capacity to generate direct and indirect reactive oxygen and nitrogen species (RONS). The cocktail of NTP-generated agents at the target surface to subsurface performs excellent cellular positive response results, proven for decades as future plasma medicine measures, which underlying principles and apply them effectively.

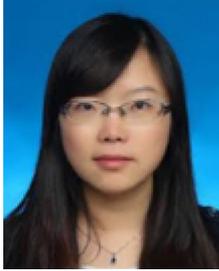
Gas cocktail: Hypoxia acts as a critical factor in stimulus tissue repair by creating an oxygen gradient from the hypoxic tissue of the wound to the surrounding unbroken tissue. Known as inflammation initiation, the central area of the wound is the most hypoxic, and the oxygen gradient progressively increases toward the uninjured tissue. However, the amount of oxygen consumed to generate the OH and, thus, the H₂O₂ agent is reduced with the RONS from the fixed air plasma gas flow (3 slm). Consequently, more leftover oxygen can be shared in angiogenesis stimulation of new blood vessels, such as producing superoxide (SOD), cell metabolism, and raising tissue oxygen tension in wound healing.

Aquease cocktail: Optimal air plasma-activated Ringer's injection (PA-LRI) conditions or PA3-LRI (3 min, 111.6 J) achieved significant cell death in lung cancer cells (A549: 59.4%, H1299: 20.4%) with minimal impact on normal WI-38 cells (10.5%). Optimized cannabidiol nanoemulsion (CBD-NE) exhibited enhanced stability and dose-dependent cytotoxicity against lung cancer cells. Combining PA3-LRI with 2 μ M CBD-NE further increased anti-tumor effects (A549: 78.7%, H1299: 45.1%) while protecting normal cells (<5.6% mortality), suggesting CBD counteracts reactive oxygen and nitrogen species (RONS) effects. This study highlights the potential of combining PA-LRI and CBD-NE as promising strategies for selective and effective lung cancer treatment.

"Crafting the perfect cellular cocktail" will present a visually appealing and memorable metaphor for tailoring plasma treatments to specific cellular needs and the desired outcome.

Keywords: plasma medicine, cellular cocktail, wound healing, cancer treatment





A Big Science Project, SESRI-SPERF: Research and Development

Qiuyue Nie

Professor

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Biography:

Professor Qiuyue Nie is the Vice Dean of School of Electrical Engineering and Automation in Harbin Institute of Technology, Senior member of IEEE. She has also served as the Editorial Board Members of the journal “Plasma Science & Technology” “Chinese Physics Letters” and “Chinese Physics B”. With 20 years of experience in low temperature plasmas and their applications, she has made significant performance in the research on the simulation of the extreme plasma environment, as well as the basic theory and application technology of electromagnetic wave controlled by plasma. She has published more than 70 journal papers, and authorized twenty-five patents. Due to her contribution to studies of plasmas, she has been invited to give talks at more than 20 international conferences, and elected as vice chairman of the Youth Working Committee of China Electrotechnical Society, as well as chairman of 2020 National High Voltage and Discharge Plasma Academic Conference.

Plenary Talk (12 Nov 2024 | 15:00 ~ 15:40)



A Big Science Project, SESRI-SPERF: Research and Development

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Abstract:

Physics of space and astrophysical plasmas is a field with the most cutting-edge scientific challenges and the most active researches. Spacecrafts are the tentacles and main means of exploration of space and astrophysics. In the long term, how to ensure the feasibility, reliability and controllability of space exploration tasks is a key issue to be solved. A world-class leading ground-based experimental facility for laboratory simulation of space environments, the Space Environment Simulation and Research Infrastructure (SESRI) with 9 typical factors of space environment simulated, is starting its operation phase at Harbin Institute of Technology (HIT) in China. Focusing on the development of aerospace technology and the needs of space frontier scientific research, it has established extensive cooperation and exchanges with 15 countries around the world and nearly 100 domestic research institutions. And the infrastructure is now available to users worldwide. The Space Plasma Environment Research Facility (SPERF) is one of the most important components of SESRI. It provides a remarkable experimental platform, with a well-designed set of coils and plasma sources, for laboratory simulation of space plasmas. SPERF includes of two experimental chambers, with the scales of 5m*10m and 5m*6m, respectively. The longer one is established to simulate the magnetosphere plasma physics processes, and consists of three sub-systems, Dipole Research Experiment (DREX), Asymmetric Reconnection Experiment (AREX), and Tail Reconnection Experiment (TREX). The DREX provides a laboratory platform for simulating radiation belt physics process, e.g., trapping, acceleration/loss, and transport of energetic charged particles in a dipole magnetic field relevant to the inner magnetosphere. The AREX provides a unique experimental platform to study 3D asymmetric reconnection dynamics relevant to the interaction between the interplanetary and magnetospheric plasmas. The TREX provides a research platform to understand the physics processes in magnetotail, e.g., the depolarization front formation and propagation. The shorter one is used to provide the plasma environment of high-speed civil aviation and space transportation. We here present an overview of SPERF, as well as recent progresses in research of space plasma environment processes.





Electron Emission and Quantum Transport: 2D Materials and Fractiona Modeling

Ricky Ang Lay Kee

Professor

Associate Provost for International Relations

Singapore University of Technology and Design, Singapore

Biography:

Professor Ricky Ang Lay Kee is the Associate Provost for International Relations, an Ng Teng Fong Chair Professor and the Programme Director of STEAMunity at SUTD. Prior to this, he has held several significant positions at SUTD, including Head of the Science, Mathematics, and Technology Cluster (2018-2023), Acting Head of Engineering Product Development (2017-2019), Director of Graduate Studies (2015-2017), and PhD Programme Director (2012-2014). His contributions to the University were recognised with the Singapore Public Administration Medal (Bronze) in 2017.

Prof Ang is a fellow of the Institute of Electrical and Electronics Engineers (IEEE), a fellow of the UK Institute of Physics (IOP), a fellow of the International Artificial Intelligence Industry Alliance (AIIA) and an IEEE Distinguished Lecturer. He is also on various advisory boards of journals including the Physics of Plasmas and Nano Express. He is a leading expert in electron emission theory, interface carrier transport, computational nanoelectronics and fractional modelling, with research funded by various agencies in Singapore and the USA. He earned his Bachelor of Science from the National Tsinghua University (Hsinchu) and his Master of Science and PhD from the Nuclear Engineering and Radiological Sciences programme at the University of Michigan. He was also the Los Alamos National Laboratory Director Postdoctoral Fellow in the Applied Physics Division before joining NTU School of Electrical and Electronic Engineering. He has also been ranked Top 2% Scientists (Applied Physics) by Stanford University since 2021, and has been a member of the jury panel (Physical Science) of the Falling Walls Science Breakthrough since 2022.

Plenary Talk (13 Nov 2024 | 09:00 ~ 09:40)



Electron Emission and Quantum Transport: 2D Materials and Fractiona Modeling

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Abstract:

Electron emission from a material through an interface is a fundamental process in cathodes, diodes, ionization and electrical contact. Depending on the energy used to produce electron emission, it can be broadly characterized into 3 processes: thermionic emission TE (thermal energy), field emission FE (quantum tunneling) and photoemission PE (photon absorption). Basic models for these processes (TE, FE, PE) have been captured in the Richardson-Dushman (RD) law, Fowler-Nordheim (FN) law, and the Fowler-Dubridge (FD) law. With the development of two-dimensional (2D) atomic scale materials, these classical laws will require revision to account for the new material properties. In this talk, self-consistent electron emission models will be presented to report new scaling laws, which shows smooth transition to the classical models. Comparison with recent experimental results, and their applications in, plasma, cathodes, electronics, and photonics will be discussed. For a practical object, it involves multiscale modelling that is time-consuming. By using fractional models developed mathematicians, a complicated object is projected into a “fractional” dimension to solve the relevant equations in this non-integer dimension with the assumption that the effects at smaller scales can be ignored. Some recent results of using such “fractional” models on problems such as fractional high current from rough cathode, fractional high current transport in organic diode, fractional tunneling law, fractional Fresnel coefficients for laser absorption, fractional capacitor, and others. These new fractional models will provide useful fractional parameters that can be characterized by experimental measurements.





Plasma Immunotherapy

Zhitong Chen

Professor

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Biography:

Zhitong Chen is a professor at the Institute of Biomedical and Health Engineering, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, and holds a joint faculty affiliate appointment at the National Innovation Center for Advanced Medical Devices, China. He did his postdoctoral training in the Plasma and Space Propulsion Lab of Dr. Richard E. Wirz at the University of California, Los Angeles. He received his Ph.D. in Mechanical and Aerospace Engineering from the George Washington University, where he worked under Dr. Michael Keidar. He received his M.Sc. and B.Sc. in Engineering Mechanics at the Institute of Mechanics, Chinese Academy of Sciences, and Mechanical Engineering at Northeast Agriculture University, respectively. His research interests focus on plasma physics, plasma applications, and medical devices. He has published about 50 papers including PNAS, Science Advances, and Materials Today. He is the author of the book “Cold Atmospheric Plasma (CAP) Technology and Applications” (Springer Nature, 2021). He has applied for about 30 patents worldwide and has been granted around 10 patents.

Plenary Talk (13 Nov 2024 | 09:40 ~ 10:20)



Plasma Immunotherapy

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Abstract:

Cold atmospheric plasma (CAP) technology, as a new physical therapy, brings new hope to cancer treatment. Plasma can achieve selective killing of cancer cells without basically harming normal tissues [1]. We have carried out plasma immunotherapy-related work: 1) We developed portable air CAP inspired by lightning and applied it to residual tumor cells at the surgical cavities effectively. It induces cancer immunogenic cell death in situ and evokes strong T cell-mediated immune responses to combat the residual tumor cells [2]; 2) Plasma combined with immune checkpoint inhibitors (ICB) for tumor treatment promotes the reprogramming of other immune cell spectra in the tumor microenvironment (TME) and inhibits tumor growth of primary tumors and distant tumors [3]; 3) Plasma activated gel is used for tumor treatment to promote the polarization of M2-like tumor-associated macrophages to M1-like phenotypes and enhance the presentation of antigens to T cells [4]; 4) Trehalose synergizes plasma immunotherapy to induce eIF2 α phosphorylation and initiate tumor-specific T cell-mediated anti-tumor immune response, reverse the immunosuppressive tumor microenvironment and promote tumor antigen presentation to T cells [5]; 5) Plasma coordinates Minoxidil (MXD) tincture to promote vasodilation around hair follicles, effectively reshape the microenvironment around hair follicles to accelerate hair regeneration [6]. Plasma immunotherapy will accelerate the promotion of plasma clinical medicine and provide new methods for the clinical treatment of tumors.

Keyword: Cold atmospheric plasma, reactive species, immunotherapy, microenvironment, T cells

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The Physics of Microscale Breakdown: A Review of Recent Progress

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Biography:

Dr. Yangyang Fu is currently an Associate Professor with the Department of Electrical Engineering at Tsinghua University, Beijing, China. He received the bachelor's degree in electrical engineering from Shanghai Jiao Tong University, Shanghai, China, in 2010, and the Ph.D. degree in electrical engineering from Tsinghua University, Beijing, China, in 2015. From 2016 to 2021, he was a Postdoctoral Researcher with Michigan State University. His research interests lie in gas discharge physics and low-temperature plasmas, with especial focus on electrical breakdown and insulation, radio frequency discharges, and microplasmas. He has authored or co-authored over 100 journal and conference articles in his research field. Dr. Fu was a Committee Member of the 2018 ICOPS NPSS Outstanding Student Paper Award. He was a recipient of the Outstanding Reviewer Award for the IOP journals Plasma Sources Science and Technology (in 2017 and 2020), Plasma Science and Technology (in 2019 and 2020), and as an Exceptional Reviewer for the AIP journal Physics of Plasmas (2020). He also received the Excellent Dissertation Award (first place), the Academic Star Award (finalist), the Excellent Graduate Award from Tsinghua University, the National Scholarship Awarded by the Ministry of Education of the People's Republic of China, and the Outstanding Student Paper Award (1st Place) at the 42nd IEEE ICOPS in 2015.

Plenary Talk (13 Nov 2024 | 10:20 ~ 10:50)



The Physics of Microscale Breakdown: A Review of Recent Progress

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Abstract

In recent decades, microfabrication technologies have been largely advanced, which enables the miniaturization of low-temperature plasma devices toward a micrometer regime [1,2]. Understanding the physics of microscale breakdown is essential for the development of novel plasma sources. It has been recognized that the secondary electron emission and the electron avalanche dominate the breakdown for the gap greater than ten-micron meters whereas the field emission dominates when the gap distance shrinks to several micron meters [3,4]. The thermal field emission plays a crucial role when the cathode is under high field and temperature conditions [5]. This presentation summarizes and discusses state-of-the-art experimental diagnostics (e.g., breakdown path) and theoretical models (e.g., breakdown threshold) for microscale electrical breakdown [6]. A unified breakdown model for the thermal field emission-induced microscale breakdown is introduced [7]. The non-dimensional model for predicting gap breakdown voltage from field emission to secondary electron emission-dominated regimes is discussed. The space charge effects in the early stage of the field emission-driven microgap breakdown, showing a double-layer sheath and ultrafast oscillations, are reported [8]. Lastly, the most recent advances in modeling an electrostatic-induced microgap breakdown with moving electrodes are presented. This talk aims to provide a comprehensive overview of the physics of microscale breakdown, which provides optimal design strategies for miniaturized plasma devices.

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Invited Talk : Abstracts

Sustainable CO₂ Conversion: The Role of Nonthermal Plasma

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Abstract:

Energy consumption is projected to increase by 28% between 2015 and 2040, leading to a 16% rise in energy-related CO₂ emissions over the same period [1]. There is an urgent need for prompt action from governments and industries worldwide to reduce greenhouse gas concentrations [2]. Carbon capture from point sources and direct air capture are potential solutions, but there are still limitations, such as high costs and reduced absorption rates [3]. Plasma generates electrons that may activate the CO₂ molecules and create new products without heating the entire gas; plasma is exciting for the conversion of CO₂ [5]. Our research has made significant progress by utilizing streamer plasma to convert CO₂ into valuable plant nutrients [6]. In another study, we have shown how humidity is used in CO₂ conversion [7].

Nevertheless, the simultaneous capture and conversion of CO₂ using NTP is a promising development. Hence, in this pioneering effort, we employed an IL for CO₂ capture and storage, then converted the captured CO₂ into CO using NTP. In this study, we utilized the IL to convert captured CO₂ to CO [8,9]. We observed that plasma and IL are integrated for simultaneous capture, storage, and conversion of CO₂. Our experimental results indicate that the water + IL solution can store CO₂ under atmospheric pressure and room temperature. Moreover, the release of CO₂ during plasma treatment produces CO. Our MD simulation supports our experimental findings, suggesting that CO₂ molecules easily transition from the gaseous phase into the water + IL solution. In contrast, the penetration of CO molecules into the water + IL solution is more challenging than water alone. This observation implies that once plasma produces CO, its solubility in the IL solution may be limited, showcasing the potential of this technology for efficient CO₂ capture and conversion.

Keywords: CO₂ conversion, CO₂ capture, non-thermal plasma, Catalyst

Acknowledgment: This work was supported by PARKS-JPMJSF2317 and JSPS-KAKENHI grant no. 22H01212. Additionally, JST COI-NEXT JPMJPF2302 partly funded it, JSPS-KAKENHI grant no. JP 24H02246, JP 24H02250, and the JSPS Core-to-Core Program “Data Driven Plasma Science”, the Plasma Bio Consortium, and the Center for Low-temperature Plasma Sciences, Nagoya University.

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Jet-Plasma Catalysis System Development for PFAS Removal: Mechanism Studies via In-Situ Raman Spectroscopy Analysis

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Abstract:

Perfluorooctanoic acid (PFOA) has attracted enormous attention since it has been used extensively in fire-fighting foams, water-resistant products, and paint. Notably, the PFOA is highly persistent with chemical and biological resistant properties, and it was found in different environmental media, including soil, water bodies, wildlife, and human beings. Up to date, the available water treatment technologies via adsorption or oxidation were ineffective for PFOA removal. Pseudo-photocatalysis driven by a UV-VIS range of light sources produced from jet plasma is a new approach toward improving reactive species (RS) formation for water remediation. Herein, this study investigates PFOA removal using argon and air-jet plasma systems with the addition of light response plasma catalysts. As a result, the combination of the catalyst and jet plasma system significantly improved the PFOA removal performance, and synergy between the jet plasma and catalysts was obtained. This is attributed to a higher formation of hydrated electrons and hydroxyl radicals induced by the catalyst via PFOA quenching experiments and electron paramagnetic resonance spin-trap analysis. This is ascribed to the increased formation of hydroxyl radicals induced by the catalyst redox reaction, as evidenced by liquid spin resonance spectroscopy analysis and in-situ Raman spectroscopy measurement. Furthermore, the addition of a catalyst results in a lower formation of PFOA intermediate species and water treatment energy consumption compared to the sole jet plasma system. The results of the multiple-plasma-jet continuous-flow experiments illustrated the scalability of the plasma catalysis system for PFOA destruction. This study opens a new platform for constructing photocatalysts to enhance plasma catalysis activities for higher reactive species production in the liquid phase.

Keyword: PFAS, Jet plasma, photocatalyst, hydroxyl radicals



Effects of Atmospheric Low-temperature Plasma on Blueberry Quality and Surface Fungal Diversity

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Abstract:

Atmospheric pressure cold plasma (ACP) is an effective treatment method to kill microorganisms, which can protect food from microbial contamination, thereby maintaining the nutritional quality of food and extending the storage time of food. As a highly nutritious fruit, blueberries are susceptible to microbial contamination during the postharvest storage period. More seriously, the gray mold caused by *Botrytis cinerea* (*B. cinerea*) is a major postharvest disease of blueberries. Herein, this study investigated the effects of ACP treatment with different time (0, 5, 10, 15 and 20 min) on the natural decay, gray mold decay caused by *B. cinerea*, postharvest quality and the microbiota community composition and diversity of blueberries (*Vaccinium corymbosum* L.) during 10-d storage at $25 \pm 2^\circ\text{C}$. The results showed that ACP treatment inhibited the native microbial growth and natural decay of blueberries during the storage period. Meanwhile, ACP treatment also exhibited marked inhibitory effects on the spore germination and mycelial growth of *B. cinerea in vitro*, and gray mold decay in blueberries inoculated with *B. cinerea* during the postharvest storage. In terms of post-harvest quality, short-term (≤ 15 min) ACP treatment has little effect on firmness, pH, redox potential and anthocyanin content, but darkens the color of blueberries, reduces lipid peroxidation, and improves overall postharvest quality. However, the 20-min ACP treatment caused serious oxidative damage to the blueberry peels, resulting in softening of the fruit and decreased anthocyanin content. Moreover, the long-term low temperature storage reduced the abundance and diversity of fungal microorganisms on the surface of blueberries. Taken together, these results have important theoretical significance and practical value in revealing the mechanism of ACP on food preservation, improving the interaction between plasma and surface microorganisms of blueberries.

Keywords: Atmospheric cold plasma, Blueberry, Microbial diversity, Postharvest quality



Effect of Plasma on Arabidopsis Senescence and its Multi-Omics Analysis

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Abstract:

In this study, plasma was applied on *Arabidopsis thaliana* throughout its entire life cycle by irrigation with plasma-activated water or combination with plasma seed treatment. Plasma spectral characteristics during seed treatment and the physicochemical properties of plasma treated water for irrigation were analyzed. Through the measurement of phenotype and nutrition, the effect of plasma application on *Arabidopsis thaliana* in aging stage was investigated. Transcriptomic and metabolomic analyses revealed the significant changes in gene expression and metabolites. These changes contribute to the effect of plasma on the senescence of *Arabidopsis thaliana*.

Keywords: plasma agriculture, multi-omics analysis, *Arabidopsis* senescence



RF and Microwave Plasma Assisted Synthesis of Nanomaterials

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Abstract:

The synthesis of graphene has attracted considerable interest due to its remarkable properties and diverse applications in electronics, materials science, and energy storage. This presentation focuses on the synthesis of graphene using Radio Frequency (RF) and Microwave Plasma techniques, which provide efficient and scalable methods for producing high-quality graphene. The study examines the optimisation of key process parameters—such as power levels, gas flow rates, and substrate temperatures—to achieve uniform graphene layers with desirable structural and electrical characteristics. RF Plasma enables a controlled growth environment, allowing for precise adjustments to plasma properties to enhance graphene's performance. Conversely, Microwave Plasma facilitates rapid synthesis with high energy efficiency under atmospheric conditions, making it suitable for large-scale production. The results demonstrate both RF and Microwave Plasma techniques for the synthesis of highly quality graphene for various applications.



Effect of Cold Plasma on Degree of Substitution and Physicochemical Properties of Fatty Acid-Starch Ester

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Abstract:

The aim of this study is to investigate the effects of cold plasma treatment in preparation for fatty acid-starch ester. It was directly synthesized by cold plasma technology of cassava starch and palm oil in dimethyl sulfoxide (DMSO) solution, which employed argon as gas input. The argon cold plasma is carried out power of 7.6 watts and treatment time in a range of 5 to 60 minutes. Determination of degree of substitution (DS) of synthesis fatty-acid starch ester using proton nuclear magnetic resonance ($^1\text{H-NMR}$). High DS of starch ester was synthesized in 15 min of plasma treatment. Fourier transform infrared spectroscopy (FTIR) confirmed the reaction between -OH groups of starch and -COOH of palm oil, which detected high intensity of ester groups on the samples. Mechanical and water resistance properties of starch/palm oil samples were improved. Cold plasma was an effective method to enhance reaction rate of starch ester synthesis, which reduced reaction time from 24h. to 15 min. Novel starch/palm oil synthesis using cold plasma with high mechanical and water resistance can be applied for single use biodegradable plastic bag application.

Keywords: cold plasma treatment, synthesis, fatty-acid starch ester, cassava starch, palm oil physicochemical properties



Development of a Simple Particle-in-Cell Code to Study Coulomb Explosion of a Hot Spot

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Abstract:

Various studies have shown plausible correlation between localised hot, dense regions (hot spots) observed in z-pinch plasmas and high energy from emission of X-ray, electron beams, ions and neutrons. While the formation of hot spots close to a pinch event, has been studied by many authors, the contribution from Coulomb explosion mechanism of dense positively charged ion cluster resulting from loss of electrons has not been well established. Our work attempts to demonstrate the Coulomb explosion through simulation by developing a Particle-in-Cell (PIC) simulation of a hot spot's Coulomb explosion close to a pinch event. We simulated a hot spot close to the pinch phase within a dense plasma focus (DPF) device by constructing a dense plasma sphere with high temperature against a cylindrical plasma background. We describe the features of our PIC code and report the initial results.



Initial Proton-Boron Tests With FF-2B Dense Plasma Focus

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Abstract:

Experiments with deuterium fill gas have demonstrated that ion energies >200 keV, relevant to pB11 fusion, can be obtained in a dense plasma focus (DPF) device. These observations have motivated LPPFusion's preparations, starting in 2023, for tests of isotopically pure decaborane (B₁₀H₁₄) as a fill gas in the FF-2B DPF. In preparing for the decaborane tests, we redesigned the spark gap switches on the device, reducing their inductance and increasing peak current by over 50% to nearly 2 MA. Tests with deuterium and the new switches demonstrated the need to redesign the beryllium electrodes in order to improve the durability of the anode and to reduce the number of filaments in the current sheath. New theoretical considerations allow us to predict the current per filament required and the effect on yield as current per filament increases. We report here on the initial tests of these improvements with decaborane as the fill gas.

Keyword: Dense plasma focus, nuclear fusion



Efficient Absorption and Sterilization of Nitrogen Fixation Products Using Air Plasma

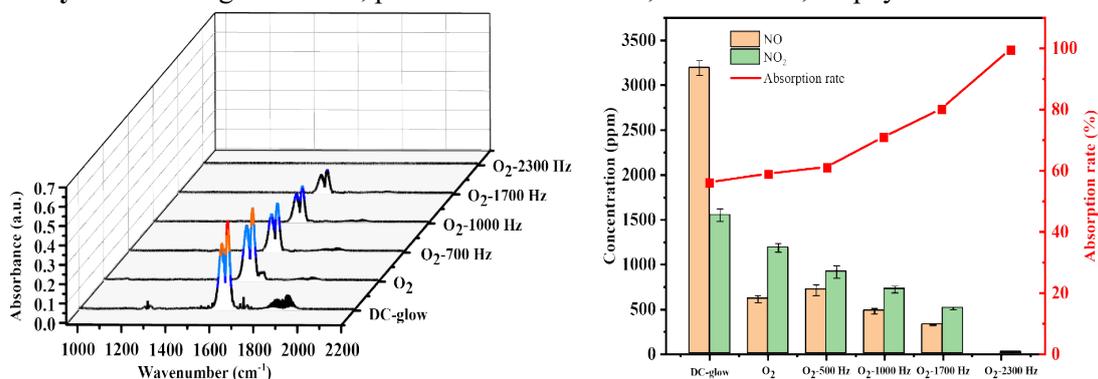
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Abstract:

Air discharge plasma has garnered significant attention as an innovative approach to artificial nitrogen fixation. The nitrogen fixation products generated from air discharge contain various reactive species and are frequently used in the preparation of activated water. In this study, ozone produced by DBD was employed to oxidize the nitrogen oxides produced from air discharge, enabling quantitative oxidation of these species within the mixed gas. The effects of different oxidation states of nitrogen oxides on water absorption efficiency and sterilization capability were investigated. Results demonstrate that by adjusting the DBD discharge frequency to modulate ozone concentration, highly selective gaseous NO_2 and N_2O_5 can be produced. Increasing the oxidation state of nitrogen oxides notably improves absorption efficiency in water, with the absorption rate for N_2O_5 reaching approximately 100% as shown in Figure 1. This indicates that once nitrogen fixation products are oxidized to the N_2O_5 state, complete and rapid recovery of nitrogen oxides can be achieved in a single water pass. Furthermore, increasing the oxidation state of nitrogen oxides decreases the pH of the prepared plasma activated water (PAW) and significantly enhances its conductivity, with only minor variations in redox potential. In sterilization experiments involving *Staphylococcus aureus*, the plasma activated water (PAW) prepared with higher oxidation states of nitrogen oxides significantly reduced bacterial survival rates, with activated water in the N_2O_5 state exhibiting an 81.8% greater reduction in survival than water prepared directly from discharge products. Extending the PAW treatment duration further enhanced sterilization efficiency. This study provides a foundational approach for the rapid absorption of nitrogen fixation products and offers a method for efficiently preparing activated water using air discharge plasma.

Keyword: Nitrogen fixation, plasma-activated water, sterilization, *Staphylococcus aureus*



a) FTIR spectra of exhaust gas

b) exhaust gas components and absorption rate

Figure 1 The influence of DBD discharge frequency on the absorption efficiency

*This work was partially supported by the National Key Research and Development Program of China (No. 2021YFB2401400) and the National Natural Science Foundation of China (No. 52377155).



Insights into Fusion Study from Pulsed Ion Beam Characterization in Hot and Dense Plasma

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Abstract:

Hot and dense plasma, typically with a density of 10^{25} particles/m³ and a temperature on the order of 10^7 °C, produced in a transient manner by pulsed plasma devices such as the plasma focus device, can generate a range of interesting phenomena relevant to fusion research. These devices operate by electromagnetic compression and pinch mechanisms that create extreme plasma conditions conducive to fusion reactions. These conditions make the plasma focus a valuable source of ion-beams, electron-beams, x-rays, and neutrons, offering substantial potential for technological applications. Thus said, the nature of the radiation emission depends on the dynamics of the plasma pinch. The plasma focus device described in this study operates at 2.7 kJ and at low pressures (<1 mbar), rather than conventional pressure of several mbar. The emission characteristics of deuteron beams produced in the plasma focus device were studied, with a focus on beam energy, fluence, and angular distribution. Measurements were made using Faraday cups to determine beam energy and fluence, and CR-39 nuclear track detectors were employed to analyze the angular distribution of deuteron emissions. The largest value of average deuteron energy measured for present conditions was found to be (52 ± 7) keV, and the fluence per shot is of the order of 10^{15} ions/m² at a pressure of 0.2 mbar. The deuteron emission is highly anisotropic, with a predominant forward direction, and shows strong dependence on the operational pressure. These findings provide insight into the dynamics of deuteron production in plasma focus devices, suggesting their potential as a suitable beam target for fusion studies and technological applications involving high-energy ion beams.

Keyword: Plasma focus device, Deuterium, Ion beam, Faraday cup, CR-39



Potential Use of Plasma-Activated Water as Green Fungicides for Wheat FHB Control

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Abstract:

Fusarium graminearum (*F. graminearum*) as the major pathogen for *Fusarium* head blight (FHB) in wheat can cause severe yield loss and secrete mycotoxins to contaminate grain. Herein, this study prepared a novel green fungicide named plasma-activated water (PAW) by only using air, water and electricity via cold plasma activation, and investigated its antifungal effects against *F. graminearum* spores. The *in-vitro* results showed that PAW achieved a 1.98 to 3.98 log reduction of *F. graminearum* spores for treatment times ranging from 30 to 120 min. PAW also efficiently inhibited mycelial growth, spore germination and fungal pathogenicity of *F. graminearum*. Hydroxyl radicals and hydrogen peroxide were identified as the major antifungal agents in PAW, which destroyed the intracellular redox homeostasis and cell membrane of *F. graminearum*, eventually causing cell necrosis. PAW maintained a strong antifungal activity (4 log reduction) at a maximum dilution ratio of 6:4 and storage time of 2 h. The field-plot experiments verified that PAW effectively controlled wheat FHB via decreasing the disease incidence, FHB index, deoxynivalenol contamination and weight loss of wheat grains. The results demonstrated that PAW holds a great potential as an efficient, economical, and green fungicide for FHB control in wheats.

Keyword: Plasma-activated water, green fungicide, *Fusarium graminearum*, reactive oxygen nitrogen species, antifungal mechanism



Cold Plasma Within a Stable Super-Cavitation Bubble – A Breakthrough Technology for Efficient Inactivation of Viruses in Water

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Abstract:

Alternative methods for the inactivation of viruses in water have recently attracted the scientific community's attention. The methods should enable rapid inactivation at room temperature and should be free from chemicals. The application of gaseous plasma fulfills these regulations but may be impractical because plasma sustained at atmospheric pressure is limited to the volume of the large electric field.

A useful method for sustaining plasma at low pressure despite the water being at atmospheric pressure is the application of hydrodynamic cavitation. The saturated water vapor pressure at the water room temperature is established in a stable super-cavitation bubble of volume several cm³, and the electrodes are immersed into a bubble and powered with a suitable voltage supply to sustain the non-equilibrium gaseous plasma in a glow discharge mode. Plasma sustained in water vapor at the pressure of a few 10 mbar is a rich source of OH radicals, which are dissolved in the liquid. The high speed of liquid water passing the cavitation nozzle enables optimal mixing, so a few passages of water enable the inactivation of viruses for 5 decades by an irreversible interaction of OH radicals with organic matter. The water pH does not change significantly, and the concentration of hydrogen peroxide remains below 1 mg/L, so the effect of H₂O₂ on virus inactivation is marginal. The preferred discharge power is between 10 and 100 W. The plasma treatment did not generate cytotoxic intermediates, which was proved by the MTS assay where the human hepatocellular carcinoma cell line was probed.

Keywords: Non-equilibrium gaseous plasma, water, OH radicals, virus inactivation, plasma sterilization, human hepatocellular carcinoma cells



Deposition of Smooth AlGa_N Thin Film on Silicon Substrate using Magnetron Sputtering Plasma Technique

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Abstract:

Aluminium gallium nitride (AlGa_N) is an alloy that made up from two compound of AlN and GaN. AlGa_N ternary alloy is used as thin films in high power devices to improve physical performance at small scale. AlGa_N growth usually using higher temperature fabrication technique to obtain high crystalline quality. High temperature processing is not entirely compatible with industrial back-end processes, which prevents the usage of III-nitrides layers in many microelectronics applications. Thus, attempts have been made to deposit AlGa_N at lower processing temperature. Since the conventional MOCVD and MBE growth of AlGa_N require high temperature process (above 1000 °C), the magnetron sputtering technique is one of the potential methods that could be deposit AlGa_N at lower processing temperature. AlGa_N thin films with high crystallinity deposited using the co-sputtering method between RF magnetron sputtering and HiPIMS was successfully done at room temperature. The parameters of the sputtering varied were nitrogen concentration, sputtering pressure and RF power at GaN target. All these parameters give huge influence in the AlGa_N thin films deposition at room temperature using magnetron sputtering technique. The growth of the AlGa_N thin films using the co-sputtering technique can be controlled using the nitrogen concentration, sputtering pressure and RF power. Thus, the optimal growth process needs to acquire moderate nitrogen concentration at 30 %, lower sputtering pressure at 3 mTorr and RF power at 30 W to obtain AlGa_N thin films with good crystal quality. Plus, AlGa_N films also possess the optimal electrical properties which is suitable for the future device application.

Keyword: Aluminium gallium nitride thin film, magnetron sputtering plasma



Characteristics of 10 kW RF High-Density Helicon Plasma Source for PMI Experiments

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Abstract:

High-density linear plasma devices can produce plasmas similar to those of Tokamaks, but they are simpler, more compact, and more cost-effective for plasma-material interaction (PMI) research. In this study, we fabricated a linear helicon plasma device using permanent magnets and electromagnets. The device employs a half-turn helical antenna and 13.56 MHz RF to excite helicon waves in the $m = +1$ mode [1-4]. The magnetic field, uniform at 800 G near the antenna, along with Ar gas, was used for plasma discharges. Electron temperatures and plasma densities were measured using optical emission spectroscopy (OES) and a Langmuir probe. With RF power up to 10 kW, high-density plasmas exceeding 10^{13} cm^{-3} were achieved, and electron temperatures ranged from 1 to 5 eV. This newly developed linear helicon plasma device is excellent for PMI studies and crucial for developing fusion-related materials. The ion fluence, similar to that of the plasma-facing wall in Tokamaks, can also be investigated.

Keywords: RF plasma, helicon wave, PMI, high-density plasma, fusion plasma

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Correlation Between Reaction Field Diagnostics and Carbon Products in Solution Plasma Synthesis

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Abstract:

In this study, we investigate the relationship between reaction field diagnostics and the properties of carbon products synthesized via solution plasma (SP) for the production of highly nitrogen-doped and crystalline hetero-carbon materials. Multivariate analysis was employed to elucidate the SP process and its impact on the characteristics of the carbon products. Reaction field diagnostics—including optical emission spectroscopy (OES), gas chromatography-mass spectrometry (GC-MS), and electrostatic potential measurements—were utilized to analyze the plasma environment comprehensively. These diagnostics were correlated with product characterizations such as X-ray diffraction (XRD), Raman spectroscopy, and X-ray photoelectron spectroscopy (XPS). Our findings reveal significant correlations between plasma parameters, intermediate products, and the final carbon material properties, particularly nitrogen content and crystallinity. This comprehensive approach provides valuable insights into the mechanisms governing the formation of highly N-doped and crystalline carbon materials in SP, offering a foundation for tailoring synthesis conditions to achieve desired product characteristics.

Keyword: Solution plasma, reaction field diagnostics, nitrogen-doped carbon, multivariate analysis, plasma-material interactions



NO_x Production for Nitrogen Fixation through DC Glow Discharge

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Abstract:

Atmospheric-pressure DC glow discharge is a common and easily accessible method for generating warm plasma. In recent years, as research on air plasma nitrogen fixation has deepened, this form of discharge has gained significant attention. Atmospheric DC glow or glow-like discharges serve as the fundamental form for many other discharge types, such as sliding arcs, air jets, and rotating arcs. Its stability and ease of control make it ideal for studying the mechanisms of NO_x production in warm plasma-based nitrogen fixation. This report presents a series of studies on the characteristics of NO_x production through DC glow discharge, revealing that the optimal conditions for NO_x generation were a discharge current of 35-45 mA and a gap distance above 8 mm. Higher gas flow rates (1-15 l/min) reduced energy costs, but this effect leveled off beyond 5-10 l/min. The use of Al₂O₃ catalyst improved efficiency at low flow rates (<5 l/min) when positioned near the plasma zone, achieving a significant reduction in energy costs, up to 45%, especially at a discharge current of 70 mA. The lowest energy cost achieved was 2.8–3.5 MJ/mol. It was also found that a floating Al₂O₃ catalyst, stabilized by a neodymium magnet, could further improve efficiency, making this catalytic method a highly promising approach for plasma-coupled NO_x generation in nitrogen fixation. Additionally, it was found that different metal cathodes influence the energy efficiency of plasma nitrogen fixation. Iron and 304 stainless steel cathodes exhibited a shift in discharge mode, reducing energy costs by up to 40% at 80 mA due to the role of iron oxide in lowering discharge voltage. This suggests that optimizing cathode materials can enhance plasma nitrogen fixation efficiency.

Keyword: Atmospheric-pressure DC glow discharge, Nitrogen fixation, NO_x production, Al₂O₃ catalyst, Energy cost

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Optimizing Therapeutic Efficacy of Nightingale® Plasma-Activated Ringer's Lactate with Cannabidiol Nanoemulsion for Targeted Lung Cancer Cytotoxicity

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Abstract:

Non-thermal plasmas offer a wide range of biomedical applications due to their unique ability to generate reactive oxygen and nitrogen species (RONS), both directly and indirectly. Nightingale®, a non-thermal air plasma device, adheres to IEC standards and holds CE certification, ensuring its safety for medical use. In this study, Nightingale® was utilized to activate lactated Ringer's injection (LRI) for *in vitro* inactivation of lung cancer cells, specifically A549 and H1299. Emission spectra analysis confirmed that Nightingale® produced N₂, OH, H α , and O species. Plasma-activated Ringer's injection (PA-LRI) under optimal conditions (PA3-LRI: 3 min, 111.6 J) resulted in significant cell death in lung cancer cells (A549: 59.4%, H1299: 20.4%) with minimal effect on normal WI-38 cells (10.5%).

The optimized cannabidiol nanoemulsion (CBD-NE) demonstrated enhanced stability and dose-dependent cytotoxicity against lung cancer cells. Combining PA3-LRI with 2 μ M CBD-NE further amplified anti-tumor effects (A549: 78.7%, H1299: 45.1%), while protecting normal cells (<5.6% mortality), suggesting that CBD mitigates the effects of RONS. This study showcases the potential of PA-LRI and CBD-NE as effective strategies for selective lung cancer treatment.

To our knowledge, this is the first investigation of the synergistic cytotoxic effects of PA-LRI and CBD-NE on lung cancer cells. Our findings open new avenues for integrating plasma and nanotechnology in medicine, with potential clinical applications. Further research is necessary to explore the mechanisms of CBD and the combined cytotoxic effects of PA-LRI and CBD-NE on tumors. *In vivo* studies involving various cancer cell types are crucial for advancing these promising therapies.

Keyword: Nightingale®, non-thermal compact air plasma jet, plasma-activated lactated Ringer's injection, cannabidiol nanoemulsion, lung cancer cells



DBD Plasma-based UV-C Excimer Light Sources for Health and Environmental Applications

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Abstract:

To render unwanted or harmful microorganism's incapable of reproducing, the ultraviolet light is very useful in our daily life. Ultraviolet (UV) light is a spectrum of light just below the range visible to the human eye. The UV light is divided into four distinct spectral areas and they are Vacuum Ultraviolet (VUV) (100–200 nm), UV-C (200–280 nm), UV-B (280–315 nm) and UV-A (315–400 nm). These spectral areas are very specific. The UV-C radiation from 200–280 nm is highly useful to inactivate a wide range of microorganisms based on DNA absorption capacity in this range. This spectral range can be further utilized in advanced oxidation processes (AOPs) to generate reactive species like hydroxyl radicals ($\bullet\text{OH}$) to oxidize organic and inorganic contaminants in water and wastewater.

For the UV-lamps used in water purification, the environmentally hazardous mercury is used for generation of UV light radiation peaking at germicidal wavelength 254 nm. Also, at present mercury based light sources including fluorescent lamps dominate the market of UV lamps and about 1.5 billion UV lamps are produced each year world-wide. These light sources contain varying amounts of mercury. The low-pressure UV lamps contain ~5-50 mg of mercury per lamp whereas low pressure high output lamps contain ~26-150 mg of mercury per lamp, and medium pressure lamps contain ~200-400 mg of mercury per lamp. As a consequence, at the end of the lamp life a considerable amount of "undesirable" toxic waste is generated. Furthermore, when we look for the wastewater discharged from the textile industry contains approximately 15% unfixed dyes, predominantly 60–70% azo dyes, which pose significant environmental and health risks due to their persistence and potential toxicity. Also, organic micropollutants (OMPs) have become common causes of pollution and have attracted considerable attention in recent years due to their extensive environmental consequences.

To mitigate the issue, in the recent decades, dielectric barrier discharge (DBD) plasma-based excimer/excimer sources are being researched in generating UV-C (230–280 nm) and far UV-C (200–230 nm) light radiations. In the present work, DBD-based far UV-C (KrCl^*) and UV-C (XeI^*) excilamps with a very narrow and intense spectrum peaking at a wavelength of 222 nm and a wide band 253 nm, respectively, in the UV-C range have been designed and developed and the same are effectively utilized for the health and environmental applications. Results of these efforts will be presented.



Comparative Study of Dielectric Barrier Discharge and Microwave Plasma-Activated Water for Food Preservation and Agricultural Applications

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Abstract:

This study presents a comparative analysis of the properties and applications of plasma-activated water (PAW) produced using dielectric barrier discharge (DBD) and microwave (MW) plasma. The reactive species and radicals generated by both methods were identified through optical emission spectroscopy. PAW was characterized by measuring its acidity, conductivity, and oxidizing potential. Additionally, key reactive species in the water, such as nitrate (NO_3^-) and nitrite (NO_2^-) ions, dissolved ozone, and hydrogen peroxide, were quantified. The resulting PAW was tested for its effectiveness in food preservation, seed germination, and plant growth applications.

The findings revealed that PAW generated via DBD plasma exhibited a higher oxidizing potential due to the presence of dissolved ozone and hydrogen peroxide, which were absent in MW-produced PAW. On the other hand, PAW produced using MW plasma demonstrated significantly higher electrical conductivity and a greater concentration of inorganic ions, including NO_3^- and NO_2^- , compared to DBD-generated PAW.

Due to its higher oxidizing potential, DBD-generated PAW was more effective at controlling foodborne microbes, extending food shelf life, and enhancing seed germination. Conversely, the higher nitrogen content in MW-produced PAW resulted in improved agronomic traits in plants grown using this water.

Keyword: Plasma Activated Water, DBD plasma, MW plasma, reactive oxygen-nitrogen species, food preservation, agriculture



Ultra-fast and Ultra-thin High sp^3 Content Carbon Coating Using High Energy Density Plasma

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Abstract:

The hard disk drive (HDD) industry has ushered into a new era with new magnetic data storage technology - Heat Assisted Magnetic Recording (HAMR), as Seagate started shipping 20 TB HAMR drives in December 2020 and successfully rolled out Mozaic 3+ HAMR drives with more than 3 TB per platter in the first quarter of 2024. The HAMR based HDD has an areal density of about 2 Tb/inch², with potential to push the areal density beyond 4 Tb/inch². One of the main challenges to do so is the deposition of carbon overcoat (COC) with key parameters: thickness of ~1 nm, high sp^3 content (>30%), particle-free (<5 particles), high thickness uniformity and without pinholes. The key technologies currently used for COC deposition, however, are unable to do so. In this presentation, we report the successful development of an alternative deposition technology using a high energy density plasma device to deposit ultra-thin carbon thin film on magnetic media platter with high uniformity and high sp^3 content. For this purpose, we specifically developed a large-volume-slow-focus-mode dense plasma focus (LVFSM-DPF) device, by deliberately designing the DPF with large external inductance to slow down its pinch phase, to achieve heat assisted magnetic media (HAMR) relevant ~1-1.2 nm thick, large area (65 mm diameter), highly uniform COC with >50% sp^3 content in a single sub-second duration DPF shot.

Keywords: High energy density pulsed plasma; carbon overcoat deposition technology; magnetic media protection; high sp^3 content



Enhanced Methane Dry Reforming via Microwave Plasma-Catalysis Using Mesoporous Ni/Al₂O₃ Catalysts Derived from MIL-53(Al)

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Abstract:

This study explores the fabrication and performance of mesoporous Ni/AlO₃-based catalysts, derived from MIL-53(Al), for the microwave plasma-catalytic dry reforming of methane (DRM). A series of Ni_x/AlMIL catalysts (where x ranges from 0 to 20 wt%) were synthesized using a facile incipient wetness impregnation method, addressing limitations in surface area and active site distribution. The catalytic efficiency was enhanced by doping the catalysts with calcium (Ca) and potassium (K), improving basicity and reducibility. Optimal catalytic activity was achieved with a composition of 5.00 wt% Ni and 2.50 wt% Ca, resulting in CO₂ and CH₄ conversions of up to 53% and 43%, respectively, with high selectivities for CO (57%) and H₂ (90%). Under low-pressure microwave plasma, the Ni₅Ca_{2.5}/AlMIL catalyst exhibited the highest efficiency in sustainable hydrogen-rich syngas production, with significant synergistic effects. Factorial design analyses further highlighted relationships between catalyst properties and DRM performance, suggesting promising applications for porous Ni/AlO₃ in scalable plasma-catalytic processes

Keyword: plasma-catalytic, microwave plasma, dry reforming of methane (DRM), calcium loading, MOFs-derived porous Al₂O₃, Ni-based catalyst



Agri-plasma Applications in Seed Germination (Pre-harvest) and Related Patents

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Abstract:

This study presents an investigation into the potential of agri-plasma technology, emphasizing its effects on seed germination and their related patents. The research is organized into two main sections: the first explores the science behind plasma treatment, showcasing significant results from experiments using water, oxygen, and argon gas plasmas on Bambara groundnuts, chili, and papaya crops. These findings highlight plasma treatment's positive impact on seed germination and associated changes. Analytical methods, including optical emission spectroscopy, X-ray photoelectron spectroscopy, and ageing studies, provide indepth insights into plasma-induced modifications and the long-term effects on seed viability and plant development.

The second part of this study explores patents related to agri-plasma technology, utilizing <http://www.lens.org> and CPC classification (class_cpc.symbol: A01C1/00)¹ with specific terms in titles, abstracts, and claims (e.g., "ion") to refine the search for patents on agri-plasma treatments and ionization for enhancing seed germination and pesticide effects. This classification reveals a growing trend in patent filings (Fig. 1: top), with the majority of patents originating from China, the USA, Europe, Canada, and Japan (Fig 1: bottom). The analysis here: <https://link.lens.org/LxWwTk5Q3U>

A patent cluster map, shown in Fig. 2, highlights five primary areas of agri-plasma advancements in 2024. This map was generated using the Amplified.ai database, a large language model-based tool (paid database), which builds on EP patent EP4108325A1 as foundational "seed" patents and iteratively identifies related patents in the 150 million patents available in the database.²

In conclusion, the experimental findings on agri-plasma technology in Part One are strongly supported by the patent analysis in Part Two, indicating a rising global interest and increase in patent filings in this field validating the potential of using plasma technology to treat seeds prior to planting.

Keyword: seed germination, low pressure plasma, atmospheric pressure, patent filing, large language model.

Reference

1. CPC A01C1/00 was given to "apparatus, or methods of use thereof, for testing or treating seed, roots, or the like, prior to sowing or planting"
2. These related patents are available upon reasonable request from the author.



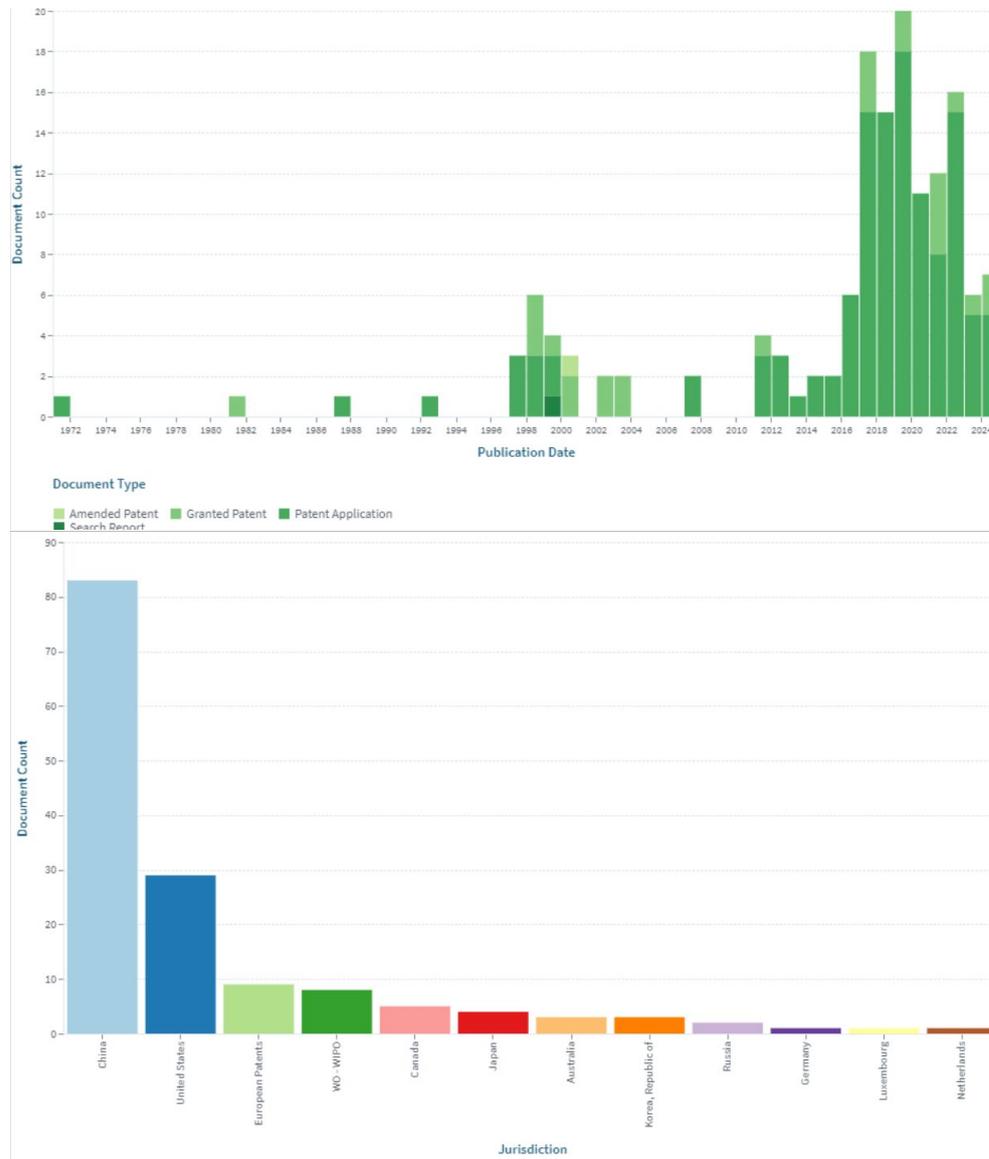


Fig.1 (top): number of patent filing using agri-plasma related patent classification
 Fig 1 (bottom): top 12 patent filing jurisdictions.

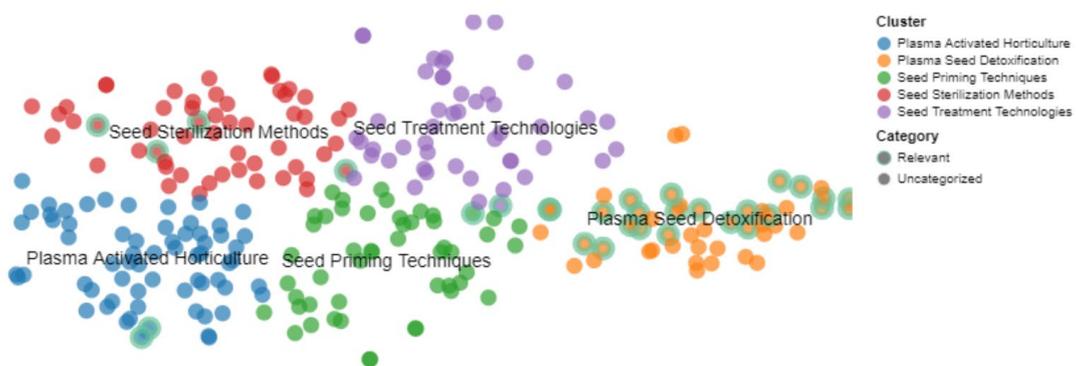


Fig 2: Amplified.ai generated patent map showing the major clusters related to this agri-plasma area.



High Count-Rate Neutron Detectors for Plasma Fusion Studies using Lithium-6 Scintillators

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Abstract:

High count-rate prompt neutron detectors enable the short-timescale neutron flux for tokamaks and other plasma fusion devices to be investigated. Shot-to-shot neutron yields for high repetition rate (~10 Hz) Plasma Focus devices can also be studied. Neutron activation detectors are not suited to this purpose. Hence, we are developing neutron detectors based on the scintillators GS20 and LiCAF(Ce), of thickness 1 and 2 mm, respectively. These two scintillators have high lithium content; isotopically enriched to 95% ${}^6\text{Li}$. The thinness of these scintillators affords a low sensitivity to gamma-rays, whilst still capturing neutrons efficiently due to their high concentrations of ${}^6\text{Li}$. The requisite ${}^6_3\text{Li}(n, t){}^4_2\text{He}$ reactions produce prompt scintillation pulses for the capture of slow/moderated neutrons. To test and develop data analysis methods for these detectors, the deuterium (D_2) filled UNU Plasma Focus is employed as a $\sim 10^8$ neutron burst source. Two methods of data acquisition are investigated: (i) Digital Storage Oscilloscope capture of photomultiplier anode signal followed by offline processing, and (ii) 500 MHz sampling, 14-bit ADC digital pulse processing (Caen DT5730SB) unit for real-time analysis. Both scintillators exhibit good discrimination against background gamma-rays, although GS20 is better in this respect. Processing of signals exhibiting a significant amount of pulse pile-up is a particularly challenging situation for this technique. However, unless pulse pile-up is excessive, satisfactory processing can be achieved. In conclusion, both GS20 and LiCAF(Ce) detectors are found to be capable of high neutron rate measurements for plasma fusion devices.



Investigating Electron Temperature and Plasma Density Using a Propagation Speed Model for Ar Plasma in Atmospheric Pressure Micro-DBD

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Abstract:

A plasma propagation velocity-based model had recently been developed to estimate the electron temperature (T_e) in atmospheric pressure micro-DBD (μ -DBD) plasma. In this study, we extend this model to calculate T_e for plasma generated with argon (Ar) gas. The plasma was generated using an input discharge voltage of 2.7 kV at a driving frequency of approximately 45 kHz. A high-speed, single-frame intensified charged-coupled device (ICCD) was employed to capture time- and space-resolved discharge images and to estimate the plasma propagation velocity (u_g). The u_g for Ar plasma was determined to be around 6.2×10^3 m/s. From this, the electron temperature was calculated, with an average value of approximately 1.18 eV. Additionally, the average plasma density was found to be about 3.62×10^{14} cm⁻³ for Ar plasma. These results, obtained using a modified convective-wave packet model, present a new contribution to the field of plasma medicine.

Keywords: Atmospheric-pressure μ -DBD plasma, Ar plasma, plasma propagation speed, electron temperature, plasma density



Plasma Cracking of Methane for Carbons

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Abstract:

This presentation explores the synthesis and application of plasma-generated carbon materials via methane cracking, with a focus on their role in hydrogen storage and energy applications. Plasma reactors offer an efficient and scalable approach to splitting methane, producing unique and high-value carbon structures. Notably, carbon nanotubes can be created in plasma reactors through the use of catalysts. The study highlights the benefits of using plasma carbon as a matrix for stabilizing nanoparticles, preventing agglomeration, and improving hydrogen storage performance. Key parameters of the plasma reaction process have been investigated to understand their impact on the performance and structure of the produced carbons. The addition of carbon materials, including plasma carbon (PC), activated carbon, and carbon nanotubes, to Mg-based composites significantly enhances dehydrogenation kinetics, with PC showing the most notable results. These findings underscore the effectiveness of plasma carbon in lowering dehydrogenation temperatures and improving hydrogen desorption rates. Future directions will focus on optimizing plasma technology for hydrogen production and seeking collaborative efforts to advance sustainable energy solutions.

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Transformative Benefits of Plasma Techniques in Value-Adding Processes

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Abstract:

Plasma technology has gained significant attention due to its diverse applications in material processing. These plasma systems are known for their simplicity, speed, cost-effectiveness, user-friendliness, and safety. This talk will share insights gained from the use of custom-built plasma systems for value-added processes. Implementing a modular open systems architecture in plasma device design enables customization, modularity, and flexibility at lower costs. Both atmospheric and subatmospheric plasma systems are designed and assembled to process various materials, focusing on treating natural and indigenous materials. Plasma treatment enhances certain characteristics of cellulosic materials without altering their bulk properties, improving processability, such as solubility and compatibility. The continuous development and advancement of versatile and reconfigurable plasma systems has been shown to improve the understanding of how gas discharges interact with surfaces to improve material processing technologies.

Keyword: plasma, surface modification



The Gas Production Characteristics and Mechanism of Mineral Transformer Oil Decomposition Under Discharge Plasma

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Abstract:

Discharge plasma is a promising way to utilize mineral transformer oil to produce hydrogen, methane, acetylene, ethylene, and ethane under room temperature and atmospheric pressure. Repetitive pulse discharge is preferred to improve energy efficiency, but the decomposition characteristics and gaseous production path of mineral transformer oil under repetitive pulse discharge are still unclear. Based on gas chromatography (GC) and optical emission spectroscopy (OES), the process and products of mineral transformer oil under repetitive pulse discharge are discussed. The experiment results show that the gas production proportion of H₂ decreases while the gas production proportion of C₂H₂ increases with the reaction time increases. Besides, the gas production proportion of C₂H₂ generated by 1000 Hz repetitive pulse spark discharge is much more than 10 Hz. Despite lower single pulse energy at high repetitive pulse discharge, the continuous dehydrogenation process of C₂H₄ and C₂H₆ is the main path of C₂H₂ production. The H α in OES is the highest intensity, and the electron density decreases as the repetitive pulse frequency increases. The experimental results are confirmed by chemical kinetics and molecular dynamics simulation. Based on these results, the possible reaction mechanism of mineral transformer oil under spark discharge was discussed. This work confirmed the feasibility of pulse repetition adjustment on the C₂ selectivity of mineral oil decomposition under discharge plasma, which provided a reliable method for H₂ and C₂H₂ production.



Dissecting the Molecular Mechanisms of Potential Cold Atmospheric Plasma-Based Pathogen Defense

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Abstract:

Cold Atmospheric Plasma (CAP) has gained increasing attention capable of addressing a broad spectrum of biological and medical challenges, including pathogen eradication, biofilm dispersal, viral infection prevention, and tissue regeneration. Our research focuses on unraveling the molecular mechanisms underlying CAP's multifaceted effects, specifically through the use of plasma-activated medium (PAM) and plasma-activated water (PAW). CAP-generated microplasma bubbles, a highly efficient method for producing PAW, have been demonstrated to effectively disperse robust microbial biofilms, overcoming the inherent resistance of biofilm-embedded pathogens to conventional treatments. In addition, CAP and PAM have shown significant potential in antiviral defense, particularly against viruses that use the ACE2 receptor for entry, such as coronaviruses. The reactive species generated by CAP can disrupt viral particles and inhibit their replication, offering a novel approach to prevent viral infections at the molecular level. PAM-triggered immunomodulation and enhanced autophagic activity in periodontal regeneration highlight CAP's capacity to promote tissue healing while controlling infections. The generation of reactive species through PAW/PAM further supports CAP's role in initiating cellular responses, expanding its application across diverse biological settings. By dissecting these molecular pathways, our research provides critical insights into the mechanisms by which CAP exerts its therapeutic effects, thereby laying a robust foundation for facilitating the clinical translation of plasma-based medical technologies.

Keywords: Cold Atmospheric Plasma (CAP), pathogen defense, plasma-activated medium (PAM), plasma-activated water (PAW), immunomodulation, underlying molecular interactions



Nanostructures Fabricated and Processed by Plasma Electrochemistry

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Abstract:

Plasma-driven solution electrochemistry (PDSE) has become a competitive technique for material fabrication and processing in the past few decades. Their applications have still been exploring to new areas. Few applications have been reported in construction materials. Also, for PDSE, the controlled nanostructure fabrication is still a big challenge due to its limited fundamental understanding. Here, two works will be reported. Firstly, the effect of gas flow rate (0.25, 0.4, 0.8 and 1.2 NL/min) on silver nanoparticles synthesized by PDSE will be discussed. With the optimized flow rate at 0.8 NL/min, pure Ag nanoparticles (Ag NPs) are fabricated with the best surface plasmon resonance property, while samples synthesized by other flow rates show impurities of silver oxides (Ag₂O and Ag₂O₂). The H₂O₂ formation in liquid phase affected by the gas flow rate is found to be one of the main reasons for the eliminated silver oxides and the fabricated pure Ag NPs. Secondly, the improved mechanical properties of cement net slurry by plasma-activated water (PAW) with PDSE treatment will be discussed. The effect of treatment duration (0, 2, 20 and 60 min) on the PAW properties and the mechanical properties of the related cement net slurry were studied. The highest enhancement rate of the compressive strength reaches ~51% by PAW with 60min PDSE treatment. The improvement might be benefited from the additional single water molecules and the more alkaline PAW.

Keyword: Plasma electrochemistry, plasma-activated water, Ag nanoparticles, cement net slurry, construction materials



Enhanced Adsorption of Malachite Green (MG) Dye using RF Glow Oxygen Plasma-Modified Coconut Carbon Shell: A Sustainable Approach for Water Treatment

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Abstract:

The textile industry produces dye pollutants that are both harmful and difficult to degrade. This study explores the enhanced adsorption of Malachite Green (MG) dye using coconut carbon shells treated with RF glow oxygen plasma discharge. Plasma treatment improved the surface properties of the adsorbent by introducing oxygen-containing functional groups and increasing surface polarity, which boosted dye adsorption through hydrogen bonding, electrostatic interactions, and π - π stacking. Experimental results revealed that a 10-minute plasma treatment optimally enhanced adsorption capacity by 39% compared to untreated samples. The Langmuir isotherm model demonstrated a maximum adsorption capacity (q_m) of 161 mg/g, surpassing the Freundlich model. At pH 8, using 0.2 g of adsorbent in 50 mL solutions with initial dye concentrations of 25 mg/L and 100 mg/L, the 10-minute plasma-treated samples achieved adsorption capacities of 6.01 mg/g and 23.95 mg/g, respectively, compared to 4.72 mg/g and 17.2 mg/g for the untreated samples. This corresponded to removal efficiencies of 96.12% and 95.8% for the treated samples, and 75.6% and 68.8% for the untreated samples, after 80 minutes of contact at 200 rpm. UV-vis spectrophotometry confirmed the reduction in dye concentration after adsorption. FE-SEM analysis revealed that plasma treatment created micro-pores on the coconut carbon shell, enhancing adsorption capacity, while SEM-EDX analysis showed increased oxygen content after 10 minutes of treatment. FTIR analysis identified additional carbonyl (-C=O) and hydroxyl (-OH) groups, indicating the incorporation of oxygen-containing functional groups due to plasma treatment. Confocal Raman microscopy was also used to analyze the microstructural changes in the samples.

Keyword: RF glow discharge, oxidation, adsorption, coconut carbon shell, and plasma treatment.



Low-Temperature Plasma for Algal Treatment and Water Quality Improvement

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Abstract:

Algal bloom has become a serious pollution issue that jeopardizes ecological environment and the safety of human drinking water worldwide. Numerous treatment approaches have been developed for the disposal of algae, but still suffer from either high cost or secondary environmental pollutions. Herein, we report on a low-temperature plasma treatment system for the inactivation of *Spirogyra* and enhancement of water quality. Experiments were conducted in a square fish pond (10 m × 3 m × 0.7 m) and a glass aquarium (0.285 m × 0.245 m × 0.483 m). The system demonstrates stable operation at low power consumption (130 to 160 W) for over two weeks during the fish pond treatment, facilitated by the efficient cooling structure. Over a period of three days, the *Spirogyra* were inactivated as the system operated at a power output of 150 W. In the water within 1-meter radius surrounding the device, *Spirogyra* exhibited gradual withering and color change from vibrant green to yellowish-brown, accompanied by reductions in chemical oxygen demand (COD) from 23 mg/L to 10 mg/L and ammonia nitrogen concentration from 0.54 mg/L to 0.30 mg/L during two weeks of treatment. Additionally, we collected 25 L algal water from the pond and treated it in the aquarium for 84 hours. The inactivation process of *Spirogyra* was characterized by a gradual disintegration of aggregated clusters into individual filaments, a color shift from vibrant green to white, with cellular structures destroyed and intracellular contents oxidized. COD and ammonia nitrogen concentration slightly increased at first but exhibited a declining trend at the end of treatment. Under the reactive oxidation of low-temperature plasma, *Spirogyra* cells are disrupted and even degraded, while also improving the water quality. Overall, this proposed strategy could provide an efficient, low-energy and eco-friendly approach to algal bloom treatment.

Keywords: Low-temperature plasma, algal bloom treatment approaches, *Spirogyra*, water quality improvement



Enhancing Myoblast Cell Proliferation through Cold Plasma Jet Stimulation as a Foundational Approach for Alternative Protein Production

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Abstract:

This study aimed to enhance cell proliferation under plasma stimulation conditions, specifically in myoblast cells. Although cell behavior may vary, we identified the optimal plasma parameters to promote myoblast growth using a full factorial experimental design. Four key factors—plasma power, electrode gap, gas flow rate, and discharge time—were systematically examined across 37 experiments. The optimal conditions for maximum proliferation were found to be a plasma power of 0.28 W, a gas flow rate of 3 L/min (with 0.63 L/min of O₂ and 2.34 L/min of N₂), a discharge duration of 1 minute, and an electrode gap of 2 cm. Under these conditions, a significant increase in myoblast cell proliferation was observed, with a minimal cell count reduction of 9.54% compared to the control group. Fluorescence imaging confirmed these findings, highlighting the potential of cold plasma as a tool for stimulating myoblast proliferation, with potential implications for tissue engineering and biological applications.

Keywords: Myoblast Cell, Plasma Jet, Cell Proliferation, Alternative Proteins



Advancements in Aluminide Coatings Via Plasma-Based Techniques

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Abstract:

Aluminide coatings have gained significant attention in various high-temperature applications due to their excellent oxidation and corrosion resistance. Recent advancements in aluminide coating techniques, particularly through plasma-based methods, have led to enhanced performance and durability. This abstract discusses the integration of hot dipping processes assisted with plasma oxidation heat treatments for fusion blanket applications. 9Cr-1Mo (P91) steels are renowned for their high creep resistance, making them essential in power plants and demanding industrial applications. The integration of aluminide coatings significantly enhances the service life of P91 steels, particularly in sectors such as petrochemical, automotive, and nuclear energy, including fusion reactor test blanket modules. These modules operate under challenging conditions, including the flow of Pb-Li at temperatures of 350-450 °C, neutron irradiation, and tritium generation, which pose critical challenges such as liquid metal corrosion and tritium permeation. To address these issues, this study explores the application of an aluminide coating (FeAl) combined with Al₂O₃. The coatings were developed using a hot-dipping process in a molten bath of Al-7%Si, followed by a glow discharge plasma oxidation process on the P91 steel substrate. The formation of a stable alumina layer is crucial, given the metastable phases of alumina (α , θ , κ , and γ). The O* species generated during the plasma treatment played a vital role in stabilizing the alumina layer, achieving a thickness of approximately 3-5 microns. Characterization techniques, including X-ray diffraction, cross-sectional scanning electron microscopy (SEM), and microhardness testing, were employed to assess the coating's structural and mechanical properties.

Similar studies have been explored for nickel-based superalloys, like Inconel 690, which are critical in nuclear waste management but face challenges such as high-temperature corrosion and premature degradation. This part of the study explores the effectiveness of hot dipping aluminizing followed by plasma-assisted heat treatment on Inconel 690, focusing on microstructure, phase transformation, and microhardness. X-ray diffraction confirms the formation of stable α -Al₂O₃ in plasma-treated samples, while thermally treated samples show metastable θ -Al₂O₃. Microstructural analysis reveals the presence of NiAl and α -Al₂O₃ layers in plasma-treated samples, mitigating intergranular embrittlement observed in thermally treated ones. These findings highlight the potential of plasma-assisted aluminizing to enhance durability in nuclear applications.



Modelling of Plasma-Bioaerosol Interactions

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Abstract:

Low-temperature plasma is a promising technique for bioaerosol decontamination and air disinfection. However, the interactions of plasmas with bioaerosols are far from understood. Based on the difference in germicidal mechanism, plasma species can be divided into charged particles and chemical species. In this study, the aerosol charging process in a dielectric barrier discharge (DBD) plasma was numerically studied by a plasma fluid model, and a 2D CFD model was coupled with the plasma model to track the motion of the aerosols in an air duct. For the chemical species, a 0D plasma model and a 2D CFD model were coupled to obtain the spatiotemporal evolution of the chemical species. Finally, a multi-species bioaerosol inactivation kinetic model was proposed considering both ionic and chemical species. These models can be applied to design proper DBD structures for effective removal and inactivation of bioaerosols.

Keyword: Plasma, bioaerosol, dielectric barrier discharge, modelling



Gas-Liquid Discharge Plasma for CO₂ Reduction into Oxalic Acid

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Abstract:

By inducing CO₂ pulse discharge within micro-channel bubbles and regulating thus-forming plasma microbubbles, we observe high-performance, catalyst-free co-formation of hydrogen peroxide (H₂O₂) and oxalic acid directly from CO₂ and water. With isotope-labeled C¹⁸O₂ as feedstock, peaks of H₂¹⁸O¹⁶O and H₂¹⁶O₂ observed by *ex-situ* surface-enhanced Raman spectra (SERs) indicate that single-atom oxygen from CO₂ dissociations and H₂O-derived OH radicals both contribute to H₂O₂ formation. The global plasma chemistry modeling suggests that high-density, energy-intense electron supply enables high-density CO₂(aq) and HCO₂(aq) formation and their subsequent coupling to produce oxalate. The enhanced solvation of CO₂, facilitated by the efficient transport of C₂O₂ ionic species and CO is demonstrated as a crucial benefit of spark discharge interacting with water at the bubble interface. We expect this plasma microbubble approach to provide a novel power-to-chemical avenue to convert CO₂ into valuable H₂O₂ and oxalic acid platform chemicals, thus leveraging renewable energy resources.

Keywords: Cold plasma, carbon dioxide reduction reaction, hydrogen peroxide, oxalic acid, carbon coupling



Oral Talk : Abstract

Synergistic Plasma-Catalyst Approach for CO₂ Decomposition: Optimizing Energy Efficiency with NiCo-CuO Catalysts

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Abstract:

Rising CO₂ emissions present a critical environmental challenge, demanding innovative solutions for CO₂ reduction. Plasma catalysis, which combines non-thermal plasma with advanced catalytic materials, has emerged as a highly promising approach for addressing this challenge. This study focuses on the renewable conversion of CO₂ into CO, a valuable feedstock, by utilizing a dielectric barrier discharge (DBD) plasma reactor under ambient conditions, in combination with metal-supported copper oxide catalysts (Ni-CuO, Co-CuO, and NiCo-CuO). Systematic analysis revealed that the NiCo-CuO catalyst exhibited superior performance, achieving a CO₂ conversion rate of 30.5%. Optical emission spectroscopy (OES) and intensified charge-coupled device (ICCD) diagnostics showed that the NiCo-CuO catalyst improved the uniformity of plasma discharge and optimized energy distribution, which promoted the generation of reactive species such as CO₂⁺ and CO₂(v), essential for lowering reaction barriers and driving catalytic decomposition on the catalyst surface. Morphological and elemental analysis using scanning electron microscopy (SEM) and transmission electron microscopy (TEM) further demonstrated that the NiCo-CuO catalyst possesses a high surface area and well-dispersed metal active sites, contributing to enhanced catalytic performance. Additionally, this method utilized minimal catalyst quantities—approximately 1% of the amount required in conventional packed bed reactors—resulting in material efficiency, an expanded reaction zone, and extended CO₂ residence time in the plasma, thereby improving overall system efficiency. These findings highlight that the plasma-catalyst synergy not only enhances CO₂ conversion but also provides a cost-effective and scalable solution. Moving forward, future work can focus on optimizing catalyst composition, reactor design, and integrating clean energy sources to scale up the process for industrial applications.

Keyword: CO₂ decomposition, plasma catalysis, conversion rate, energy distribution, CO₂ utilization



Evaluation of Gas-Liquid Discharge Plasma for Inactivation of Microorganisms in Pond Sewage

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Abstract

Water treatment plants contain a large number of microbial communities. The presence of bacteria, viruses, and other contaminants in water causes many diseases, which pose a threat to human health. Cold atmospheric plasma purification water treatment technology combines high-energy particle radiation, oxidant oxidation, and to provide efficient and comprehensive treatment of pond sewage. In this study, a gas-liquid discharge device that can generate air plasma driven by a sinusoidal AC power supply was designed and its sterilization effect was investigated. The spatio-temporal evolution characteristics and the voltage and current waveforms of the gas-liquid discharge device were first investigated. Subsequently, we used the emission spectra of the second positive band system of nitrogen molecules to fit the gas temperature of the plasma. The fit is better when the rotation temperature is set to 1500 K, which indicated that the plasma generated by the device was at a high temperature, and that the thermal effect may be significant in the treatment of water sources. Then, the concentrations of reactive oxygen and nitrogen species (RONS) in the discharge were characterized, and the physicochemical properties of activated water were explored. The sterilization effect of the device on *P. aeruginosa* was then tested, and the results showed that after discharging for about 10 min, the sterilization efficiency of the device reached about 90%. Finally, to further investigate its applicability, pond water sources were treated with the device, and changes in the microbial diversity of water samples were analyzed using 16S rRNA assays. The results showed that both the species and number of microorganisms in the water decreased after plasma treatment. Therefore, the device has the potential to be used as a novel method of water purification.

Keyword: Gas-liquid plasma, reactive oxygen and nitrogen species, pond sewage, inactivation of microorganisms, 16S rRNA



RF Plasma Treatment on Carrageenan-Based Food Packaging Materials

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Abstract:

This study investigates the application of radio frequency (RF) plasma treatment on carrageenan-based food packaging materials to enhance their properties and functionality. Carrageenan, a natural polysaccharide derived from red seaweed, serves as a biodegradable alternative to conventional food packaging materials. Typically, the RF plasma treatment will modify the surface characteristics of carrageenan films, in addition to their barrier properties and water contact angle values. However, the change in water contact angle depends on the gas, RF power and time of exposure. This study explores different RF plasma conditions to assess their impact on the surface properties of packaging materials, with a focus on water contact angle analysis. In this study, RF power is used to create plasma in the presence of various gases, and exposed to various carrageenan-based samples. In addition, a plasma polymer encapsulation layer is created on the carrageenan-based substrates using essential oil precursors. This innovative approach will help develop sustainable packaging solutions to improve the shelf life of food products. The findings suggest that RF plasma treatment can effectively transform carrageenan-based materials into high-performance, eco-friendly packaging options, contributing to reduced environmental impact in the food industry.



Observation of Kolmogorov Turbulence due to Multiscale Vortices in Dusty Plasma Experiments

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Abstract:

Dusty plasmas consist of highly charged micron-sized particles suspended within a plasma environment. These dust particles interact through a shielded Coulomb potential, with electrons and ions providing the necessary shielding. Their relatively slow dynamics compared to electrons and ions make them ideal for tracking trajectories, providing a unique platform for studying various phenomena.

This talk will present experimental observations of turbulence in a rotating dust cloud, conducted using the Shivalik Plasma Device-I (SPD-I) [1] at IIT Jammu. In our experiments, a 3D dust cloud forms in the diffused region of a DC discharge within an Argon plasma environment. We used poly-dispersive Kaolin microparticles, ranging from 2-8 μm , to induce a charge gradient in the dusty plasma. We consistently observed dust rotation across multiple experimental campaigns under varying discharge conditions, spatial locations, and background plasma environments. A thin sheet laser, with a thickness of approximately 150 μm , illuminates a single layer of the dust cloud for planar dynamics observation. We employ Particle Image Velocimetry (PIV) to visualize and measure dust rotation, with velocity fields analyzed using the open-source MATLAB software PIVlab [2].

We present one of the first experimental evidence of fully developed Kolmogorov turbulence arising from self-excited vortex flows within a three-dimensional (3D) dust cloud. Our observations reveal the characteristic $-5/3$ scaling of Kolmogorov turbulence [3] in both spatial and temporal power spectra, along with a $2/3$ scaling in the second-order structure function, confirming the presence of Kolmogorov turbulence. Additionally, we noted a slight deviation in the tails of the probability distribution functions for velocity gradients. Our results reveal distinct features of Kolmogorov 3D turbulence within various diffused plasma regions. This highlights the universality of turbulence phenomena in laboratory dusty plasma environments.

Keywords: Dusty Plasma, Dust vortices, Turbulence.

Acknowledgments: The authors acknowledge Dr Sayak Bose for his valuable discussions and support for this work through SERB Grant No. CRG/2020/003653.

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Turbulence in Many-Particle System

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Abstract:

Turbulent flows are almost everywhere in nature, be it water flowing through the pipes or chaotic airflow in the atmosphere. Researchers have extensively investigated hydrodynamic turbulence through diverse numerical approximations of the Navier-Stokes equation. However, at the molecular level, turbulent processes exhibit exciting properties like thermalization, which remain beyond the reach of the Navier-Stokes equations due to its continuum approximation.

Molecular dynamics simulation provides insight into particle-to-system-size level dynamics. It solves Newton's equations of motion for each particle and gives us the positions and velocities at desired time intervals. It captures physics at the particle level and includes the thermal fluctuations, which most of the hydrodynamic models miss, thus making it the suitable representative for studying the effect of molecular motions on turbulent flows.

This talk focuses on the phenomenon of thermalization within realistic fluid systems. Through molecular dynamics simulation, we illustrate macroscopic and microscopic aspects of a many-particle system, specifically a Lennard-Jones gas. We introduce a large-scale vortex into a noisy environment akin to hydrodynamic flows and examine the system's evolution from nonequilibrium behavior to eventual thermalization. Initially, the system's progression aligns with Kraichnain's theory of turbulence. Over an extended period, the system converges to thermal equilibrium, similar to the two-dimensional Euler turbulence.

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Mechanism of Periodic Convective Oscillations in Laser-Sustained Plasmas

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Abstract:

Laser-Sustained Plasma (LSP) is a type of dense plasma generated through the interaction of lasers with ionized gases, with temperature reaching tens of thousands Kelvin.[1] LSP has been adopted as a mainstream light source for wafer optical detection in the semiconductor manufacturing due to its high radiation intensity, broadband radiation spectrum, and higher stability. However, relatively small fluctuations of LSP brightness (less than 1%) have been reported in recent studies. It is believed that the periodic brightness pulsation was caused by the oscillations of the convective flow around the LSP core, and the oscillation is directly related to the dynamics of the toroidal vortices developed in the convection plume.[2] Based on the experimental results of the Ar or Xe LSP at 3-50 bar, the oscillation frequency f and the characteristic radius of the convection plume r_0 are found to obey a scaling relation, i.e., $0.5 f g r = 0.5 / 2$, where g is the magnitude of gravitational acceleration. [2] However, the relationship between the oscillation frequency and the LSP control parameters, e.g., the laser power, the gas pressure, and the boundary temperature, remains unexplained. In this work, a two-dimensional fully laser-thermal-hydrodynamically coupled fluid model [3-4] is established to reveal the mechanism of the vortex-induced LSP oscillation. Three stages in a pulsation period, i.e., the generation of vorticity, the roll-up of the toroidal vortex, and the detachment of vortex around LSP are identified, and the evolution processes are characterized by using the vorticity transportation equation. In addition, quantitative effects of various factors on the LSP oscillation frequency, including the gravitational acceleration g , the viscosity μ , the induced laser power P , the gas pressure p , and the boundary temperature T_{bou} , are demonstrated based on the scaling method. The results from this study could offer a valuable guidance for improving the LSP stability in practical applications.

References:

1. Y. P. Raizer, *Sov. Phys. Usp.* 23, 789 (1980).
2. M. A. Kotov, S. Y. Lavrentyev, A. N. Shemyakin, N. G. Soloviyov, and M. Y. Yakimov, *Plasma Sources Sci. Technol.* 31, 124002 (2022).
3. D. Zhang, J. Liu, and Y. Fu, *Acta Phys. Sin.* 73, 025201 (2024).
4. J. Liu, D. Zhang, and Y. Fu, *New J. Phys.* 25, 122001 (2023).



Poster presentation : Abstract

Neutron Production in Deuterium-Argon Mixture Plasma Focus Discharge

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Abstract:

The current work investigated the impact of argon doping in deuterium plasma focus discharge at 2.7 kJ of maximum energy. The total neutron yield and the enhancement due to doping are measured here with an indium activation counter. The detector is placed at the end-on position for time-integrated neutron measurement. The pinch voltage and energy into the pinch are correlated to the neutron yield for the different levels of argon-doped deuterium discharge. The pinch voltages indicating the pinching action for the deuterium discharge with 10%, 30%, 50%, 60%, and 70% argon mass percentage are compared, as an effort to deduce the pinch enhancement with the gas mixtures. At 50% argon doping, the discharge presented the highest yield, more energy into the pinch, and good reproducibility. The highest average neutron yield in the 50% argon-doped deuterium discharge was $(3.0 \pm 0.6) \times 10^7$ neutrons per shot, compared to pure deuterium discharge, having the average neutron yield of $(4.7 \pm 0.8) \times 10^6$ neutrons per shot. The enhancement correlated with the (139 ± 16) J energy into the pinch.

Keyword: Argon doping, deuterium, deuterium-argon mixture, neutron yield, plasma focus



Development of DC magnetically well-type cathode and thermal plasma torch for treatment of hazardous wastes

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Abstract:

The 30 kW DC plasma torch system with the well-type cathode (WTC) has been developed to generate thermal plasma above 1200 °C, which is adding the external magnetic coil on the cathodic part of the torch. The well-type torch is hollow cylindrical copper's 5 mm thickness, whose cathode electrode and anode electrode was 150 mm in each length, the diameter is 22 mm through the center, The gap between both electrodes is 1.5 mm isolated with a swirl gas ring. Under the experimental conditions at 0.5 - 0.8 MPa compressed air is applied to both sides of the torch, the airflow rate is 60 L/min and 120 L/min from the sides, and above, as followed. the thermal plasma has been generated, their maximum current is 200 A and 160 V, the length is about 30 cm, its diameter about 3 to 5 cm wide, recognized UV emission has been present.

In this work, the 500 G of the magnetic field produced by an external solenoid has been developed, to drive the arc root and reduce the cathode erosion damage.[2,3] The result shows the necessity of a magnetic field, a rotational arc root inside the cathode surface, and electrode life hours are compared with the case of un magnetic field-driven has been present. Finally, the knowledge of this work to extend electrode life and applied to the system to be suitable for the disposal of infectious wastes.

Keyword: DC plasma torch, Thermal plasma, well-type torch

References:

[1] J. Mostaghimi and et.al., Plasma Chem Plasma Process. 35, (2015)J.M. Osepchuk, IEEE Transactions. 50, 975-985 (2002)

[2] K. S. Kim and et.al., PHYSICS OF PLASMAS. 15, 023501 (2008)

[3] P. Freton and et.al., J. Phys. D: Appl. Phys. 42, 195205 (2009)



Atmospheric Pressure Plasma Jet Treatment for Bacterial Biofilms of Two Common Pathogenic Bacteria

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Abstract:

To address the issue of incomplete sterilization of medical instruments in hospitals, which can lead to nosocomial bacterial infections, this study utilized a custom-built plasma jet device driven by a high-frequency, high-voltage alternating power supply. The device generates plasma jets at atmospheric pressure to sterilize biofilms on metal and glass substrates. Under discharge conditions of a peak-to-peak voltage of 15 kV, a frequency of 23 kHz, and an air flow rate of 0.1 slm (Standard Liters per Minute), biofilms of *Staphylococcus aureus* and *Acinetobacter baumannii*, known for their strong biofilm-forming ability and widespread occurrence, were placed 6 mm below the device and treated for 0, 1, 3, 5, and 10 minutes. The treated biofilm samples were subsequently analyzed using colony-forming unit (CFU) counts, crystal violet staining, optical microscopy, and field emission scanning electron microscopy (FE-SEM). The study investigated the effect of different treatment durations on the sterilization efficiency of various biofilms. Results showed a positive correlation between treatment time and sterilization efficacy. Notably, *A. baumannii* biofilms were completely inactivated after 1 minute of plasma jet exposure or longer. FE-SEM analysis further revealed that plasma jet treatment damaged bacterial cell wall structures, disrupted extracellular polymeric substances, and exposed intracellular bacteria, ultimately leading to bacterial death.

Keyword: Atmospheric pressure plasma jet, biofilm, sterilization, FE-SEM, CFU



The Doppler backscattering diagnostic for the study of plasma processes in the tokamak Globus-M2

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Abstract:

Doppler backscattering (DBS) is a microwave diagnostics method typically used to study the poloidal plasma rotation velocity. The DBS diagnostic has become an integral part of plasma research on the largest tokamaks around the world and there are several DBS systems in use on the spherical Globus-M2 tokamak. The available probing frequencies allowed for measurements to be made in a wide area spanning from the scrape-off layer (SOL) to half of the minor radius of the plasma. A multitude of results have been obtained using DBS since the upgraded Globus-M2 began its operation. These include research similar to that done on other devices into the properties of the LH transition such as the measurements of the radial electric field and velocity shear, as well as investigation of turbulence behavior and its reaction to the formation of edge-localised modes (ELMs). Additionally, the study of a variety of oscillating processes was performed. Innovative works regarding the detection and investigation of the characteristics of Alfvén eigenmodes (AEs), tearing modes (TMs) and filaments are presented. The employment of radial and poloidal correlation Doppler reflectometry is also discussed. Apart from that, the specific aspects of DBS application on a spherical tokamak are discussed along with an in-depth look into the gradual change and improvement of the DBS diagnostics on Globus-M2.

The work was carried out with the financial support of the Russian Science Foundation (project no. 23-72-00024, <https://rscf.ru/project/23-72-00024>).

Keyword: Nuclear fusion, tokamak, plasma diagnostics, Doppler backscattering, plasma turbulence, H-mode, edge-localised modes, filaments, Alfvén eigenmodes, tearing modes



The ID Card + TNG card



This ID card is also a Touch 'n Go NFC Card (further information in the website <https://www.touchngo.com.my/consumer/overseas-travel/>) can be used together with the [Touch 'n Go e-wallet](#), conveniently top-up by a NFC-enabled mobile phone. The TNG card serves as stored valued travel card to public transportation in Kuala Lumpur, including the metro (MRT, LRT, KTM, ERT), train and local buses. TNG eWallet can be used for payment in Malaysia, as well as overseas with a wide acceptance network. It works seamlessly with Alipay+, Promptpay, QRIS & NETS. The card can be used for tolls on highways and parking fees in most of the shopping malls. With this convenient in your hand, we wish you a wonderful time in the conference, smooth travelling and exploring local culture and the nature in Malaysia.



Reload from Touch 'n Go e-wallet

- Requirements:
1. Mobile phone with NFC enabled.
 2. Touch 'n Go eWallet account activated with local/Singapore mobile number

1 Enable NFC on your phone.

2 Open the Touch 'n Go e-wallet APP and Click TNG Card

3 Click Add Card

4 Hold the card against the back of your phone, then tap the scan button to initiate detection

5 Complete face verification. (sometime need 't)

6 Click Reload
The ID Card + TNG card is now linked with your e-Wallet

7 Hold the card against the back of your phone.

8 Select or enter the amount to reload

9 Yay! Reload successful
You've successfully reloaded RM 50.00 into Touch 'n Go Card. View more details now!
Reload successful
RM 50.00
Date & Time 24/09/2022 18:01:47
New Balance RM 50.00
Finished
You'll be able to check the latest details of your card's balance with NFC.



Conference Location

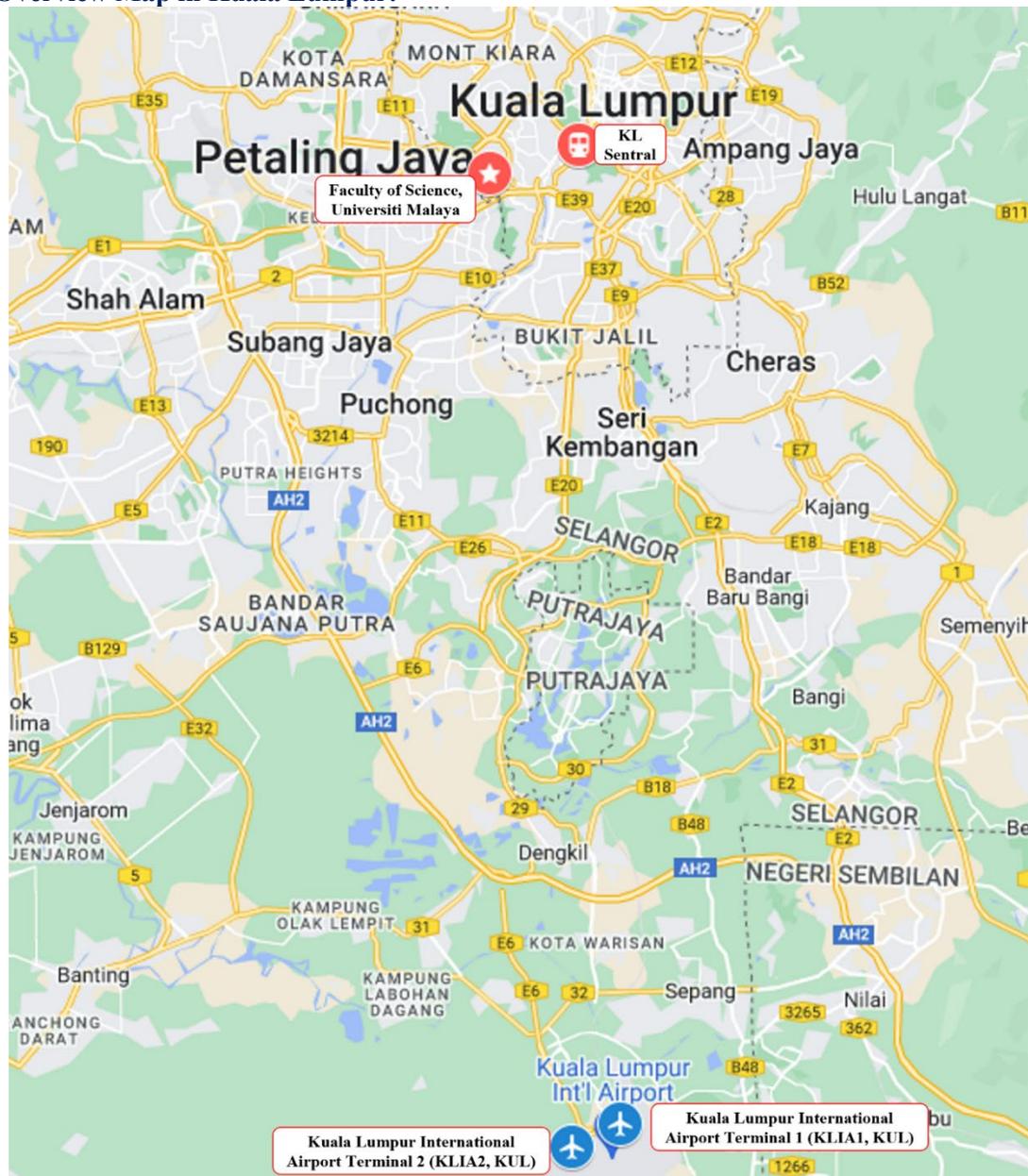
Conference Venue of 17th International Conference on Plasma Science and Applications is located at Faculty of Science in Univeristi Malaya, Malaysia.

Address: Faculty of Science, University Malaya, Lingkungan Budi, 50603 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur.

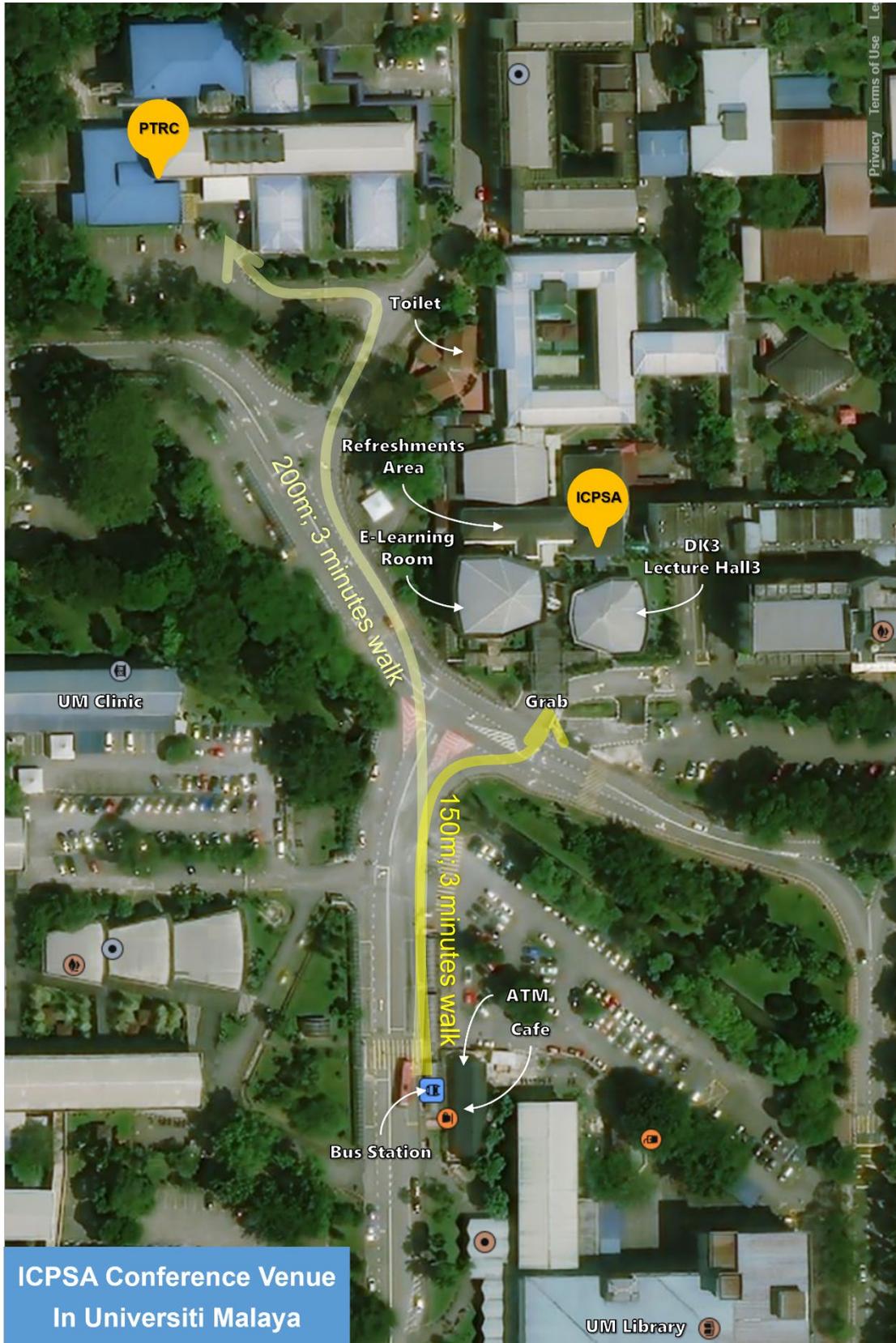
Google Map with important locations:

<https://www.google.com/maps/d/u/6/edit?mid=1PxMJjr0dSX2xSOI6q0ACukoP2RfApzk&usp=sharing>

Overview Map in Kuala Lumpur:







Transportation & Information

1. Kuala Lumpur International Airport (KLIA, KUL) to Faculty of Science, Universiti Malaya:

Car	Public transport
<ul style="list-style-type: none"> • Travel distance – approximately 57 km • It takes 60 minutes to travel by car • Taxi/Grab Fare is about RM 80 	<ol style="list-style-type: none"> 1. Take <i>KLIA Express</i> from KLIA to KL Sentral, 1 stop. 2. Take <i>LRT of Kelana Jaya Line</i> (KJL, from Gombak->Putra Heights) from KL Sentral to Universiti Station, 4 stops. 3. Take <i>RapidKL bus T789</i> to Station Perpustakaan UM, 5 stops. 4. <i>Walk for 130m</i> to reach Faculty of Science. <p>Whole journey ~60 minutes.</p>

2. Kuala Lumpur International Airport (KLIA2, KUL) to Faculty of Science, Universiti Malaya:

Car	Public transport
<ul style="list-style-type: none"> • Travel distance – approximately 64 km • It takes 70 minutes to travel by car • Taxi/Grab Fare is about RM 85 	<ol style="list-style-type: none"> 1. Take <i>KLIA Express</i> from KLIA to KL Sentral, 2 stops. 2. Take <i>LRT of Kelana Jaya Line</i> (KJL, from Gombak->Putra Heights) from KL Sentral to Universiti Station, 4 stops. 3. Take <i>RapidKL bus T789</i> to Station Perpustakaan UM, 5 stops. 4. <i>Walk for 130m</i> to reach Faculty of Science. <p>Whole journey ~70 minutes.</p>

3. Kuala Lumpur Sentral (KL Sentral) to Faculty of Science, Universiti Malaya:

Car	Public transport
<ul style="list-style-type: none"> • Travel distance – approximately 10 km • It takes 20 minutes to travel by car • Taxi/Grab Fare is about RM 15 	<ol style="list-style-type: none"> 1. Take <i>LRT of Kelana Jaya Line</i> (KJL, from Gombak->Putra Heights) from KL Sentral to Universiti Station, 4 stops. 2. Take <i>RapidKL bus T789</i> to Station Perpustakaan UM, 5 stops. 3. <i>Walk for 130m</i> to reach Faculty of Science. <p>Whole journey ~40 minutes.</p>



Special Events

Conference Dinner

12 Nov 2024 (18:00 p.m. – 21:00 p.m.)

Mitasu Japanese Restaurant (Buffet)

Lot 306, Old Klang Rd, Batu 3, 58000 Kuala Lumpur, Federal Territory of Kuala Lumpur



Visit to Malaysia Nuclear Agency

- 13 Nov 2024 (13:30 p.m. – 16:30 p.m.)
- Agensi Nuklear Malaysia, Bangi, 43000 Kajang, Selangor
- Bus from Dataran Sains at 12:15 p.m.



Pre-arranged meeting Xiamen University Malaysia

- 13 Nov 2024 (13:30 p.m. – 16:30 p.m.)
- Xiamen University Malaysia, Jalan Sunsuria, Bandar Sunsuria, 43900 Sepang, Selangor
- Transport from Dataran Sains at 12:15 p.m.



Awards

AAAPT – ICPSA 2024

Distinguished Service Award

Professor Dr. Size Yang

Institute of Physics, Chinese Academic of Sciences, China
AAAPT Founder member, since 1988

Excellence Service Award

Dr. Pradoong Suanpoot

Maejo University Phrae Campus, Thailand

Dr. Rusen Zhou

Xi'an Jiaotong University, China

Dr. Lian Kuang Lim

Universiti Malaya, Malaysia

Dr. Haruna Peter Wante

Universiti Malaya, Malaysia

Han Yi Tan

Universiti Malaya, Malaysia

Best Oral Presenter Award {Young Scientists}

Yuting Gao

Xi'an Jiaotong University, China

Dongheyu Zhang

Tsinghua University, China

Sachin Sharma

Indian Institute of Technology Jammu, India

Best Poster Award {Young Scientists}

Muhammad Luqman Haqqim Bin Omar

Universiti Malaya, Malaysia

Shun Tan

Universiti Malaya, Malaysia

Ridhvee Taleh

Walailak University, Thailand



EXPLORING THE BEAUTY OF MALAYSIAN BATIK



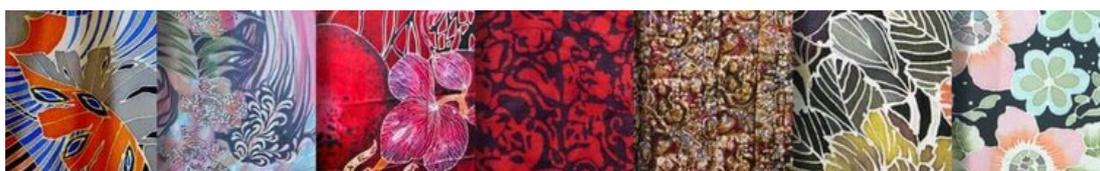
The term "batik" refers to a traditional fabric dyeing technique where patterns are created using wax as a dye-resistant medium, allowing for intricate and unique designs. The process involves a tool called a "canting," which applies hot wax in dots and lines to outline patterns on the fabric. A stamp called a "cap" is sometimes used for repetitive motifs, allowing for faster and more consistent designs. The unique traditional designs and patterns are often reproduced by modern technology into various fabric products, like wallets.



When was Batik first created?



In Malaysia, batik's history dates back to 1913, beginning in the state of Kelantan. Malaysian batik makers introduced the wax-resist technique, and both states of Kelantan and Terengganu became hubs for batik production. Early styles included "skrin batik" (filtered silk batik), with wax application marking a significant evolution in the craft. Malaysian batik is deeply rooted in Malay culture, using natural motifs inspired by flora such as bamboo shoots, lotus flowers, and cempaka blossoms. Today, several distinct batik styles are produced in Malaysia, including canting batik, block-printed batik, screen batik, and rainbow batik.



The Rising Popularity of Batik

Batik's intricate designs and vibrant colors have sparked a resurgence, with modern designers reimagining traditional motifs for contemporary appeal. Lightweight fabrics like silk and cotton add to its popularity in tropical climates. Once a cottage craft, batik has evolved into a trend-driven industry, with innovators like Kartini Illias and En. Zamrudin Hj Abdullah promoting creative, eco-friendly designs that resonate with younger audiences. Organizations such as Kraftangan Malaysia and Karyaneka support this growth through R&D and workshops, while global efforts by Yayasan Budi Penyayang Malaysia and the World Batik Council help broaden batik's appeal worldwide.



Why Do People Love Batik?

Batik's versatility makes it popular among all ages. Beautiful and elegant batik art is featured in painting, collectible items and fashion design.

When is Batik Day in Malaysia?

December 3, declared Batik Day by former Prime Minister Datuk Seri Ismail Sabri Yaakob, celebrates Malaysia's batik heritage, encouraging citizens to wear it proudly and support the industry.



MALAYSIAN COFFEE CULTURE & TECHNOLOGY

Malaysia boasts a vibrant and varied coffee culture that fuses traditional techniques with contemporary advancements. Coffee is intricately woven into everyday life, social connections, and regional identity, providing a distinct viewpoint on how the drink has transformed from simple origins to a worldwide commodity.

Traditional Coffee Culture

The traditional coffee scene in Malaysia is heavily influenced by local history and colonialism, with a unique fusion of Southeast Asian and European coffee practices.



Kopitiam Tradition

At the core of Malaysian coffee culture is the "kopitiam" (coffee shop), a daily meeting place for people to savor freshly made coffee, frequently paired with local breakfast favorites such as kaya toast (toasted bread with coconut jam) and soft-boiled eggs. The classic coffee, referred to as kopi, is prepared with beans that are roasted with

sugar and margarine, producing a unique dark and slightly caramelized taste. The coffee is usually made with a sock, resulting in a smooth, rich flavor.



The OLDTOWN Nan Yang series has aromatic ground coffee in traditional filter bags to recreate the typical Kopi O pulled through a coffee sock.



A traditional coffee prepared by Traditional Hot Beverage Kiosks (known as "WARUNG" in Malay). The Warung range is set to wow with the local favorite.

Modern Innovations and Coffee Technology

In recent years, Malaysia's coffee scene has evolved, embracing modern techniques, international trends, and an increasing demand for specialty coffee. This shift has been fueled by a younger generation of coffee enthusiasts and an expanding café culture.



Specialty Coffee

Malaysia has witnessed a rise in specialty coffee shops, where baristas are trying out various brewing techniques like pour-over, Aeropress, and cold brew. Specialty coffee beans are now obtained from local farms, especially in the Cameron Highlands and Pahang areas, recognized for their premium Arabica beans. The emphasis is on coffee from a

single origin that is ethically sourced and highlights distinctive flavors and characteristics.



Third-Wave Coffee Movement

The emergence of the third-wave coffee movement in Malaysia has led to an increasing appreciation for coffee as a craft item. This initiative emphasizes the subtleties of taste, quality management, and eco-friendly agricultural methods. Contemporary Malaysian roasters and cafes emphasize direct connections with coffee producers, guaranteeing a just and clear supply chain.



Coffee Technology and Automation

From espresso makers to advanced grinders and automated brewing setups, technology has simplified the process for coffee lovers consistently create perfect cups of coffee. Cafes currently employ state-of-the-art siphon brewing or nitro coffee machines, which infuse nitrogen into cold brew coffee to produce a smooth, bubbly consistency.



Sustainability and Innovation

The coffee culture is a lively mix of traditional and modern elements, customs continue to flourish alongside cutting-edge technology. Whether you're savoring a traditional cup of kopi at a kopitiam or warung, delving into the newest trends in specialty coffee, Malaysia provides a varied and developing coffee experience that embodies its rich cultural legacy and innovative attitude towards coffee technology.



General Information

Emergency Contact Information:

Emergency calls	Direct dial numbers
Police	999 or 112
Ambulance	999 or 991
Fire Brigade	999 or 994

Signage translation:

English (英语)	Bahasa Malaysia (马来语)	中文 (Chinese)
Registration	Pendaftaran	签到
Conference Hall	Dewan Persidangan	会议大厅
Exhibition Area	Ruang Pameran	展览区
Refreshment Area	Ruang Makanan	餐饮区
Toilet	Tandas	卫生间
Square	Dataran	广场
Stairs	Tangga	楼梯
Free	Percuma	免费
Taxi	Teksi	出租车
Parking Lot	Tempat Letak Kereta	停车场
Metro Station	Stesen (MRT, LRT, KTM, ERT)	地铁站
Free Shuttle Bus	Bas Ulang-alik Percuma	免费巴士
First Aid Station	Stesyen Pertolongan Cemas	急救站
Exit	Keluar	出口
Emergency Exit	Pintu Keluar Kecemasan	紧急出口

