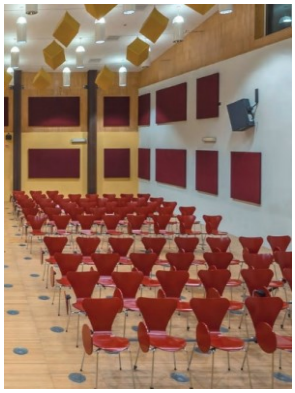
XXVII Conference
TURIN (Italy)

Energy Transition and Environmental Sustainability: Materials, Processes and Devices for Research and Industrial Applications

Turin, 6 - 9 May 2025 – Environment Park

The AIV XXVII Conference approaches the issues associated with materials and processing, in the research and manufacturing communities.
The four-day Conference promotes a multidisciplinary environment to encourage a cross fertilization between attendees on emerging technologies. We cordially invite you to participate to the 27th edition of AIV Conference that will offer the opportunity to present and discuss your recent advances in vacuum science and technology and related fields.



Summary

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Plenaries

The Museo Egizio, two hundred years after its birth (06/05/2025)

Christian Greco

Museo Egizio, Torino, Italy

Christian Greco is the Director of Museo Egizio since 2014. He is responsible for the projects of renovation and reorganization of the exhibition path of 2014-2015 and 2023-2025. He supervises the legal and financial aspects of the Museum and all the scientific activities. As Director, he promoted several temporary and travelling exhibitions, the organization of conferences and workshops, projects of social inclusion, as well as national and international collaborations with museums, universities and research institutes. Born in Italy, he obtained an MA in Classical Literature from Pavia University (Italy), another in Egyptology from Leiden University (The Nethelands) and a PhD from Pisa University (Italy). Before taking up the position of Director of Museo Egizio, he was curator of the Egyptian section of the Rijksmuseum van Oudheden of Leiden (The Netherlands) and member of the Epigraphic Survey of the Oriental Institute of the University of Chicago in Luxor (Egypt). Since 2011 he is Co-director of the joint Dutch-Italian mission to Saqqara (Egypt). He serves as a member of the scientific committees of several national and international museums and research institutions, among which the Museo Archeologico Nazionale of Napoli (MANN) and the Fondazione Scuola dei Beni e delle Attività Culturali (Italy). He is a member of the Accademia Olimpica di Vicenza and Advisor for the Ministry of the Antiquities and Tourism for the Grand Egyptian Museum, Cairo (Egypt). Between 2019 and 2022 he led the consortium made of Museo Egizio (Italy), Musée du Louvre (France), British Museum (UK), Neues Museum (Germany), Rijksmuseum van Oudheden of Leiden (The Netherlands) for the EU-funded project ‘Transforming the Egyptian Museum of Cairo’. He is the author of over 90 scientific publications and was keynote speaker in several national and international conferences. In parallel to his engagement as professor of Egyptology and Museum Studies in Italy and the Emirates, he delivers a significant amount of public lectures dedicated to the dissemination of knowledge. He received several prizes and awards, among which Best Director of an Italian Museum by Artribuen both in 2019 and 2022, Torinese dell’anno 2023 and Premio Ghislieri 2014. In 2021 he was invited speaker to the opening ceremony of the G20 of Culture in Roma. He is currently Honorary Consul of the Netherlands in Italy.

The Museo Egizio, two hundred years after its birth

On the occasion of the bicentenary of the Egyptian Museum, a major transformation of the museum's exhibition spaces and model of use is underway, which will be inaugurated according to a dense calendar between 2024 and 2025.
This transformation will be an opportunity to celebrate the Egyptological and museological disciplines, placing Turin and Italy at the centre of the international scientific and cultural debate, also retracing the long journey since 1824.

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This new chapter of renovation is based on an innovative and technologically advanced approach to improve the accessibility of the collection and interaction with different audiences. The numerous activities to reorganize the exhibition spaces have included the complete refurbishment of the Hall of Nefertari and Deir el Medina, while the new Gallery of the Kings and the Temple of Ellesiya will open on 20 November. In addition to these, new permanent halls will be created such as Matter. The shape of time, which will explore the role of modern technologies in the study of the past, or the exhibition Immersive Egypt, which will investigate the millennial relationship between the ancient Egyptians and the landscapes of the Nile Valley. Finally, the constant dialogue between ancient and modern, between art and science, will lead international artists Sara Sallam and Ali Cherri to develop works that will interact with the collection, questioning contemporary issues and problems.

Working with the future (07/05/2025)

Roberto Poli

UNESCO Chair in Anticipatory Systems, Department of Sociology and Social Research, University of Trento (Italy)

Roberto Poli is Full professor at the University of Trento, where he teaches Social Forecasting and Epistemology of the Social Sciences. Poli has obtained the UNESCO Chair on Anticipatory Systems, heads the master in Social Foresight (presently in its eleventh edition), and the series Anticipation science (Springer). He is President of AFI-Associazione dei Futuristi Italiani and -skopìa-Anticipation Services. Poli is in the Stanford list of most cited scientists, has published 7 books and more than 300 scientific articles. He edited the Handbook of Futures Studies (Elgar 2024).

Working with the future

Why is the future an increasingly important component of our decision-making efforts? "Working" with the future emphasizes that the future is far from being something we think, imagine, or fantasize about. Futures professionals (yes: there is a professional use of the future) do not simply "look" into the future but use it to make decisions. In my talk I will also explain why it is increasingly important to increase the information base we use to make decisions by including "information from the future".

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NewCleo's projects for clean, safe and sustainable energy (08/05/2025)

Francisco Garcia Ferrè

NewCleo Futurable Energy, Torino

Francisco is a global R&D management professional, with experience leading academic and industrial innovation. He has held a number of roles at CEA, Istituto Italiano di Tecnologia, and ABB, ranging from Researcher and Research Team Manager to Technology Center Manager and Global R&D Lead. At Newcleo, Francisco is Head of Unit - Materials.
A native of Buenos Aires, Francisco holds a Master of Science in Nuclear Engineering and a PhD in Energy and Nuclear Science and Technology, both from PoliMi with Honors.

Newcleo's projects for clean, safe and sustainable energy

Newcleo is working on advanced fission reactors fueled by reprocessed nuclear waste to deliver clean, safe, and affordable energy. In this keynote, we'll introduce the benefits of nuclear power and advanced modular reactors, sharing an overview about newcleo, its projects and its technology. The presentation will also describe the importance of materials for the project and newcleo's ambitious R&D programme.

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Failure-free electronics: fantasy or reality? (09/05/2025)

Luciano Bonaria

SPEA, Torino, Italy

Luciano Bonaria, in 2023, receives an honorary Master's Degree in Mechatronic Engineering for his outstanding contributions to mechatronic engineering as a designer of innovative testing equipment for electronic boards and circuits, as well as founder, CEO and president of SPEA, leading the company over the years to a role of global technological leadership in the sector of testing machines for electronic circuits and systems.For this commitment, the Polytechnic of Turin recognizes the great value of Luciano Bonaria's professional path and his vision of the future - underlines the Rector Saracco, who awarded the title.
Bonaria is the head of an established Italian industry leader at a global level and continues to be the driving force and inventor of most of SPEA's products.The Engineer was its founder, back in 1976, and is still active full-time in the company on a daily basis, with the roles of Chairman of the Board of Directors, CEO, "Design Architect" of products and commercial strategy, as well as "Inventor" of most of SPEA's products. SPEA is around the entire globe. A company with a strong and constant vocation for innovation, it invents and produces testing machines necessary for the manufacturing of electronics. Since its beginning, SPEA based its success on the capability to establish partnership with the most important electronic manufacturers worldwide. To attain this aim, SPEA has stacked on a great number of test engineers, and a network of branch offices placed in every area in the world where electronic manufacturing is located, from Europe to the Americas to Asia.

Failure-free electronics: fantasy or reality?

We are used to observing that electronics often create operating problems during use.
Although manufacturers of semiconductors and electronic devices have strict quality procedures applied in production processes, we have to see that electronics sometimes or too often break down or malfunction. But not all electronics break down, we observe that there is electronics that continue to work without faults and defects for many decades.
During the speech some questions will be addressed:
1 - What is the difference between electronics that break and those that don't break down?
2 - How to buy electronics that don't break down while you're using it?
3 - Everyone is interested in buying electronics that don't break down?
4 - Is every manufacturer interested in producing electronics that don't break down?

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Sessions and Invited

Surface Science and Engineering: thin films and nanomaterials

(Synthesis of multifunctional surfaces, interface design, nanostructured coatings, nanosized electronics, energy harvesting, biotechnology and bio-medical research surfaces for applications in harsh environments, cultural heritage: conservation and diagnostics)

(Paolo Ossi, Mario Rocca, Sebastiano Trusso).

"Surfaces and interfaces play a dominating role in our lives since they separate solid devices from the external world. Applications of surface science and engineering range from chemistry (catalysis and electrochemistry) to electronics (nanosized devices and two dimensional materials) and plasmonics (surface plasmons and surface optical properties) to medicine (biocompatible materials for prostheses). Surface properties are of overwhelming importance for nanosized objects since a relevant fraction of their atoms is exposed at the surface. Evergreen topics in the field include cultural heritage conservation and diagnostics, adhesion, and friction.
The session welcomes contributions on the synthesis of materials with peculiar surface properties, surface modification and functionalization, modeling of fundamental properties of surfaces, and advanced surface characterization techniques"

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Ligation and molecular activation at 2D biomimetic functional materials

Erik Vesselli

Department of Physics, University of Trieste (Italy); CNR - Istituto Officina dei Materiali (IOM), Area Science Park, Basovizza, Trieste (Italy); Center for Energy, Environment and Transport Giacomo Ciamician, University of Trieste (Italy).

Erik Vesselli is associate professor in experimental condensed matter physics at the University of Trieste and affiliated to the CNR-IOM Materials Foundry and to the Center for Energy, Environment and Transport Giacomo Ciamician. His main expertise is on synchrotron radiation applications and spectroscopic techniques for the characterization in situ and operando of model surfaces, nanostructures, thin films, 2D materials and heterostacks. He leads the IR-Vis SFG group of the University of Trieste, implementing sum-frequency generation vibronic spectroscopy for the characterization from UHV to ambient pressure of solid-liquid interfaces, 2D materials and surfaces. His main scientific interests concern the catalytic synthesis of clean energy vectors, growth and characterization of model 2D materials, biomimetic metallorganic networks, and single atom catalysts. He authored more than 80 peer-reviewed papers and delivered tens of seminars including invited talks and keynote lectures.

Ligation and molecular activation at 2D biomimetic functional materials

Complex mechanisms underlying the functionalities provided by tetrapyrrolic macrocycles in biochemistry fascinatingly include light harvesting, molecular transport, and catalytic conversion. The main function is determined by the single atom that is caged in the reaction pocket, with fine-tuning capabilities (band gap, chemical selectivity etc.) offered by the geometric and electronic structure of the macrocycle, including its residues, and by the proximal and distal surrounding structures. Hence, a scientific and technological challenge consists in the artificial replication of both structure and functionality of natural reaction centers in 2D ordered arrays at surfaces. Nano-architected 2D metalorganic frameworks can be obtained by self-assembly under controlled conditions at supporting surfaces and, in the specific case, porphyrin- and phthalocyanine-based systems have been widely investigated in ultra-high vacuum conditions by means of surface science approaches. However, in the case of ligation, the strong experimental constraint of vacuum conditions represents a relevant gap with respect to natural counterparts and to potential applicative views at both solid–liquid and solid–gas interfaces. A step forward in the direction of near-ambient pressure is necessary, while maintaining atomic level characterization accuracy. The in situ and operando characterization of heme-like, fundamental model systems has been tackled only very recently. I will review the findings in this direction so far with respect to relevant reactions like e.g. activation of carbon oxides and oxygen.

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Engineered metasurfaces coupled to quantum emitters for enhanced emission and nanolasing

Giovanni Mattei

NanoStructures Group, Department of Physics and Astronomy, University of Padova (Italy)

Giovanni Mattei is Full Professor in Physics since 2011 at the Department of Physics and Astronomy (DFA) of the University of Padova, Italy. He is Principal Investigator of the NanoStructures Group (NSG) at DFA and Scientific Coordinator of the Low Energy Ion Implantation Lab at the INFN-LNL National Laboratories, Padova, Italy. His main research interests are in nanophotonics, plasmonics, and quantum optics, with particular emphasis on the light-matter interaction at the nanoscale for controlling the emission efficiency of quantum emitters.He is the author of more than 310 publications in ISI Journals and of various chapters in scientific books. Currently, he has an h-index of 43 with about 7000 citations (Scopus). He holds 2 international patents.

Engineered metasurfaces coupled to quantum emitters for enhanced emission and nanolasing

Optical metasurfaces are engineered two-dimensional materials that can manipulate light at subwavelength scales. These metasurfaces offer a powerful platform for controlling the emission properties of quantum emitters, such as single molecules or atoms, when they are coupled in the near-field. By precisely designing the metasurface geometry and material composition, it is possible to tailor the local density of optical states, thereby enhancing or suppressing spontaneous emission rates, directing emission patterns, and even enabling polarization control. This capability is crucial for manipulating light-matter interactions at the nanoscale and for developing advanced quantum photonic devices, including single-photon sources, nanolasers, quantum sensors, and components for quantum information processing. Here we present three case studies of different metasurfaces for controlling at room temperature the emission efficiency of different emitters in the visible or telecom spectral range: (i) 2D ordered arrays of metallic nanoparticles coupled with dye molecules for coherent emission in the Vis range (nanolasers)1; (ii) slotted Si nanodisks arrays for the enhancement of the emission at λ = 1540 nm from Er3+ ions2; (iii) phase-change materials thin films based on VO2 for the active control of Er3+ ions3.

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Nuclear Fusion Technology

(Samuele Dal Bello, Espedito Vassallo)

"Nuclear fusion is the process where two lighter atomic nuclei combine to form a heavier nucleus, releasing a tremendous amount of energy. This is the same reaction that powers the sun and other stars. Hydrogen nuclei fusion can be generated using a tokamak machine (magnetic confinement fusion), where the fuel is heated until a plasma is formed, a high-energy state of matter where atoms are fully ionized. The plasma must be heated to temperatures of over 100 million degrees Celsius for fusion to take place. It is apparent from what has been said that making fusion a flexible, clean energy source is not without its challenges, not least the need for breakthroughs in both plasma physics and materials science, along with other complex engineering hurdles. The participants of the session will discuss the main issues related to the development of thermonuclear energy through international scientific research in the framework of the implementation of national and international thermonuclear projects"

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Progress in R&D on Plasma Facing Materials and Components for Fusion Devices

Rudolf Neu

MPI for Plasma Physics, Boltzmannstr. 2, 85737 Garching, (Germany)

After studying physics at the University of Tübingen and receiving his doctorate in nuclear physics in 1992, Rudolf Neu worked as a researcher at the Max Planck Institute for Plasma Physics (IPP) in Garching. In 2011 he was appointed adjunct professor at the University of Tübingen. After spending a year (2011/2012) as task force leader at the Joint European Torus (JET) in Culham, UK, he returned to Germany to became head of the ITER Physics Department at EFDA, the European Fusion Development Agreement (2012/2013). Since 2014, within the framework of a dual appointment, he has been a professor at TUM and head of an independent research group at IPP. His field of research is plasma material interaction and its effect on high temperature plasmas. The main emphasis of his current work is on the study of materials and components for the first walls of fusion reactors.

Progress in R&D on Plasma Facing Materials and Components for Fusion Devices

In view of the severe operating conditions for plasma facing components (PFCs) in future power producing fusion devices, the development of advanced components and materials is mandatory. The PFCs not only have to withstand high steady state power loads but also a high number of thermal cycles and shocks. Moreover, the change of thermo-mechanical properties by lattice damage, activation and transmutation through fusion neutrons has to be considered when designing PFCs and selecting adequate armour and structural materials. Presently, water-cooled PFCs are foreseen in all future fusion devices in order to provide reliable heat removal capability and to only moderately extrapolate the technologies developed and tested for ITER. However, attempts were undertaken to optimize the design as well as the armour and heat sink materials in view of future applications with even harsher conditions. The contribution will give an overview on the requirements for plasma facing components and the state-of-the-art solutions. In addition, new concepts and materials will be presented which should be capable of facing the challenges in future fusion reactors.

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The ITER Project: Status, New Baseline and Prospects

Mario Merola

ITER Organization, 13067 St Paul Lez Durance, France

Mario Merola got the PhD in Development and Testing of Plasma Facing Components of the ITER Fusion Reactor in 1993 at the Polytechnic of Milan, Italy. He was Assistant Professor in “Nuclear Plants” at the Polytechnic of Turin, Italy until 1996, when he joined The NET Team / EFDA in Garching, Germany, the former European co-ordination entity of the Fusion Technology Programme. He was Responsible for the European Technology Programme in the Divertor until August 2005. Then, M. Merola joined the ITER Organization at Cadarache, France, as Leader of the Divertor Section until September 2009 when he became Head of the Internal Components Division. From February 2021 till September 2023 he was Head of the Engineering Design Department before being appointed as Head of the Nuclear Technologies Program until July 2024 when he became Deputy Head of the Engineering Services Department, which counts about 750 ITER staff. He is author of more than 200 scientific papers, including invited talks at international conferences. He has participated to a number of Italian television broadcasts (“La Scala Mercalli” RAI 3, “TG2 Post” RAI 2, “Restart” RAI 2). On 2 June 2023, the President of the Italian Republic Sergio Mattarella appointed him Knight of the Order "To the merit of the Italian Republic" (Cavaliere dell’Ordine “Al merito della Repubblica Italiana”), for his scientific excellences.

The ITER Project: Status, New Baseline and Prospects

Fusion, the nuclear reaction that powers the Sun and the stars, is a promising long-term option for a sustainable, non-carbon emitting global energy supply. Harnessing fusion's power is the goal of ITER, which has been designed as the key experimental step between today's fusion research machines and tomorrow's fusion power plants. The ITER Project has gone through a period of transition, with progress continuing despite challenges, and is moving forward on the basis of a new project baseline. Following more than a year of review, a new baseline proposal was submitted to the ITER Council in June 2024, and is now serving as the working reference schedule. The discovery and analysis of geometric non-conformities in the bevel joints of several vacuum vessel sectors, as well as chloride corrosion cracking in the cooling pipes of the thermal shields, led to a slowdown in ITER tokamak assembly while repairs are carried out. In parallel, an assessment of root causes, including a thorough self-examination of project quality culture, was followed by a reorganization to prepare for the challenges ahead.

Meanwhile, progress has continued on construction, manufacturing, assembly, and system commissioning. The power supply systems, cryogenics plant, and cooling water system have completed installation and are largely commissioned. All poloidal and toroidal field coils have been delivered, as well as most of the central solenoid modules and many other major components.

The largest task over the past year has been to channel all of these elements into a realistic, feasible updated project baseline. In the resulting proposal, the previously envisioned stages

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of assembly and operation are largely consolidated. Technical and operational risks are mitigated by incorporating the divertor, shield blocks, a sacrificial first wall, and other risk-reducing components into a more complete machine before initial operations, as well as fully testing some toroidal and poloidal field coils before installation. Highlights from these areas (manufacturing, tokamak assembly, system commissioning), will be presented along with the updated baseline proposal and other aspects of project status. ITER construction is now progressing amid challenges, and the following exploitation of the machine promises to pave the ground for the demonstration of the goal of producing electricity from fusion power for the benefit of mankind.

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Innovative technologies for precision agriculture and models for sustainable nutrition

(Digital farming, mobile and in-field devices, sensors, customized robotics, transforming and sustainable food production, nutrition security, sustainable food profiling models, modeling methodology)

(Sergio Ferrero, Fabrizio Giorgis)

"The aim of this session is to share experiences and new ideas on Smart Agrifood Sciences, bringing together scientists from different fields. The concept of circular economy, related to the development of bio-based and green processes will be exploited.

In such framework, digital farming, innovative sensors and detection methods, new mobile and in-field devices, transforming and sustainable food production, nutrition security and sustainable food profiling models will represent the main topics, in an interdisciplinary approach"

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Sustainable nutrition between circular economy, new technologies and "novel food" regulation: a challenge for the new generation of food scientists

Marco Arlorio

Department of Pharmaceutical Sciences - University of Piemonte Orientale "A. Avogadro", 28100 Novara (Italy)

Marco Arlorio is Full Professor of Food Chemistry, to date serving as Director of the Department of Pharmaceutical Sciences, University of Piemonte Orientale (Novara, Italy). In the recent past, he was Chair of the Division of Food Chemistry, EuChemS (Brussels, B), now serving as past-Chair in the same Board. Former member of the Executive Board of the SAFE Consortium (Brussels, B), in 2020 he was appointed in the Scientific Advisory Committee of ILSI Europe (Brussels, B) where he is currently working. He led the interdivisional Group of Food Chemistry within the Italian Chemical Society (SCI, Rome, IT). He is a member of the Food Allergies Board of the Ministry of Health in Italy (Rome, IT). Member of Scientific Committee and organizer of different international Congresses (EuroFoodChem, Pigments in foods, CoCoTea, In vino Analytica Scientia, RAFA and others). His main scientific interested is related to food quality, safety and integrity, especially focusing on new functional ingredients for food and food supplements. Marco has received numerous awards and recognitions for his work.

Sustainable nutrition between circular economy, new technologies and "novel food" regulation: a challenge for the new generation of food scientists

The concept of a "sustainable nutrition" for humans is considered a key topic worldwide. The development of alternative sources of protein and new sustainable technologies, as well as the up-cycling of by-products/waste collected from the agrifood chains, will be probably the main goals for the food scientists in the next decade. Moreover, the "food design" applied to the production of new safe "functional" foods with high nutritional density is considered today the selected strategy for a smart and customized nutrition. According with the "circular economy" concept, often strictly related to the development of "bio-based and green" processes, a large number of by-products may be considered an interesting source of new ingredients/molecules, addressed to functional foods and food supplements market, beside the pharmaceutical one. Unfortunately, some performing technological approaches sometimes faces with regulatory-related limits, leading to novel ingredients and novel foods (Regulation EU 2015/2283). The food safety, beside the food quality concept, is the required pre-requisite for a high quality nutrition in the future: the challenge of food integrity (in terms of food authenticity and food traceability assessment) is also strictly linked with the new technological approaches, like block-chain and the smart at-line/on-line analytical sensoring. Rapid analytical methods will permit in the future a quick response in food analysis, allowing to ensuring food safety for consumers at different level of application.
All these topics will be discussed in this oral communication, particularly debating the limits and the technical gaps to be bridged in the next future.

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Horizon Scanning, Omics Methodologies and Data Analysis: How advanced technologies may help in ensuring food safety in circular economy

Chiara Dall'Asta

Department of Food and Drug, University of Parma, 43124 Parma (Italy)

Chiara Dall'Asta is Full Professor of Food Chemistry, to date serving as Rector's Delegate for Doctoral programmes at the University of Parma, Italy. She has been also appointed Honorary Professor of Food Science, School of Biological Sciences, Queen's University Belfast (UK).
In 2023 she was appointed as member of the Directive Committee of the Division of Food Chemistry, within the Italian Chemical Society (SCI, Rome, IT). Since 2014 she has been participating as experts to several EFSA working group within the CONTAM Panel, and has co-authored 8 scientific assessments.
Chiara is mainly interested into natural compounds and their biological effects as well as in the application of advanced non-targeted methodologies (i.e. i.e. High-Res MS, imaging-MS, ion mobility MS, ambient MS) to food fingerprinting and markers identification. She is also active in the field of computational toxicology applied to food and in application of risk-benefit assessment to novel food.

Horizon Scanning, Omics Methodologies and Data Analysis: How advanced technologies may help in ensuring food safety in circular economy

In the past decade Circular Economy principles have revolutionized the agro-food system, allowing for a more sustainable use of resources and increasing the upcycling and valorization of food and feed production side streams. However, a transition to a more sustainable circular economy will likely bring additional vulnerability to the food and feed sector. Setting up a multidisciplinary methodological toolbox for anticipating and mitigating the risk is therefore a priority in order to facilitate the transition while ensuring public health as well as environmental safety. One of the most promising methodologies so far, horizon scanning involves systematically examining potential threats and opportunities in the food supply chain, allowing stakeholders to proactively prioritize and tackle risks to maintain food safety standards in a dynamic and interconnected global market. On the other hand, omics technologies paired with advanced data analysis can help in identifying patterns and correlations that might be missed by traditional analysis methods, providing deeper insights into biological phenomena and ultimately improving safety and resilience in the agri-food system. In the context of a circular economy, these advanced technologies support sustainable practices by optimizing resource use, supporting informed upcycling, and allowing prioritization along the supply chain. Starting from real-world case studies, this oral communication will discuss opportunities and limitations in the use of advanced and innovative methodologies for ensuring food safety under a circular economy approach.

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Innovation in Vacuum technology: advances in measurements, gas analysis, pumping and large systems

(Particle accelerators, large interferometers and energy research)

(Giuseppe Firpo, Michele Mura)

"*Advancements in vacuum technology are driving innovations in measurement techniques, gas analysis, pumping systems, and large-scale applications such as accelerators, interferometers, and vacuum fusion plants. Focus areas include gas flow studies at microscale and low pressures, particularly in low-permeability porous materials for filtration and flow control. New methods for accurately measuring gas permeability and theoretical models based on gas kinetic theory will be presented. Additionally, quantum-based standards for vacuum science, leveraging the redefinition of SI units, will be examined. Emerging technologies such as Artificial Intelligence (AI) and Additive Manufacturing (AM) will also be explored for their potential to enhance vacuum systems and processes.*"

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Experimental and numerical characterization of gas flows at microscale and low pressure: applications to gas transport in low permeable porous media

Irina Grau

IUSTI UMR CNRS 7343, Aix Marseille Université, France

Professor Irina Grau graduated from Lomonosov Moscow State University in Applied Mathematics. She also received her PhD from Moscow State University in 1989 and joined the Keldysh Institute of Applied Mathematics where she set up her activity in the field of rarefied gas dynamics. In 2000, she joined the University of Provence in France and established a group on experimental and numerical study of gas flows at the microscopic scale. She obtained the habilitation to supervise research in 2008 and joined the University of Aix-Marseille as a full professor. Irina Graur has made numerous contributions in the field of rarefied gases for aerospace research. Her current research interests include experimental and numerical characterization of gas properties at the micro and nano scales. She leads the research group “Non-equilibrium phenomena and microfluidics” at IUSTI laboratory. She has participated in the organization of a number of international conferences, workshops and summer schools. She is co-author of more than a hundred journal articles and conference communications.

Experimental and numerical characterization of gas flows at microscale and low pressure: applications to gas transport in low permeable porous media

Gas flow through low-permeability membranes is of great interest, particularly in vacuum technology for applications such as filtration, separation processes, protection, and flow control. These membranes can combine a high mass flow rate with a high degree of rarefaction. This characteristic makes them particularly useful as leak elements, benefiting from the constancy of conductance in the free molecular regime, for example, in the calibration of ionization gauges or mass spectrometers. The constant volume technique, originally developed for measuring mass flow rates through microchannels, has been adapted to characterize the permeability of low-permeability porous media. This experimental method offers greater accuracy and shorter experiment times compared to other commonly used methods like "pulse-decay" techniques. Additionally, modeling based on gas kinetic theory enables the extraction of useful parameters, such as the “characteristic flow dimension” of a porous medium. Several examples of applying this methodology are presented for various types of porous media and different gases, under both isothermal and non-isothermal conditions.

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NIST on a Chip Program, Quantum-Based Standards for Vacuum Science Technology Innovations and Beyond!

Jay H. Hendricks

NIST National Institute of Standards and Technology, Gaithersburg (USA)

A world-class expert in low pressure and vacuum metrology, Dr. Hendricks is the Deputy Program Manager for NIST on a Chip (NOAC), an innovative approach that seeks to utilize fundamental physics to develop quantum-based sensors and standards. Dr. Hendricks received his M.A. and Ph.D. in Physical Chemistry from Johns Hopkins University (1996), and his B.S. in Chemistry from Penn State University.
Dr. Hendricks has authored 114 publications on vacuum science, metrology and technology, surface chemistry, and on-beam laser spectroscopy (source google scholar). He holds 6 patents US Patents vacuum science technology. He is a two-time winner of US Department of Commerce Gold Medal (the highest honor the Commerce Department Awards), for an innovative quantum-based pressure standard and the encasement of documents of historical significance including the US Bill of Rights, and the US Declaration of Independence. He is the President-Elect for IUVSTA (International Union of Vacuum Science, Technique and Application)

NIST on a Chip Program, Quantum-Based Standards for Vacuum ScienceTechnology Innovations and Beyond!

The re-definition of the SI units enables new ways to realize fundamental units. Quantum-based metrology systems, however exciting, do raise new challenges and several important questions: Can these new realizations enable the size and scale of the realization to be miniaturized to the point where it can be imbedded into everyday products? What will be the role of metrology institutes in the is new ecosystem of metrology and measurement? This talk will begin to explore these important philosophical questions. The technical core of the lecture will be a deeper dive into research on measurement methods for pressure, the Fixed Length Optical Cavity (FLOC) and for vacuum the Cold Atom Vacuum Standard (CAVS). What is exciting about many of these new measurement approaches is that they are both primary (relying on fundamental physics), are quantum-based and use photons for the measurement readout which is key for taking advantage of the fast-growing field of photonics.

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Science and Technology R&D for Innovative Vacuum Systems

Roberto Kersevan
Vacuum, Surfaces and Coatings Group
Technology Department
CERN Geneve (GH)

Graduated in physics in 1985, with a thesis on CO dissociation kinetics on Ni single crystals. In 1988 joined the Elettra light source design team. He then left for the SSC collider project in Dallas, 1992. Upon termination of SSC in 1994 he joined the CESR e-e+ collider team at Cornell for a redesign of the vacuum in the interaction region. Moved back to Europe to join ESRF as head of vacuum group, in 1997. In 2004 took a 1-year sabbatical leave to join the SNS team at Oak Ridge. Left ESRF in 2009 to join the ITER project. Joined CERN's vacuum group in 2011. Member of Machine Advisory Committee for ALBA, SLS, SLS2, Diamond, Diamond-2, ESRF-EBS, SESAME, MAX-IV, Soleil 2.0 light source projects. Reviewer for FRIB, NSLS-II, APS-U, ALS 2, CEPC e-e+ collider, MAX 4U.Lecturer at IUVSTA-sponsored Gas Dynamics workshops and JUAS/CERN accelerator schools.

Mainly known for having been the first to characterize and install NEG-coated chambers on a light source ring (ESRF). Original developer of the Molflow+ and SYNRAD+ ray-tracing montecarlo codes.

Science and Technology R&D for Innovative Vacuum Systems

The field of vacuum science and technology for accelerators is evolving rapidly in order to keep pace with the challenging design of new machines. In particular, the diffraction-limited 4th generation light sources present major design and pumping challenges due to their very aggressive design characterized by very small vacuum chamber cross-sections, compared to previous generations. High-energy colliders also present new challenges (e.g. FCC-ee and –hh, CEPC, EIC). New materials and fabrication techniques are being adapted to vacuum components, to cope with extremely high power densities and mechanical forces (e.g. synchrotron radiation and superconducting magnets' quenches). In parallel to this, novel simulation tools have been developed, most notably the suite of ray-tracing montecarlo codes Molflow+ and SYNRAD+ which have become a de-facto standard in industry and other scientific fields, like design of gravitational wave detectors, contamination of space probes and satelittes, micromechanical devices, and more. Examples will be given of all this.

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Energy Transition: Energy production, Storage and Environment

(New technologies, systems and devices for energy conversion, storage and power consumption reduction)

(Andrea Lamberti, Stefano Lettieri, Maria Miritello, Giulia Mossotti, Luciano Scaltrito)

"The energy transition is at the forefront of global efforts to combat climate change and achieve sustainable energy systems. This session will explore cutting-edge technologies and innovations in renewable energy production, including solar, wind, and geothermal power, as well as emerging solutions like hydrogen fuel and bioenergy. Focus will also be given to advancements in energy storage, such as next-generation batteries and electrochemical systems, which are critical for balancing intermittent renewable sources. Techniques for carbon capture, utilization, and storage (CCUS) will be discussed, with particular emphasis on their role in reducing industrial emissions. Additionally, novel methods for electrochemical fixation of CO2 will be examined. The session will highlight the integration of these technologies into systems that aim to reduce overall power consumption, increase energy efficiency, and address the environmental impact of energy production and consumption"

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About the use of the versatile chemistry of nanoporous carbon materials for energy storage and conversion

Martin Oschatz

Institute of Technical and Environmental Chemistry and Center for Energy and Environmental Chemistry Jena, Friedrich Schiller University Jena, Philosophenweg 7a, 07743 Jena (Germany); Helmholtz Institute for Polymers in Energy Applications Jena (HIPOLE Jena), Lessingstraße 12–14, 07743 Jena (Germany)

Prof. Dr. Martin Oschatz is currently a Full Professor (W3) at the Institute of Technical and Environmental Chemistry, Friedrich Schiller University Jena, Germany. He studied Chemistry (B.Sc. and M.Sc.) at TU Dresden, where he earned his PhD in 2015 (summa cum laude) with research on nanoporous carbon materials. His career includes a research stay at Georgia Institute of Technology, a postdoctoral position at Utrecht University, and leadership roles at the Max Planck Institute of Colloids and Interfaces. Oschatz has received several academic distinctions, including an ERC Starting Grant in 2021. He is also engaged in various scientific boards and editorial roles, and declined a W3 professorship at the University of Potsdam in 2021. His work primarily focuses on materials for energy applications and catalysis.

About the use of the versatile chemistry of nanoporous carbon materials for energy storage and conversion

Nanoporous carbon materials play an ever increasing role in various fields like gas purification, electrochemical energy storage/conversion, and catalysis. In all of them, adsorption phenomena on the carbon surface are crucial for the working principles of the respective devices. It is well known that the adsorption properties of such materials are a function of their pore architecture. Pore size, pore geometry, pore connectivity, and pore hierarchy determine important factors like mass transport and the strength of interaction with different guest species. Another (and possibly even more powerful) “regulation screw” to control the adsorption properties of nanoporous carbon materials is their atomic construction. The controlled integration of heteroatoms (most often nonmetallic group III or group V and VI elements with nitrogen being the most widely studied heteroatom) into porous sp2-based carbon networks can significantly change their physicochemical properties. This includes but is not limited to their acidity/basicity, oxidation resistance, electric conductivity, and surface polarity. In order to make use of these effects it is important that the heteroatoms are significant in number, that they are uniformly distributed over the bulk of the material, and that the local atomic construction motives are as defined as possible. The synthesis of nitrogen-rich carbon materials by controlled condensation of well-defined nitrogen-rich molecular precursors is a particularly elegant way to synthesize porous carbon materials with large concentrations and precisely incorporated heteroatoms. My presentation will give an overview of the attempts in my research group at the FSU Jena to develop synthetic methods for the precise tailoring of the chemical architecture and pore structure of functional nanoporous carbon materials. Special focus will be on the fabrication of all-carbon hybrid materials which combine a rather heteroatom-rich carbon phase and a pristine porous carbon on the nanoscale to combine, for instance, a demanded chemical property with high electrical conductivity. The structure-property-relationships of these materials in some selected energy applications like the adsorption and electrochemical

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conversion of small molecules (CO_2 or N_2) as well as in sodium ion battery electrodes will also be presented.

Photovoltaics: how one of the most underestimated technologies in history is leading the energy transition

Massimo Mazzer

IMEM - CNR, Parma (Italy)

Massimo Mazzer is a physicist with 30 year experience in the field of photovoltaics in Italy and in the UK. He is currently the head of the team "Materials and Technologies for Green Energy" of the CNR-IMEM institute in Parma, Italy. Over the last 7 years he has represented Italy in the IWG-PV of the SET Plan and coordinated the Italian Network of Photovoltaics for R&I (ReteIFV). Since December 2024 he has also been a member of the Scientific Council of CNR.

Photovoltaics: how one of the most underestimated technologies in history is leading the energy transition

Photovoltaics is booming at the global scale. The cumulative installed capacity crossed the 2TW mark in November 2024, only two years after the historic milestone of the first TW was reached while the global economy was bouncing off the COVID crisis. Today about 8% of the global electricity demand is met by PV whose growth rate is such that the cumulative installed capacity could top 100TW by 2050. Cost is driving this rapid expansion as PV is now by far the cheapest energy source as well as the most sustainable in terms of carbon footprint in most of the world. In this talk the potential of the new PV technologies to change the way we generate, distribute and consume electricity will be analysed in combination with the results of several models of sustainable energy systems at different scales. Research and Innovation along the whole PV value chain is bound to play a key role in the effort to meet the energy transition and the decarbonisation targets. Europe and Italy have still the opportunity to be at the forefront of the transition despite their current weakness on the global PV market. In fact, the market is rapidly developing and new opportunities are emerging, particularly in the field of Integrated Photovoltaics (IPV) where volume manufacturing might not be a prerequisite for competitive advantage. Are we ready to take advantage of these opportunities or are we underestimating the potential of photovoltaics once again?

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Special Session: Energy Storage

This session represents a dissemination event of the *Orangees project*

The ORANGEES (ORgANics for Green Electrochemical Energy Storage) project activity is aimed at the synthesis, characterization and validation of innovative, eco-sustainable and low-cost materials for application in electrochemical storage (SAE) systems, such as batteries and supercapacitors (SC). The activities concern the study of both hybrid (inorganic/organic) and purely organic materials, isolating among them those obtained from waste compounds (e.g., Biomass), with the idea of progressively increasing the degree of environmental sustainability of the proposed solutions from which storage technologies will benefit in the medium to long term

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La ricerca di sistema: Energy Storage Projects in Italy

Alessandra Di Blasi

ITAE - CNR, Messina (Italy)

The research activity is mainly focused on the field of chemical methods and processes for the storage and transformation of energy. The professional profile covers knowledge in the electrochemical storage sector, specifically in the field of materials for post-lithium (redox flow batteries-RFB,Metal-ion/air battery), Na-ion battery and lead acid batteries, as well as the field of hydrogen production and utilization by PEM fuel cell and PEM electrolyzer technologies, from materials up to prototypes development and electrochemical characterizations. Energy storage national projects manager financed by La Ricerca di Sistema (RdS): AdP PT 22-24 “Integrated Project: Tecnologie di Accumulo elettrochimico e termico” and Tender type A “Organics for green electrochemical energy storage “ ORANGEES. Co-author of 57 papers on International Journals and over 100 scientific contributions at international conferences, meetings and schools. Her papers have been cited more than 3000 times and her H-index is 39.

La ricerca di sistema: Energy Storage Projects in Italy

European research in the electrochemical storage sector (ESS) is increasingly focused on sustainable solutions to achieve the 2050 decarbonization goal, from material selection to process optimization. In alignment with the European roadmap and the PNIEC objectives, Ricerca di Sistema (RdS) funds strategic projects critical to the Italian energy grid. Through an Integrated Project on electrochemical and thermal storage within the AdP-PT 22-24, and the ORANGEES Project—funded by the PT 19-21 program—RdS has supported research activities in ESS with investments of national importance, targeting both medium- and long-term advancements. CNR showcases several key achievements, ranging from the synthesis of bio-based materials for electrochemical storage devices to experimental testing on commercial lithium-ion batteries.

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Additive and Smart Manufacturing: Materials, Technologies and Applications

***(Exploiting additive manufacturing, materials and processes, design for additive manufacturing, next generation of additive manufacturing technologies*)**

(Valentina Bertana, Annalisa Chiappone, Matteo Cocuzza, Ignazio Roppolo, Stefano Stassi)

"Additive manufacturing (AM), also known as 3D printing, is rapidly expanding its reach across various industries. Its versatility in handling a wide range of materials, from fine powders to viscous liquids and from polymers to metals, enables the fabrication of prototypes at diverse scales. This adaptability has made AM an invaluable tool for rapid prototyping and iterative design processes. Beyond traditional prototyping, AM is increasingly used to create functional prototypes. Additionally, the development of new materials enabled the possibility to produce parts that can actively respond to external stimuli, opening-up new unexplored possibilities. In this context, this session aims at disseminating the most recent advances and the innovations in additive manufacturing and smart fabrication"

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CerAMfacturing - Trends and challenges in the additive manufacturing of ceramic components

Uwe Scheithauer

Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Dresden (Germany)

Dr.-Ing. Uwe Scheithauer (Dresden,1980) studied Mechanical Engineering at the Technische Universität Dresden, from October 1999 to October 2005, specializing in textile machinery engineering. Since November 2005, he has been a scientist at the Fraunhofer IKTS. In March 2021, he earned his doctorate from the Technische Universität Dresden under the supervision of Prof. Dr. Alexander Michaelis, with a focus on shaping dense piezoceramic fibers. Since 2022, he has led a group dedicated to additive and hybrid manufacturing. He is member of the User Group Additive Ceramic Manufacturing of the German Ceramic Society since 2023, where he currently leads the "Standardization" Working Group. He also represents IKTS in the Fraunhofer Society's Additive Manufacturing competence field. Dr. Scheithauer has authored over 100 publications and holds more than 20 patents. Since 2018, he has been a lecturer at the TU Dresden.

CerAMfacturing - Trends and challenges in the additive manufacturing of ceramic components

Ceramics are used where other materials fail. Their main advantages are their excellent thermal, chemical and mechanical properties. However, ceramics are not yet widely used because, in addition to their low ductility, complex mechanical processing using conventional methods (e.g. milling) poses a major challenge. In addition, the integration of various functions into one component is only possible to a limited extent. Additive manufacturing (AM) technologies act as a "game changer" here. Geometrically highly complex ceramic components with previously unattainable functionality can now be produced. And the potential in terms of miniaturization and additional functionalization by combining different materials in a single component is also enormous and will be shown in the presentation using a few examples. So far so good. But why don't we see additively manufactured ceramic components everywhere? In this presentation, I will discuss the technical, economic and regulatory challenges that still exist along the entire process chain for ceramic AM components. What still needs to be done and where, and what approaches are there?

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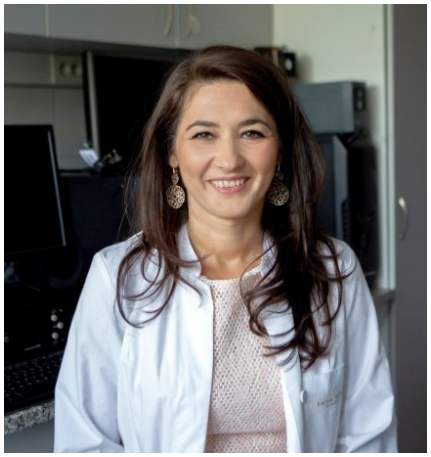
Novel Radical and Cationic Photoinitiators and Their Potential for Developing Innovative Photo-Curable Resins for 3D-Vat Printing of Polymeric Nanocomposites

Joanna Ortyl
Cracow University of Technology, Poland



Joanna Ortyl is professor at the Faculty of Chemical Engineering and Technology, Cracow University of Technology. After her PhD, she completed a research internship at Müenster University of Applied Sciences in the Institute for Optical Technologies (Germany) in 2012-2013. In 2013, she also completed the Master of Business Economics (MBE) course at the Haas School of Business at the University of California, Berkeley (USA). She is the inventor of more than 30 patents and has received more than 50 international and national awards for her research. She is a laureate of the Rector's Award of the Cracow University of Technology for 2017, as well as a manager of scientific projects funded by the Foundation for Polish Science, the National Science Centre, or the National Centre for Research and Development. Her research is always based on organic chemistry, photochemistry of small molecules, and photochemistry of polymerization processes and is always correlated with practical applications. Current research interests are: modern photochemical technologies, synthesis and characterization of photochemical and photophysical properties of initiators of polymerization, photochemistry and photophysics of spectroscopic probes. She conducts interdisciplinary scientific research activities at the intersection of photochemistry, chemistry, materials engineering, chemical engineering, and cell biology including studies on new photo-curable materials (including composites and nanocomposites) for 3D printing in photochemical technologies

Novel Radical and Cationic Photoinitiators and Their Potential for Developing Innovative Photo-Curable Resins for 3D-Vat Printing of Polymeric Nanocomposites

The advancement of 3D printing technology has revolutionized the field of material science, particularly through the introduction of innovative photo-curable resins. This presentation explores the development and potential applications of new radical and cationic photoinitiators in the creation of these resins, specifically designed for 3D-VAT printing of polymeric nanocomposite materials.By focusing on the synthesis and characterization of these novel photoinitiators, we aim to enhance the curing efficiency and mechanical properties of the resulting materials. This talk will cover the fundamental principles and mechanisms by which these initiators operate under light, as well as their interaction with various polymer matrices and nanofillers. Moreover, we will discuss the advantages these new photoinitiators bring, including improved thermal stability, greater control over polymerization rates, and the ability to produce materials with enhanced strength and durability. The introduction of these advanced resins opens up new possibilities for applications in diverse fields such as electronics, aerospace, and biomedicine, where precision and material performance are critical. Through this presentation, attendees will gain insights into the promising future of 3D-VAT printing technology, driven by cutting-edge

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photochemical advancements, which are set to lead to more sustainable and efficient manufacturing processes.

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Participating Companies

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