AMPERE Newsletter

Trends in RF and Microwave Heating

http://www.ampere-newsletter.org

Issue 119 **July 8, 2024**

In this Issue:

ISSN 1361-8598

Microwave Materials Processing Activities at the Karlsruhe Institute of Technology

Guido Link

Institute for Pulsed Power and Microwave Technology, Karlsruhe Institute of Technology, Karlsruhe, Germany
Contact E-mail: guido.link@kit.edu

Karlsruhe Institute of Technology (KIT) as "The research university in the Helmholtz Association" is a pioneer in the German science system which maximized the synergies by the merger of a national large-scale research center and a state university. A major activity of KIT is allocated in the Helmholtz Research Field Energy.

The working group on microwaves materials processing, which is part of the Institute for Pulsed Power and Microwave Technology is active in the Helmholtz Program Materials and Technologies for the Energy Transition (MTET). Actual microwave applications of interest are motivated by the need to electrify process heat, to increase resource and energy efficiency. The group started by Guido Link more than 30 year ago has gathered broad expertise in various fields of applications and has acquired knowledge on dielectric characterization, on system and process design and simulation as well as experimental validation and process control. Based on many years of work in this field and several public funded joint R&D projects with partners from research and industry, a considerable infrastructure of measurement and testing facilities is available. This can be offered to interested partners from industry and science for feasibility studies of new application ideas.

Actually, the main activity of the microwave groups within the Helmholtz MTET program is on the development of power-to-X technologies to convert renewable electricity into chemical energy carriers. A major focus is plasma-based activation of CO_2 using atmospheric microwave plasmas sustained with pulsed high-power solid-state microwave generators [1]. Various plasma torches and nozzle designs for plasma quenching have been investigated to further optimize the conversion and energy efficiency of the CO_2 dissociation process.

$$CO_2 \rightarrow CO + 1/2\ O_2 \quad + 283\ kJ/mol$$

Latest results are presented in Fig. 1.

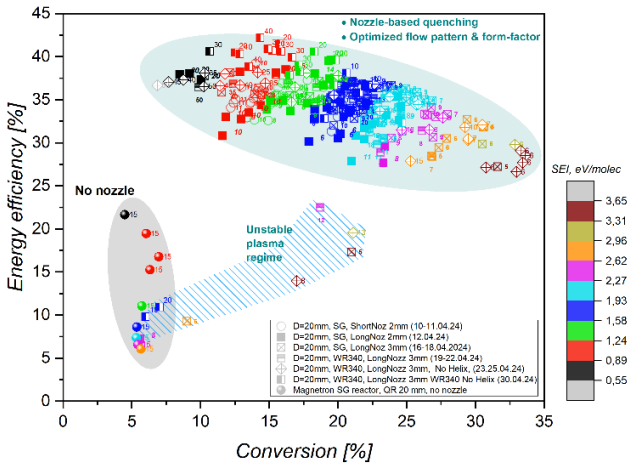


Fig. 1: Energy efficiency vs. conversion of CO2 for different nozzle designs. Specific energy input (SEI) is color coded.

In addition to this activity, there are several very diverse and public-funded joint research projects in which KIT is supporting innovative microwave ideas. Recently completed and still ongoing projects include the following:

TOMOCON

The European Marie Skłodowska-Curie Training Network “Smart tomographic sensors for advanced industrial process control” (TOMOCON – www.tomocon.eu) joined 12 international academic institutions and 15 industry partners, who worked together in the emerging field of industrial process control using smart tomographic sensors. In close collaboration with Chalmers University of Technology and the University of Eastern Finland, the KIT was engaged in the development of a microwave tomography (MWT) and its application in microwave drying of porous materials.

This microwave tomography (MWT) system was integrated in a high-power hybrid heating system to determine the moisture distribution inside wet polymer foam. The microwave drying system is equipped with a conveyor belt that enables a continuous drying process. The objective was a

uniform drying of the foam to a specific moisture content. This requires in-situ and non-invasive measurements of the unknown moisture distribution inside the foam. Therefore, the developed MWT was installed next to the HEPHAISTOS oven (see Fig. 2). Various models and algorithms to solve the inverse problem have been developed and investigated [2].

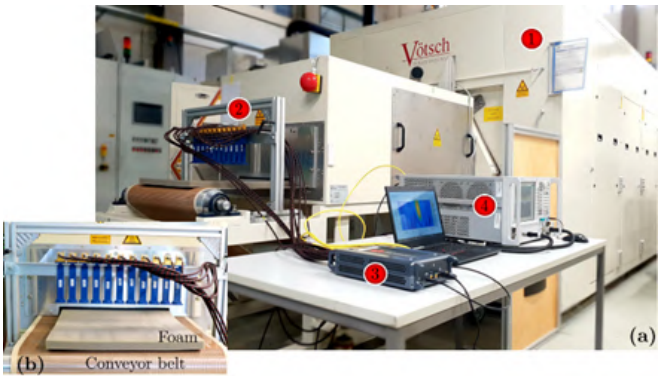


Fig. 2: (a) MWT system and its integration with the HEPHAISTOS is shown. The numbers 2, 3, and 4 shows the MWT system, Solid state switch, and VNA respectively. (b) shows the enlarged view of the MWT antenna array.

IMPULS

IMPULS was a national funded project related to microwave assisted pultrusion of carbon fiber reinforced composites. The IMPULS Project mitigates the limitation of state for the art pultrusion technology with contact heat. As microwave heating allows to selectively heat the profile in the otherwise cold tool, the degree of cure of the profile can be changed instantaneously by changing the microwave power. By alternating between fully cured and uncured segments, the profile can be locally deformed in a subsequent process step, opening the process to a variety of new applications. Within the scope of the project proper microwave heated forming tools were built and tested. Successful test ware performed and the desired transitions between cured and uncured segments, with small transition lengths, was demonstrated. [3]

MWPrint4ReCon

The MWPrint4ReCon project is a Helmholtz Technology Transfer and Validation project to validate the KIT patented microwave assisted 3D printing technology [4, 5] on a meter scale, for the production of continuous carbon fiber reinforced spatial lattice structures (CCFSLS) and those structures will be used for the reinforcement of concrete. Concrete is used in most of the world's buildings and constructions. Forecasts predict that the annual production of cement, which is an essential component of concrete, will increase by 50% by 2050 which today is responsible for more than 8% of the global anthropogenic CO_2 emissions. The usage of (CCFSLS) instead of conventional steel reinforcement is a potential solution for a significant reduction in concrete consumption and thus improvement of its carbon footprint. The MWPrint4ReCon project is to validate the idea with CCFSLS reinforced precast concrete elements. The microwave assisted printing head is already designed and built. The robot-based printing cell as well as the printing process itself is still under development.

CORAERO

The Helmholtz CORAERO project (www.coraero.de) brings together a multidisciplinary group of scientists from virus biology, medicine, applied physics, chemistry, and engineering to understand virus spreading through aerosols and designing technical and administrative measures for mitigation, detection and virus control. The COVID-19 pandemic, caused by SARS-CoV-2, led to over 774 million cases and seven million deaths globally by January 2024, highlighting the continuing need for the development of innovative and effective technologies to prevent virus transmission and manage future pandemics effectively. The IHM microwave group supports CORAERO with R&D on air purification systems that utilize microwave radiation to reduce virus load in enclosed spaces, targeting airborne viruses in public and private ventilation systems. First tests with virus laden aerosol in biosafety level 3 laboratory with CORAERO project partner show promising results. Further experiments are planned and will be published.

PAMICO

In farming, weeds compete with crops for sunlight, space, nutrients, water, and CO_2 and can significantly impact crop products worldwide.

Even though an estimated 3 billion kg of pesticides is currently applied worldwide, it is estimated that 37% of global crop production is still lost. Controlling and demolition of the distribution of weeds in a crop field is vital to increase the production rate. Weed control by microwaves is supposed to be an environmentally friendly method for replacing chemical and pesticide methods, which are no longer acceptable from an ecological point-of-view.

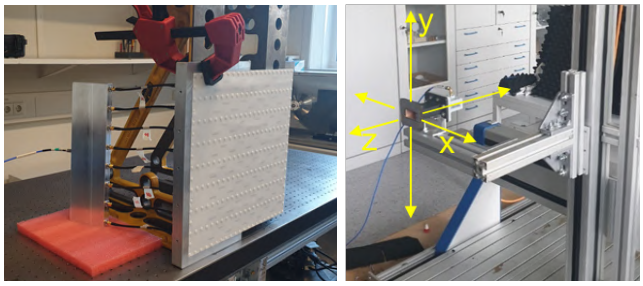


Fig. 3: Test stand for measuring antenna characteristics using a power divider connected to the slotted waveguide array antenna (left) and a WR159 receiving antenna fixed to a xyz positioning stage.

As part of an IraSME funded project, IHM is in charge of development and demonstration of a novel phased-array 5.8 GHz microwave antenna, which will allow to focus the microwave power installed to the weed location which was identified before by optical methods and AI technology [6]. The volumetric and selective heating by microwaves, can lead to the bursting of cells inside the plant at high power densities. The test stand for the validation of the designed and developed slotted waveguide phased array antenna is shown in Fig. 3. In a next step, phase shifters will be installed to each antenna port to demonstrate the beam steering capabilities prior to the setup being prepared for testing on the field.

Acknowledgement

I kindly acknowledge the working group consisting of 2 senior scientist, 2 engineers and a number of PhD students acting as project engineers, continuously solving all microwave-specific problems with great enthusiasm and motivation. The group is well supported by a competent in-house mechanical and electronic workshop. Those projects listed are supported by national and European funding programmes within the support codes: ZF4204604BL8; KK543301DF1; HGF contract numbers KA1-Co-06 and KA-TVP-11 and Marie Skłodowska-Curie Innovative Training Networks grant agreement number 764902.

For further readings

1. Sergey, S. et al. Time-Resolved Optical Emission Spectroscopy Reveals Nonequilibrium Conditions for CO_2 Splitting in Atmospheric Plasma Sustained with Ultrafast Microwave Pulsation. ACS Energy Letters, 2021, 6(1), 124–130.
2. Omrani A.; Yadav R.; Link G.; Jelonnek J. A Multistatic Uniform Diffraction Tomography Algorithm for Microwave Imaging in Multilayered Media for Microwave Drying, IEEE Transactions on Antennas and Propagation, 2022, 70(10), 9583–959.
3. Engler M.; Link G.; Jelonnek, J. Multiphysics Modelling of an Intermittent Microwave Pultrusion Process. Proc. 19th International Conference on Microwave and High-Frequency Applications (AMPERE 2023), Cardiff, UK, 2023, 268-269.
4. Li N., et al. Path-designed 3D printing for topological optimized continuous carbon fibre reinforced composite structures. Composites Part B: Engineering, 2020, 182, 107612.
5. Li, N.; Link, G.; Jelonnek, J. Rapid 3D microwave printing of continuous carbon fiber reinforced plastics. CIRP Annals, 2020, 69(1), 221–224.
6. Omrani A.; Link G.; Jelonnek J. A Near-Field Focused Phased-Array Antenna Design Using the Time-Reversal Concept for Weed Control Purpose, arXiv, 2023, https://doi.org/10.48550/arXiv.2302.01012.

About the author

Guido Link received the Dipl.-Phys. and Dr. degree in physics from the Technical University Karlsruhe (now KIT), Germany in 1990 and 1993, respectively. His diploma thesis and graduate research was devoted to the frequency and temperature dependent dielectric characterization of low loss ceramics and ionic crystals. Since 1993, he has been working at the Karlsruhe Institute of Technology, Germany in the field of high-power microwave and millimeter-wave processing of materials as a team leader at the Institute for Pulsed Power and Microwave Technology. His research interest includes dielectric measurements, design and simulation of microwave systems and processes, microwave assisted sintering, curing of polymer composites, additive manufacturing and plasma chemistry.

Report on IMPI's 58th Annual Microwave Power Symposium, 29-31 May 2024 at Reston Town Center, suburban Washington, D.C.

John Bows

R&D Director, PepsiCo UK
Contact E-mail: John.Bows@pepsico.com

The venue for the 58th IMPI conference was Reston Town Center, 21 miles west of Washington, D.C.. Founded in the 1980s, Reston Town Center is built around a Fountain Square (**Figure 1**) with open avenues and pathways, noted for its Garden City design, and was a pleasant, calm location for the conference. In keeping with IMPI conferences, the hotel venue doubled as delegate accommodation which maximised opportunities for networking.

Figure 1. View of fountain square in Reston town center.

As usual, a day of short courses preceded the main 2 day conference. Immediately after the short courses, an Exhibitor Showcase took place with an impressive 18 exhibitors in attendance (**Figures 2, 3**) with a well-attended welcome reception buffet to kick-off lots of reacquaintances between old colleagues and plenty of new networking opportunities for everyone. Solid state (components, systems) were the dominant technology theme of the exhibitors.

The conference itself was opened by the Program Committee Chair, Prof Reeja Jayan with contributions from Ralph Bruce, Programme Vice-Chair, and John Gerling, IMPI President.

The conference had 118 registrations from 13 countries, with a student talk competition and 43 presentations in total. Two special sessions were included on Industrial Applications and THz Technology.

Figure 2. Welcome reception buffet during the exhibitor showcase.

Figure 3. Further photo of the welcome reception buffet during the exhibitor showcase.

The first presentation was a Keynote from Christina Wildfire from the US National Energy Technology Laboratory. She talked through her team's experiences and pain points in the development of microwave technologies particularly for conversion of materials into energy or value added products. The group is investing in facilities to complement lab facilities to better understand industry scale applications, and plan to pilot promising microwave chemistries in 2024 to scale-up.

A plenary session (**Figure 4**) followed on Biomedical and Bioengineering applications. David Vennin (Sairem) showed results from a pilot 54kW 915MHz continuous flow reactor (80 mm diameter, 1500 mm long tube), for decontamination of wheat grains. Capable of treating 1015 kg/h wheat grain, with an 8 sec microwave treatment time, total bacteria count reductions matched conventional methods. It was interesting that the microwave approach is a similar cost to conventional methods, but grain quality is improved.

Figure 4. Plenary session.

Parallel sessions followed on Chemistry & Plasma, and Food Technology. Solid state investigations were a recurring theme from presenters. Purposeful frequency shifting (typically over 2.4 to 2.5 GHz) for improved heating uniformity and avoided overheating was shown by several authors. Scale-up challenges (e.g. energy cost comparison to magnetrons) still need further research to deliver the process benefits.

Further parallel sessions on Solid State applications and Dielectric Properties were followed by the Annual IMPI Business meeting. IMPI currently has 211 members of which 29 are corporate members. Arjun Ghimere received the RF Schiffmann Memorial Scholarship award for 2024.

Day 1 ended with the conference dinner at the *Fogo de Chao* Brazilian steakhouse, a delighted experience with meat served from skewers at your table.

Day 2 kicked off an announcement on the newly elected IMPI Executive Board effective 1st June. John Mastela (JFM Technical) as President, Brian Blackwell (Odyssey Technical Solutions) as Vice President, Sean McKeown (Graphic Packaging International) as Treasurer and Candice Ellison (USDA-ARS) as Secretary. John F. Gerling (Gerling Consulting) will remain on the Exec Board as the Immediate Past President.

The keynote was delivered by your author, John Bows, on microwave process solutions to deliver positive food choices for consumers. This was from the perspective of large food companies, who own their own factories and process lines, hence it's much harder for them to disrupt highly cost-efficient processes with more expensive microwave-assisted processes. Successful commercialisation requires breakthrough thinking across finance, marketing, supply chain and R&D functions. The outlook for commercialising microwave processes is improving (for large food manufacturers) with increasing nutrition regulations (e.g. nutrient labelling front-of-pack), the electrification agenda and strategic statements from major food companies to offer more healthy food choices to consumers.

Parallel sessions followed on Modelling and Industrial Process Equipment followed by a plenary on Industrial Applications. Various topics were covered spanning particle beds, tuning considerations, catalysis, plasma torches, nanomaterial synthesis, ammonia and oxide syntheses.

The Day 2 final session was on THz technology. THz defined as 100 GHz to 10 THz (3 mm to 30 micron), historically a gap between photonic and optical techniques, though this gap has narrowed as devices creep into THz frequencies. With established applications in spintronics, astronomy, quantum optics and communications (6G), THz overlaps water relaxational motions and intermolecular vibrations of water and bio-macromolecules, so could have interested biological effects.

Permittivity measurements for extreme temperature conditions was presented by Cesar Nieves, Air Force Research Lab. In hypersonic flight, aircraft Radomes can reach 1000-1500°C hence dielectric properties at these temperatures are important for material characterisation. Marzena Olszewska-Placha (QWED) presented on low

temperature GHz and THz characterisation of ceramic materials. Driven by demanding new material requirements for 5G/6G & THz communications, co-fired glass ceramics at very low temperatures (<650°C) offer advantages in their material properties.

A Spotlight Panel on opportunities for young professionals was moderated by Beeja Jayan. Early career panellists Cesar Nieves, Jacob Sturgis, Zane Cohick and Aniruddh Vashisth talked about their route into their "RF engineering roles". Surprisingly, none are electrical engineers, and fell into their jobs serendipitously, learned on the job through hands-on experimentation. A lively Q&A followed with the audience on handling failure, biggest struggles, role of mentors, 5 year plan, and IMPI could support early year careers.

Throughout the 2 days, delegates networked and had refreshment & lunch breaks in the same room as the Exhibitors and posters, which greatly enriched the experience for all. The all-in-one venue location provided by a large hotel has its merits.

The conference closed with awards for Best Poster to Ryo Ishibashi, Best Oral Presentation to Anna Maria Cavazzini, and the announcement that IMPI 59 will be held 24-26 June, 2025 in Westin Edmonton, Alberta, Canada.

Ricky's Afterthought:

Matters AMPERE

A.C. (Ricky) Metaxas

Life Fellow St John's College Cambridge UK
Contact E-mail: acm33@cam.ac.uk

I was browsing through some of the AMPERE files and came across some of the activities that we were concerned with. It is perhaps worth updating our readers with some of these initiatives.

Memoranda of Understanding (MoU)

The first MoU that AMPERE instigated was with Union International de Electrothermie (UIE) starting in 2002 and is still ongoing. The latest collaboration entails a member of AMPERE being invited to present a plenary at the next UIE conference to be held in Nice in October 2024.

I then came across an MoU's with the Uk's High Power RF Partnership (HPRF) signed in Nov 2003. This was a UK Department of Trade and Industry grant funded partnership formed to generate UK wealth from UK knowledge and know-how in High Power RF and microwave engineering, to encourage closer relationships between UK industrial sectors and to promote lifelong learning. It was for an initial period of four years after which it could be renewed if both parties agreed. I recollect that I took part in a number of projects where engineers and scientists discussed potential projects. As is usual in a government funded initiative a change of government in the UK coincided with the initial period of the MoU and HPRF being dissolved hence the termination of our MoU.

In 2006 shortly after the Microwave working Group was formed, under the leadership of Bernie Krieger, the following organisations IMPI, AMPERE, The Microwave Working Group and JEMEA got together to form an MoU called MAJIC which stands for **M**icrowave, **A**MPERE, **J**EMEA and **I**MPI. After initial discussions it was agreed that this MoU should manifest itself in a quadrennial series of conferences of the four associations called **G**lobal **C**ongress **M**icrowave **E**nergy **A**pplications (GCMEA). The original MoU stated that other associations such as the Chinese and Indian should subsequently join if they wish. As we are all aware the Chinese CAMSA has already joined.

Finally another MoU started with the European Microwave Association (EuMA) for the period between Oct 2019 and Sept 2021. I recollect the exchange of speakers with the EuMA at our respective conferences. To my knowledge no recent exchange with the EUMA has taken place.

Standards, frequency spectrum and exposure guidelines

When I was heavily liaising with industry over 30 years ago, I was often asked about hazards relating to personnel engaged in running high power microwave and RF equipment. I stated the then recommended hazards and advised the users to use a hazard meter and check for leaks particularly after modifications to their system. Moreover I made the point that any new equipment that was installed in our labs originally at the Research Centre (Now called CTech Innovation) and subsequently at the Engineering Labs in Cambridge was carefully tested for leakage which emanated from input and output ports on a conveyorized system or from flanges stacked together without proper seals. I insisted in operating below what was then the recommended standard of 5 mW/cm^2 at 5 cm from any aperture. In fact in a closed system involving, say, a resonant cavity the leakage was often below 1 mW/cm^2.

AMPERE had a subcommittee which would often meet at our biennial conferences and one such meeting took place at Loughborough University in 2003 with **Peter Puschner** as a member of DIN/VDE working group K362 and convenor of

MT23 group 'Industrial Microwaves' within IEC TC27 and also as active link to SC61B 'Consumer, commercial and household microwave ovens', **David Sanchez** (then at Cartagena, Spain) as member of AEN/CTN-215 Spanish Committee "EM fields in the human environment" and a member of AEN/CTN-82 Spanish Committee "Electric & Electronic metrology"and also a member of CENELEC CLC/TC106X "EM fields in the human environment", **Walter Van Loock** as member of the Belgium Electroheat Technical Committee and **Cristina Leonelli** as member of Italian Technical Committee 27 (Electroheat). The minutes of the meeting made a fascinating read in that they considered not only RF and Microwaves but standards involving a host of other electroheat equipment such as plasmas, arc furnace, resistance heating and so on. They discussed the latest in **IEC TC27 (MT23) and CENELEC TC106X** and various other initiatives.

I am in no doubt that industrialists ask similar questions nowadays about hazards so as a prominent European association promoting the use of RF and microwaves at high power levels I ask whether we have kept abreast with the latest initiatives on standards and frequency allocation? Specifically, has anybody monitored the latest guidelines issued in reports published by the International Commission for Non-Ionizing Radiation Protection (ICNIRP) for limiting exposure to time varying electric, magnetic and electromagnetic fields (up to 300 GHz) and reports issue by its equivalent UK body, the National Radiological Protection Bureau (NRPB)?

Glancing at our Scientific Committee I cannot see a delegation relating to this topic. The closest might be the Industry link comprising five members. Perhaps they should be tasked to get themselves familiarised with the latest reports.

A recent paper updated the guidelines published in 1998 by the International Commission (ICNIRP) and is extremely comprehensive. The reference is given below and I advise many AMPERE colleagues who are involved with high power equipment to glance through that paper and absorbed the relevant sections applied to their operations.

However the latest report from NRPB dates back to 2003 when it reported on Health effects of radio frequency Fields written by the Independent Advisory Group on non-Ionizing radiation.

Founding members of AMPERE

Of the original 27 founding members when AMPERE was set up in the mid 1990's the only ones that are still regularly attending the biennial AMPERE conferences are John Bows and myself.

For further reading

Ramirez-Vasquez, R.; Escobar, I.;Vanderboch, G.A.E.; Arribas, E. Personal exposure to radiofrequency electromagnetic fields: A comparative analysis of international, national, and regional guidelines. Elsevier, Vol 246, 1 April 2024. Three of the authors are from University of Castilla-La Mancha while G.A.E. Vanderboch is with the Katholicke Universiteit in Leuven.

5GCMEA 2024

Timetable

5GCMEA 2024 Time Table (July 22-25, 2024)

2024/7/22	
Time	Concert Hall (Room A)
9:30	Opening
9:35	WS1 Einaga
10:05	WS2 Ohno
10:35	WS3 Ishihara
11:05	Coffe Break
11:20	WS4 Gregory
11:50	WS5 Tanaka
12:20	Lunch
13:30	Opening
13:35	WS6 Wada
14:05	WS7 Takizawa
14:35	WS8 Kono
15:05	WS9 Bell
15:35	Coffe Break
15:50	Panel Discussion
16:30	Welcome Reception

WS	Workshop
KL	Keynote Lecture
IS	Invited Speech
J	JEMEA Award Lecture
O	Oral presentation
O	Oral presentation (JEMEA session)
P	Poster presentation

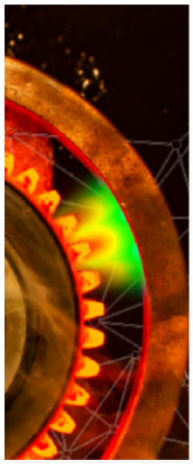
2024/7/23				
Time	Concert Hall (Room A)	Lecture Room 2 (Room B)	Lecture Room 4 (Room C)	Lecture Room 5 (Room D)
9:30	Opening			
9:40	KL1 Shang			
10:30	Coffee Break			
10:50	IS1 Jie	OB101	OC101	OD101
11:10		OB102	OC102	OD102
11:30	OA101	OB103	OC103	OD103
11:50	OA102	OB104	OC104	OD104
12:10	OA103	OB105	OC105	OD105
12:30	Lunch			
13:30	Poster (odd number) Exhibition			
13:50				
14:10				
14:30	OA104	OB106	OC106	IS2 Tsai
14:50	OA105	OB107	OC107	
15:10	OA106	OB108	OC108	OD106
15:30	Coffee Break			
15:50	OA107	OB109	OC109	OD107
16:10	OA108	OB110	OC110	OD108
16:30	IS3 Auresenia	OB111	OC111	OD109
17:00		OB112	OC112	OD110
17:20	KL2 Sutar			

2024/7/24				
Time	Concert Hall (Room A)	Lecture Room 2 (Room B)	Lecture Room 4 (Room C)	Lecture Room 5 (Room D)
9:30	KL3 Gerling			
10:20	Coffee Break			
10:40	OA201	OB201	OC201	OD201
11:00	OA202	OB202	OC202	OD202
11:20	OA203	OB203	OC203	OD203
11:40	OA204	OB204	OC204	OD204
12:00	OA205	OB205	OC205	
12:20	Lunch			
13:30	Poster (even number) Exhibition			
13:50				
14:10				
14:30	OA206	OB206	OC206	OD205
14:50	IS4 Murphy	OB207	OC207	OD206
15:10		OB208	OC208	OD207
15:30	Coffee Break			
15:50	OA207	OB209	OC209	OD208
16:10	IS5 Noto	OB210	OC210	OD209
16:30		OB211	OC211	OD210
17:00	KL4 Stefanidis			
19:00	Banquet			

2024/7/25				
Time	Concert Hall (Room A)	Lecture Room 2 (Room B)	Lecture Room 4 (Room C)	Lecture Room 5 (Room D)
9:30	KL5 Sugiyama			
10:20	Coffee Break			
10:40	IS6 Kon	OB301	OC301	J1 Yamanaka
11:00		OB302	OC302	
11:20	OA301	OB303	OC303	J2 Matsumura
11:40	OA302	OB304	OC304	
12:00	OA303	OB305	OC305	
12:20	Lunch			
13:30	IS7 Nishioka	OB306	OC306	OD301
13:50		OB307	OC307	OD302
14:10	OA304	OB308	OC308	OD303
14:30	OA305	OB309	OC309	OD304
14:50	OA306	OB310	OC310	
15:10	Round table			
15:30				
15:50	Closing			

THE DATEILED PROGRAM FOR WORKSHOPS, ORAL AND POSTER PRESENTATIONS IS AVAILABLE AT: https://www.5gcmea2024.jp/program.html

UIE 2024



UIE 2024
CONFERENCE
ELECTRIFICATION OF INDUSTRIAL THERMAL AND MANUFACTURING PROCESSES

NICE **FRANCE**
OCTOBER 8-11, 2024

PROVISIONAL AGENDA UIE 2024 CONFERENCE

	October 8th, 2024	October 9th, 2024	October 10th, 2024	October 11th, 2024
8:30 - 9:00		Conference opening		
9:00 - 9:45		Keynote 1	Keynote 2	Keynote 3
9:45-10:45		Decarbonisation of Thermal Processes by Electrification	Numerical Simulation of Electromagnetic-Coupled Processes	Microwave and Radiofrequency Heating
10:45-11:10		Break	Break	Break
11:10-12:30		Decarbonisation of Thermal Processes by Plasma Heating	Optimisation and Machine-Learning Tools for Design of Electromagnetic-Coupled Processes	Electromagnetics in Process Control and Monitoring
12:30-13:30		Lunch	Lunch	Conference closure
13:30-14:30		*Roundtable "Decarbonisation of Industrial Thermal and Manufacturing Processes"*	*Roundtable "Smart Processes: Integrating AI and Digitalization in Electro-Thermal Manufacturing"*	
14:30-15:10		Induction heating and heat treatment processes	Electromagnetic Melting and Stirring Processes	
15:10-15:40		Break	Break	
15:40-17:20		Induction heating and welding processes	Induction Cold Crucible and Skull Melting Processes	
17:20-18:00	Registration	Poster Session 1	Poster Session 2	
18:00 -	Welcome Cocktail			
19:00 -			Conference banquet	

FURTHER INFORMATION ARE AVAILABLE AT: https://uie2024.sciencesconf.org/?lang=en

AMPERE 2025

We wish to announce that during the 20th International Conference on Microwave and High-Frequency Applications: AMPERE 2025 to be held in Bari, Italy, 15-18 September 2025, a new one-day pivotal event dedicated to microwave and radiofrequency industrial applications, called the **AMPERE 2025 INDUSTRY DAY** will be staged.
It will be a unique meeting point for end-users, experts and enthusiasts of these technologies who want to discuss industrial scaled-up applications and share ideas, results, problems, and solutions.

There will be an Industry Day-only option, limited to one-day registration for industrial participants who wish to attend only the AMPERE 2025 INDUSTRY DAY. This does not include industry speakers, who must register for the full conference. This registration option covers all technical and social conference activities scheduled for the day.

Distinguished industrial speakers will reveal interesting details of how microwaves and radio-frequency can enhance modern industrial processes in two interactive sessions chaired by prominent experts in state-of-the-art industrial applications:

SESSION A - Industrial Microwave Heating
Main topics: Food Processing, Microwave Chemistry, Materials Production and Curing

SESSION B - Industrial Microwave Plasma
Main topics: Power-to-X including hydrogen production, industrial and gem diamonds

Speakers from the industry will have 20-minute for the presentation followed by a 5-minute interactive Q&A session from the audience.
The INDUSTRY DAY will be rounded off with short presentations by AMPERE 2025's industrial sponsors and exhibitors, and networking social events with delicious local food and drinks.

During one of the social events, the AMPERE President will award the special "AMPERE SCALE-UP" prize to highlight the value of the most remarkable industrial microwave application among those presented at the INDUSTRY DAY.

The new AMPERE Prize will be awarded after taking into account the results of a joint vote by the members of the AMPERE Industrial Committee and by all participants at the AMPERE 2025 INDUSTRY DAY.

The AMPERE 2025 INDUSTRY DAY, which will be held in a spacious conference room, is open to all registered academic and industrial participants who wish to explore world best practices that have allowed advanced R&D efforts to be transformed into real industrial applications with high added value.
For more information, please visit AMPERE website: https://www.ampereeurope.org/.

About AMPERE Newsletter

AMPERE Newsletter is published by AMPERE, a European non-profit association devoted to the promotion of microwave and RF heating techniques for research and industrial applications (http://www.ampereeurope.org).

New structure of the AMPERE Newsletter

At a management meeting during AMPERE23 it was decided that in view of the introduction of the new scientific Journal entitled "European Journal of Microwave Energy" supported by CUP, no technical papers will be published in future Issues of the Newsletter. Instead, AMPERE welcomes submissions for short bios on individuals, articles, research proposals, projects, briefs as well as news.

AMPERE Disclaimer

The information contained in this Newsletter is given for the benefit of AMPERE members. All contributions are believed to be correct at the time of printing and AMPERE accepts no responsibility for any damage or liability that may result from information contained in this publication. Readers are therefore advised to consult experts before acting on any information contained in this Newsletter.

AMPERE Newsletter

ISSN 1361-8598

https://www.ampereeurope.org/newsletter/