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Abstract Deadline • October 15, 2025

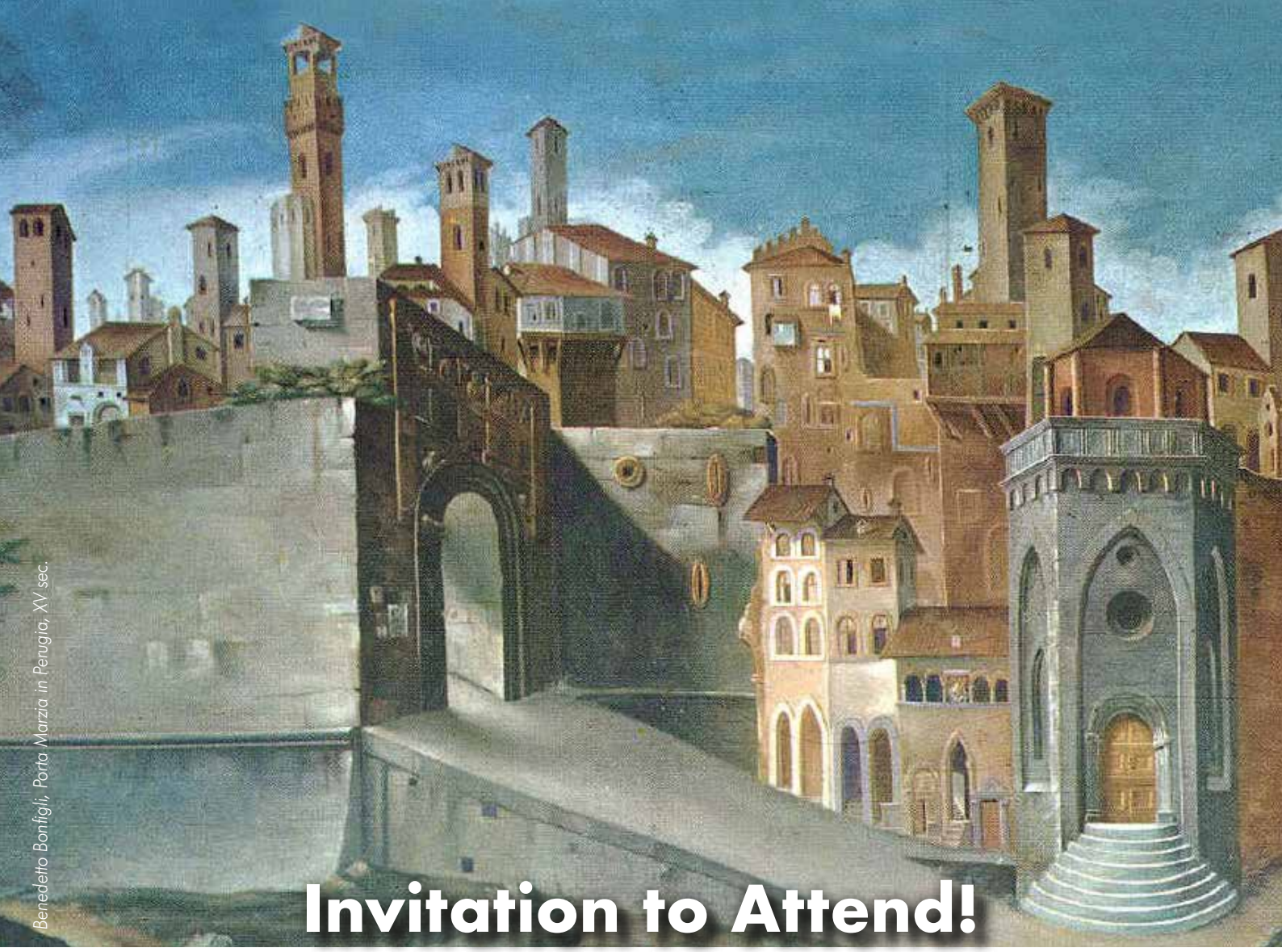
Perugia - Italy • June 15-25/2026

CIMTEC 2026

16th International Ceramics Congress
June 15-19/2026

10th Forum on New Materials
June 21-25/2026

www.cimtec-congress.org



Benedetto Bonfigli, Porta Marzia in Perugia, XV sec.

Invitation to Attend!

CIMTEC 2026 - 16th International Conference on Modern Materials and Technologies - will be held in Perugia, Italy, June 15 to 25, 2026. It will feature the 16th International Ceramics Congress (June 15-19) and the 10th Forum on New Materials (June 21-25), each of them including a number of international Symposia and Conferences. As a major longstanding event for the international materials community, CIMTEC will gather together a large and qualified audience of materials scientists, physicists, chemists and of experts of a wide range of the most demanding application engineering areas of modern materials, from the molecular and nanoscales to large complex integrated systems.
The National Research Council of Italy (CNR) and the National Agency for New Technologies, Energy and the Economic and Sustainable Development (ENEA) will act as major endorsers of CIMTEC 2026 together with the World Academy of Ceramics (WAC) and The International Ceramic Federation (ICF).

Chair, Co-Chairs and CIMTEC 2026 Symposia/Conferences Conveners invite you to foster the progress in the field by contributing with your expertise to what promises to be a very comprehensive and exciting event, and to enjoy the immense unique artistic heritage and wonderful landscape of Umbria district.

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General Chair CIMTEC Conferences
National Research Council, Italy

Co-Chairs CIMTEC 2026

Mrityunjay Singh
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International Ceramic Federation

CIMTEC 2026

CIMTEC 2026

Perugia, June 15-25, 2026

16th International Ceramics Congress
June 15-19, 2026

10th Forum on New Materials
June 21-25, 2026

Symposium CA

Advances in Processing Science and Manufacturing of High Performance Ceramics and Composites

Recent progress in the science and manufacturing of advanced ceramics and composites will be at the forefront of this symposium. Topics will include both conventional powder processing routes and innovative, environmentally friendly, energy-efficient "green" processing methods. The scope spans dense and porous bulk materials, composites, thick and thin films, laminated and graded structures, and hybrid and hierarchical nanostructures.
Key focus areas include the rational improvement of traditional powder synthesis, processing, and sintering methods, along with the mechanisms and kinetics underpinning novel fabrication techniques. Emerging directions for designing complex, high-performance structures—from the atomic and molecular scale to micro-, meso-, and macro-structures—will also be emphasized. These advancements aim to optimize properties for specific performance requirements.
By integrating cutting-edge experimental, theoretical, and IA/computational approaches, this symposium seeks to chart new directions and address the challenges shaping the future of advanced ceramics and composites.

Session Topics

CA-1 Advances in powder synthesis and processing

- **Powder synthesis and characterization** (solid state, solution processes, sol-gel, hydrothermal, combustion synthesis, mechanosynthesis, laser/microwave/plasma assisted synthesis; structure, chemistry, morphology, state of aggregation, packing, flowability, sinterability)
- **Colloidal processing** (surface chemistry, rheology, agglomerate softening/removal, new surfactant/dispersant systems…)
- **Shape forming and green body processing** (pressing, injection moulding, slip/tape casting, plastic forming, freeze and gel casting, additive free forming, large/complex shape components, debinding processes, computer-aided processing, modelling and simulation of forming processes…)
- **Sintering and related processes** (free and constrained sintering, pressure assisted, atmosphere-controlled sintering, interface phenomena, simulation of sintering and interface dynamics, nano/microstructure control, structure/property relationships…)

CA-2 Advanced molecular-level processing of functional nanomaterials

1D/2D-materials, nanoparticles, nanocomposites, hierarchical and hybrid structures: structural and functional characterization

CA-3 Polymer-derived ceramics

Novel preceramic polymers systems, conversion mechanisms, innovative processing for polymer-to-ceramic conversion, composites, hybrid materials, fibres, coatings, foams; structural and functional characterization, modelling of materials, processes and functions

CA-4 Microwave processing
Microwave-material interactions; temperature control during processing, non-contact temperature sensing: microwave-assisted synthesis, sintering, melting, coating and joining; hybrid processes; structural and functional characterization of materials; theory and modelling and simulation of materials and processes

CA-5 Novel sintering approaches - Spark Plasma, Flash Sintering, Laser Sintering, Cold Sintering
Advances in understanding the dynamics of activated sintering mechanisms; hybrid techniques; process control, structural and physico-chemical properties characterization; modelling and simulation of process and properties

CA-6 Inorganic Functionally Graded Materials
Design criteria synthesis and processing of FGM bulk materials, composites and hybrids; Functionally graded thin films and coatings; characterization, structure and functionality.
Mechanical, thermochemical and functional applications; modelling and simulation of materials and processes

CA-7 SHS ceramics
Theory and modeling of SHS processes and structural transformations; SHS of powders from the micro- to nano-scale. Consolidation of the SHS-powders (sintering, HP, SPS, HIP, etc.); SHS of bulk materials (functional and structural ceramics, composites, metal/ceramic composites, foams…); application and industrialization

CA-8 The glass ceramics route
Fundamentals of glass crystallization; structure/properties relationships; advances in processing for bulks, thin films, fibers, composites; process monitoring and control; in-situ and operando testing

CA-9 Bio-inspired and bio-enabled processing
Complex multifunctional nano structured materials with peculiar and specially designed electrical, magnetic, electro chemical, bioresponsive and structural properties resulting from bio inspired processing routes are stimulating growing research as they involve such diverse areas as molecular recognition and self assembly, self healing, hierarchical patterning, biotemplating and microorganisms-mediated materials synthesis.
This session will cover topics such as: i. Self-assembly, mineralization and hierarchical organization; ii. Hybrid structures and living materials; iii. Structure and mechanics of bioinspired materials; iv. Bioinspired functional surfaces; v. Bioinspired materials for biomedical applications; vi. Application and performance of bioinspired materials.

CA-10 Other special processing routes
Electrophoretic deposition; ultra-high pressure and shock synthesis and compaction; microgravitational processing; directional solidification from eutectics

Symposium CB

Progress in Additive Manufacturing of Ceramics and Composites

Additive manufacturing (AM) enables the manufacturing of components with intricate shapes and a previously unattainable degree of optimization of their morphology. The versatility of AM techniques has revolutionized the ceramic industry, allowing for the creation of complex geometries and customized designs that were once impossible to achieve using traditional manufacturing methods.
This paradigm shift has not only enhanced the performance of ceramic components but also expanded their potential applications across various sectors. In fact, AM has opened up several opportunities for employing different 3D printing processing technologies to manufacture ceramic parts to be used in advanced applications in fields ranging from energy to aerospace and defense, from automotive to constructions and healthcare. Furthermore, a transition from mere prototyping and lab-scale manufacturing to industrial-scale fabrication is currently occurring. Despite significant advances in terms of equipment and feedstocks, more effort should still be devoted to further

advancements in terms of materials, technologies and design. Moreover, issues of quality control and non-destructive characterization should also be considered, in order to enable further progress in the field. Addressing these challenges will be crucial for improving the reliability, reproducibility, and overall performance of additively manufactured ceramic components, ultimately facilitating their wider adoption in critical applications across various industries.

This symposium aims at showcasing recent developments in all different aspects related to additive manufacturing of ceramic materials, including traditional, advanced, functional, bio-, high and ultrahigh-temperature ceramics, glasses and composites, and their applications. The event will bring together researchers, industry professionals, and experts to explore innovative techniques, discuss challenges, and share insights on the future of ceramic additive manufacturing in different sectors.

Session Topics

CB-1 Recent advances in additive manufacturing technologies for ceramics, glasses and composites

CB-2 New additive manufacturing approaches, including multi-material and hybrid printing technologies

CB-3 Development of novel feedstock formulations

CB-4 Characterization of printed ceramics

CB-5 Novel applications and validation of AM ceramic components

CB-6 Design for AM

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Symposium CC

Joining of Ceramic Materials: Scalable, Reliable, and Sustainable Solutions

As deep-tech innovations drive the development of novel materials and manufacturing processes, new approaches to inorganic materials joining and integration are emerging. The demand for advanced joining solutions for ceramics, glasses, and their composites continues to grow, fueled by cutting-edge applications such as advanced microelectronics, next-generation energy systems, biomedical implants, space exploration, and more. These fields require engineered joining solutions that harness the unique properties of ceramic materials while ensuring structural integrity and functionality in complex final components.

One of the key challenges in this field is the joining of materials with inherently different chemical, thermal, and mechanical behaviors. Achieving robust and durable dissimilar joints necessitates a deep understanding and control of materials interactions across multiple length scales, from nanoscale to macroscopic assemblies. Surface functionalization, interfacial reactions, and advanced or unconventional joining techniques play a critical role in optimizing performance and reliability.

Building on the success of previous CIMTEC symposia, this symposium will serve as a dynamic forum for researchers, engineers, and industry experts to discuss the latest advancements, share insights, and explore future directions in ceramics joining and integration.

Topics will cover modeling, processing, characterization, and testing across multiple scales—from nano- and microscale to macroscale—addressing a range of technology readiness levels. Key Topics Include:

- Surface and interface science: wetting phenomena, diffusion mechanisms, and interfacial reactions
- Innovative joining techniques: nano-bonding, transient liquid phase bonding, laser joining, rapid heat-source methods, and more
- Characterization and reliability assessment
- Computational modeling and simulation: from atomic-scale interface modeling to macroscopic joint design and performance prediction

Session Topics

CC-1 Interface science for integration of inorganic materials

- Thermodynamics and kinetics of interface formation
- Mechanisms of wetting and adhesion
- Characterization and control of interfaces for high-performance joints

CC-2 Innovations in joining methods and materials

- Challenges and solutions in joining similar and dissimilar materials
- Joint performance: strength, thermal/chemical stability, and reliability
- Modeling, design, and characterization of joined components

CC-3 Engineering applications

- Joining and integration challenges across macro-, micro- and nanoscales
- Joining techniques for MEMS, microelectronics, and packaging
- Applications in space, automotive, energy, biomedical, and other high-tech industries
- Sustainable joining techniques

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Symposium CD

Ceramic Thin Film and Coatings for Protective, Tribological and Multifunctional Applications

This symposium focuses on cutting edge experimental, theoretical and manufacturing issues associated with advanced thin films and coatings deposition techniques and surface modification and functionalization processes. These processes allow the realisation of surfaces with enhanced properties and/or novel multi-functionality, thereby enabling them to meet present requirements and future challenges for more efficient, reliable, inexpensive and clean applications that serve the technological needs of our society. Of interest are materials systems based on oxide and non-oxide ceramics; new carbons; metal-ceramic, organic-ceramic and nano-composites; and hybrid and graded structures. Focus will be on:

- Advances in deposition, surface modification, and nanostructuring techniques
- Refined characterization and properties at meso- to nanoscale
- Protective coatings aimed at improving the often combined, thermal, chemical and mechanical degradation of components in corroding, oxidizing and generally harsh environments.

- Tribological thin films and coatings used in, for example, cutting tool and machining, medical devices, electronic displays, hard disks, optical coatings.
- Smart and multifunctional thin films and coatings: self-cleaning, anti- microbial, anti-fouling, catalytic, electrically/magnetically/optically responsive, thermo-electrics, piezoelectrics.
- Multiscale materials and process modeling and simulation; data-base development for coatings

Session Topics

CD-1 Thin film deposition techniques and film growth

CD-2 Multifunctional thin films and coatings

CD-3 Hard and wear-resistant coatings

CD-4 Protective coatings in oxidizing, high-temperature, and harsh environments

Symposium CE

Porous Ceramics for Environmental Protection, Energy-related Technologies and Advanced Industrial Cycles

The focus of this Symposium is to discuss innovative approaches to develop, characterize and apply ceramics containing a high volume of tailored porosity, ranging in size from Angstroms to millimeters.
These porous ceramics include high surface and cellular architectures such as honeycombs, foams, scaffolds, hollow fibers, fiber networks, membranes, nano-, micro- and meso-porous materials, monoliths and coatings possessing hierarchical porosity, as well as structures produced by the replication of biological templates or by additive manufacturing technologies.
Such porous components find use in a wide range of emerging applications in environmental protection, water purification, energy production and saving, molecular scale sensing, optical devices and a number of advanced industrial applications.
The main topics that will be addressed are:

- New materials and synthesis mechanisms
- Materials optimization at the nano- and meso-scale
- Theory and experimental evaluation of physical and chemical processes related to material functions such as transport phenomena, defect chemistry, interface reactions, separation and catalysis mechanisms, etc…
- Novel design and fabrication of components and devices
- Evaluation of material/component/ device performance
- Advances in testing methods
- Modeling of structure and properties of porous ceramics
- Topological optimization of porous ceramic components
- Engineering applications of porous ceramics

Session Topics

CE-1 Novel processing, microstructural and morphological control of porous ceramics, synthesis of porous ceramics (nano to macro), including Additive Manufacturing

CE-2 Adsorption, capillary phenomena, molecular thermodynamics of fluids and intermolecular interactions within the porous network

CE-3 Structure and functional, mechanical and thermal properties of porous ceramics; structure/transport/functional properties relationships

CE-4 Advances in the characterization of the porous structure (adsorption and intrusion porosimetry, thermophotometry, high resolution microscopy, image analysis, scattering techniques, computed tomography, etc.)

CE-5 Modeling and simulation of porous structure and properties

CE-6 Progress in applications of porous ceramics

- gas filtration and separation
- micro filtration and ultrafiltration
- catalysis and catalyst supports
- membrane and reactors
- functional applications
- energy storage, conversion, and saving applications
- thermal management application
- biological application
- light-weight application
- other advanced industrial applications

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Symposium CF

High and Ultra High Temperature Ceramics and Composites for Extreme Environments

Revolutionary improvements in operating efficiency or performance characteristics require increasingly hostile operating environments. For example, handling of molten metals exposes materials to extreme temperatures, reducing conditions, and thermal shock. Other applications of interest include leading edges for hypersonic aerospace vehicles, components in nuclear fission or fusion energy systems, refractories for steel, glass, and specialty metal processing, and many others. Ceramic materials and ceramic matrix composites are candidates for many applications that involve severe temperatures, chemical reactivity, or mechanical stresses.

In recent years, a number of oxide, non-oxide, and compositionally complex ceramic materials have been investigated for use in extreme environments. This symposium will examine the critical aspects in four different areas: 1) Synthesis and Processing; 2) Corrosion, Oxidation, and Testing; 3) Mechanical and Thermal Properties; and 4) Characterization, Analysis, and Simulation. The materials of interest comprise a wide range of ceramics including conventional oxide ceramics such as alumina and zirconia to more specialized compositions such as boride, carbide, and nitride materials. The materials of interest can be monolithic, single phase ceramics, porous materials, multi-phase particulate ceramics, or composites, HT coatings, and compositionally complex materials.

Session Topics

CF-1 Synthesis and processing

- New materials and novel synthesis routes
- Production of nano-powders, coatings, and engineered architectures
- Carbothermal and borothermal reduction
- Polymer derived ceramics and solution synthesis routes
- In-situ reaction synthesis
- Shape forming methods such as pressing, tape casting, extrusion, etc.
- Additive manufacturing and net shape forming
- Densification kinetics
- Pressureless and pressure-assisted sintering
- Field assisted sintering and other advanced methods
- Directionally solidified eutectics
- Ultra-high temperature ceramic matrix composite

CF-2 Corrosion, oxidation, and testing

- Analysis of reaction mechanisms and kinetics
- Testing in simulated hypersonic flight conditions or other operational environments
- Highly energetic reaction environments
- Correlation of laboratory testing to application environments
- Simulation and modelling of degradation reactions
- Phase equilibria and thermodynamic tools
- Non-equilibrium reaction analysis

CF-3 Mechanical, thermal and optical properties

- Strength and fracture toughness
- Friction and wear
- Elevated temperature properties
- Testing above 1600 °C
- Finite element simulations and other models
- Testing under combined loads (e.g., mechanical and electrical)
- New test methods
- Microstructure-property relationships

CF-4 Characterization, analysis, and simulation

- Advanced characterization methods
- In-situ and in-operando characterization under extreme conditions
- Electron microscopy and high resolution imaging
- Emerging characterization tools for structural materials
- Spectroscopic methods
- Thermodynamic and kinetic studies
- Ab-initio calculations and other predictive tools
- First principles simulations
- Experimental and computational studies of phase equilibria
- Multiscale simulations and models

Symposium CG

High-Entropy Ceramics

High-entropy ceramics (HECs) represent a groundbreaking advancement in materials science, emerging as a transformative class of materials with exceptional properties and vast potential for diverse applications. Originating from the broader concept of high-entropy alloys (HEAs), high-entropy ceramics extend the principles of entropy stabilization to ceramic systems, typically comprising four or more principal cations in near-equimolar ratios. This unique compositional complexity leads to the formation of single-phase or multi-phase structures with remarkable thermal, mechanical, and functional properties.

The development of high-entropy ceramics has opened new frontiers in materials design, enabling the exploration of previously uncharted compositional spaces. Their inherent chemical diversity and configurational entropy contribute to enhanced phase stability, superior mechanical strength, exceptional resistance to extreme environments (such as high temperatures, corrosion, and radiation) and extraordanary functionalities. These attributes make HECs highly attractive for applications in energy storage, aerospace, nuclear engineering, catalysis and advanced electronics, among others.

Recent advancements in synthesis techniques, computational modeling, and characterization tools have accelerated the discovery and optimization of high-entropy ceramics. Researchers are now able to tailor their properties with unprecedented precision, paving the way for innovative solutions to some of the most pressing technological challenges. As the field continues to evolve, high-entropy ceramics are poised to play a pivotal role in shaping the future of materials science and engineering, offering a paradigm shift in how we design and utilize advanced materials.

This symposium aims to bring together leading researchers, scientists, and engineers to share their latest findings, innovations, and insights in the rapidly evolving field of high-entropy ceramics.

Session Topics

CG-1 Process development and advanced manufacturing

- Novel synthesis techniques for microsized and nanosized high-entropy ceramic powders
- Advanced processing and manufacturing technologies of high-entropy ceramics, coatings, films and composites
- Phase formation, stability, microstructure control and characterization and cutting-edge analysis techniques

CG-2 Mechanical properties, performance and applications

- Mechanical properties at room/high temperatures
- Corrosion, oxidation and ablation behaviors
- Tribology and wear resistance
- Radiation tolerance and other extreme environment performance
- Applications in aerospace, defense, and nuclear industries
- Other innovative industrial applications

CG-3 Functional properties and applications

- Physical, magnetic, thermoelectric, microwave absorbing, dielectric, transparent properties and applications
- Energy storage, conversion and applications
- Catalytic properties and application
- Other potential functionalities and applications

CG-4 Theoretical and computational studies

- Computational modeling, simulation and data-driven design of high-entropy ceramics
- Thermodynamics and kinetics in synthesis and applications
- Predictive modeling of properties and performance
- Insights into entropy stabilization and phase formation
- Emerging trends and future directions

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Symposium CH

MXenes and Related Materials: From Fundamentals to Sustainable Applications

This Symposium aims to be an international forum where the different aspects of layered carbides, nitrides, and borides and their 2D derivatives are discussed. The Symposium will focus on the multifaceted world of MXenes, highlighting their synthesis, tunability of chemistry, structure and properties, and scalability through experimental and computational approaches. The sessions will cover advances in the structural, morphological, chemical, and surface characterization of MXenes, their optical and electronic properties, bridging theory and experiments. The program will cover diverse applications, from energy harvesting and storage, sensing, catalysis, and healthcare to electromagnetic interference shielding, thermal management, and communication. MXene composites, hybrids, and their respective properties and applications will also be covered. This event will serve as a platform for researchers to exchange ideas, foster collaborations, and push the boundaries of MXene science and technology.

Session Topics

CH-1 Synthesis and structure, morphology and chemistry of MXenes and their composites and hybrids

CH-2 Property characterization
- Mechanical and tribological
- Thermal
- Optical and electronic
- Electrochemical and catalytic

CH-3 Applications
- Electronic and optoelectronic
- Energy harvesting and storage
- EM shielding
- Sensing
- Catalysis
- Biomedical
- Mechanical

CH-4 Theory, computational modelling, data science and new directions for MXenes

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Symposium CI

Advances in Functional Materials for Energy Harvesting, Storage and Solar Fuels

This symposium highlights the pivotal role of functional nanomaterials with tailored properties in driving sustainable solutions for energy, environment, and health challenges. The focus is on cutting-edge energy technologies and devices based on inorganic, hybrid, and composite materials, emphasizing recent advances in nanotechnology and their industrial impact.

The sessions will cover advancements in the processing, characterization, and application of nano- and heterostructured materials, with a special focus on their use in photovoltaics and solar fuel technologies. Topics will explore cutting-edge chemical processing techniques, scalable fabrication methods, and interface-driven

functionalities to enhance energy conversion and harvesting. Experts will highlight innovations in catalytic systems for hydrogen and ammonia production and CO_2 reduction, and new materials for solar cells and self-powered devices, driving sustainable solutions for energy challenges.

This event serves as an international platform for researchers, industry professionals, and innovators to showcase technological advancements, exchange ideas, and explore collaborative opportunities in developing sustainable energy and environmental solutions. Participants are invited to submit abstracts on these and related topics.

Session topics

CI-1 Innovative nano- and heterostructured functional materials for renewable energy applications

- Chemical processing of nanomaterials: electrospinning, plasma-assisted deposition, sol-gel, and microwave-enhanced synthesis
- Energy-efficient and scalable production of nanomaterials and nanocomposites
- Fabrication of interface-driven functionalities and multi-material heterostructures
- Transparent conducting oxides and heterostructures for energy harvesting
- Nanostructured oxides and composites for excitonic solar cells
- Piezoelectric and plasmonic materials for energy transfer and self-powered systems
- Innovative techniques for characterizing and manipulating nanostructures
- Large-scale integration of functional nanodevices and heterostructures

CI-2 Recent developments in photoactive materials

- Advanced materials for next generation photovoltaic devices
- Frontiers of organic, hybrid, and perovskite solar cells
- Solar cell architectures and materials requirements
- Next generation electron and hole transport materials
- Hybrid interfaces and nanocrystalline junctions
- Charge generation, trapping and transport
- Optoelectronic devices based on nanoparticle, nano-wires and composites

CI-3 Green hydrogen production, storage and utilization

- Advanced materials for artificial photosynthesis and solar hydrogen
- Tandem concepts (PV-PEC) for green hydrogen production
- (Photo)electrosynthesis of ammonia and other solar fuels
- Hydrogen's role in CO_2 capture, utilization, and conversion to synthetic fuels
- Hydrogen as a carrier for energy transport and storage
- Circular economy approaches linking hydrogen, CO_2, and ammonia value chains
- Electrolysis advancements for green hydrogen production

Symposium CJ

Geopolymers, Inorganic Polymers and Sustainable Materials

Refractory inorganic polymers can be made at ambient temperatures and pressures. These materials include alumino-silicates or "geopolymers", phosphates, borates, silicates, cuprates and other chemically bonded, inorganic compounds. The use of waste products or components derived from biological materials as starting compounds or as reinforcements in composites demonstrates the eco-friendly and sustainable nature of these materials. Novel potential applications of such composites include fire and corrosion resistant materials, infrastructure and construction materials, thermal insulation, porous materials, structural ceramic composites containing ceramic, metal or biological reinforcements, hydrogen storage, liquid and water purification, porous materials for CO2 sequestration and precursors to ceramics.

Main proposed matters for discussion:

- Synthesis, processing microstructure
- Mechanical properties, thermal shock resistance
- Infrastructure and construction materials
- Waste encapsulation
- Composites
- Coatings (fire, oxidation or corrosion resistant)
- Alternative forming methods and conversion to ceramics
- Novel applications
- Alkali activated cements

Session Topics

CJ-1 Synthesis, processing and microstructure

CJ-2 Properties

CJ-3 Structural and functional applications

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Symposium CK

Progress in Electroceramics Research

Improvements in basic knowledge and practical exploitation of their unique properties, has established electrical ceramics as a central and fast developing sector in materials research, resulting in a significant impact on several areas of modern technologies. The increasing demand for even more refined or novel properties hardly to be competitively met by other materials is fuelling the interest for improved or new processing routes and deeper understanding of the fundamental materials science to meet requirements coming from a variety of advanced civilian and defence applications.
Normal and relaxor ferroelectric materials, microwave dielectric ceramics, lead-free piezoelectrics, multiferroic materials, thermal electric materials and ionic and mixed ionic electronic conducting ceramics are but some examples of the ongoing developments in the area which massively makes use of the opportunities offered by nanoscience and nanotechnology, and by computational modelling and new theory.
Major focus will be on:

- Development of new and more efficient processes, better characterisation tools of bulk, crystalline, glassy and amorphous materials, thin films, multilayers, superlattices, nanomaterials, nanostructures and hybrid materials; advances in thin-film and related micro/ nano-fabrication techniques and "bottom-up" approaches that offer the potential for high-density integration of nanoscale devices
- Fundamental mechanisms, novel (multi)functional characteristics and behaviour of materials such as electronic structure, quantum effects, phase transitions, transport phenomena, defects, diffusion, domain structure and switching, grain boundary controlled mechanisms, nanosize effects, surfaces and interfaces, dielectric, piezoelectric, magnetic and optical properties, ageing and fatigue, reliability, fractals, modeling and simulation, etc.
- New developments in devices including resonators, filters, fuel cells, batteries, high energy density capacitors, gas separation membranes, piezoelectric devices, sensors and actuators, MEMS/NEMS devices, and related integration technologies.

A Special Session *"Magnetoelectrics and Multiferroics: Advances in Materials, Devices and Applications"* will complement the Symposium activities.

Session Topics

CK-1 Dielectrics and microwave materials
- Fundamentals, synthesis, processing, characterisation
- Capacitor dielectrics
- Mott insulators
- Microwave and millimeter wave dielectrics
- LTCC
- New thin film materials and integration technologies
- Packaging and interconnect issues

CK-2 Ferroelectric, piezoelectric, pyroelectric, and ferroelastic ceramics
- Synthesis and processing: polycrystalline ceramics and composites, thin/thick films, single crystals, novel materials
- Ferroelectric new materials
- Lead-free ferroelectrics and piezoelectrics
- Relaxor ferroelectrics
- Theory and modelling
- Characterisation
- Electromechanical behaviour and piezoelectric applications
- Thin film devices
- Capacitor applications, MLCC
- Sensor applications
- Novel applications

CK-3 Thermoelectric ceramics
- Bulk materials, composites, nanostructures
- Low-dimensional materials
- Energy conversion mechanisms
- Device design and applications
- Modeling and simulation of materials and devices

CK-4 Caloric ceramics
- Magneto-/electro-/elasto-/boro-caloric ceramics
- Underlying phenomena in reversible thermal effects
- Improving cooling-power density, temperature span, energy efficiency
- Devices and applications

CK-5 Semiconducting and fast ion-conducting ceramics
- Amorphous and crystalline semiconducting and fast conducting oxides
- Non-oxide semiconductors and fast ion conductors
- Synthesis, processing, characterisation
- Defect chemistry, doping mechanisms, carriers origin and dynamics
- Devices and applications

Special Session CK-6

Magnetoeletrics and Multiferroics: Advances in Materials, Devices and Applications

Single phase or composite materials that exhibit more than one type of ferroic ordering have attracted considerable interests in recent years for studies on the nature of cross-coupling between the ferroic orders and for useful applications in sensors, information storage and signal processing. In addition to traditional single phase multiferroics such as bismuth ferrite, significant advances have been reported on molecular, organic-inorganic, non-oxide, and 5d- multiferroics. Other topics of importance in single phase multiferroics are domain walls, magnetoelectric interactions in topological insulators, and multiferroic nanostructures. Investigations on composite multiferroics have focused on electric field control of magnetism and magnetic field control of ferroelectric order parameters, complex oxides and interfaces, ferromagnetic alloy-ferroelectric composites and self-assembled composite multiferroics. Significant progress has been reported on device applications for composite multiferroics in recent years and include efforts on magnetic sensors, high frequency devices, gyrators, energy harvesting and power electronics.
This Special Session, which follows the ones organized in previous CIMTEC conferences, will highlight developments in the understanding of the physics of multiferroic materials, theory, advances in materials synthesis and applications.
Of specific interests are: Theory and modeling of single phase and composite multiferroics, Advances in materials, synthesis and processing; New single phase multiferroic materials; Layered and multiferroic heterostructures; Nanocomposites and Self-assembly; Physics of interfaces; Magnetic field sensors; Memory application; Tunable, multiferroic microwave and mm-wave devices; Miniature antennas.

Session Topics

CK-6.1 Theory and modeling of single phase and composite multiferroics

CK-6.2 Non-oxide, organic-inorganic and 5-d oxide multiferroics

CK-6.3 Advances in materials synthesis and processing

CK-6.4 Multiferroic nanostructures, self-assembly and nanocomposites

CK-6.5 Magnetoelectric characterization and electric field control of magnetization

CK-6.6 Domain walls and dynamics of multiferroics

CK-6.7 New effects

CK-6.8 Devices and applications

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Symposium CL

Development and Application of new Functional Transparent Conducting and Semiconducting Inorganic Materials

Oxide based electronics are seeing an increasing set of applications based on new materials and the ability to tailor structure and functionality to enable new functionality. This includes improved TCs new semiconductors for high speed and wide bandgap electronics, new piezoelectric materials and photovoltaic absorbers. Achieving this requires an increasingly broad materials set but also structural diversity from amorphous to expitaxial and the

inclusion of new hybrid materials. Increasingly diverse structures with complex composition including amorphous and crystalline metal oxide materials as well as wide band-gap nonoxide materials including e.g. nanowire networks and quantum dot structures are extending device designer's palette of transparent conductors and semiconductors by addressing a variety of cutting edge applications in flexible electronics, new active optoelectronics, even spin photonics. New advanced in materials and processing are also extending the range of the more experienced use of transparent conducting oxides in large area flat-panel displays, thin-film solar cells, antistatic coatings, functional and smart glasses and a number of other applications.

Underlying the development of new functional materials for example organic and nanotube based TCs is the need for a clearer and predictive understanding of basic materials science such as the electronic structure, carrier and trap origin, mobility and scattering, and doping mechanisms which govern conductivity and transparency, coupled with a better insight into interfacial and chemical compatibility issues and the development of models of the performance limits of materials and devices.

Objective of the International Symposium *"Development and Application of new Functional Transparent Conducting and Semiconducting Inorganic Materials"* to be held in the frames of CIMTEC 2026, which follows the discussions on related subjects held at previous CIMTEC Conferences, is to gather specialists from academia and industry to highlight updated developments in the area from fundamental science to materials synthesis, processing techniques device development and advanced/novel/prospective applications.

Session Topics

CL-1 Fundamentals

- Basic Theory of functional electronic oxides
- Materials Genomics of functional oxides including
  - Electronic structure
  - Doping mechanisms
  - Carriers origin and dynamics
  - Optimizing band structure
  - Surfaces and interfaces in hybrid structures
- Amorphous vs crystalline materials basic physics and application considerations
- Characterizations of basic TC properties including inoperando

CL-2 Material design and device development

- Advanced crystalline materials
- ZnO based materials
- p-type transparent conductors
- Indium-free TCOs
- Amorphous metal-oxide materials
- Non-oxide transparent conductors
- Nanowire/nanotube arrays and Q-dot based transparent structures
- Other novel materials/concepts
- Device characterisation and properties
- Growth Approaches
  - PVD/CVD
  - Atomic layer deposition
  - Spin coating, spray pyrolysis and other chemical techniques
  - Direct writing/printing/patterning
- Novel tools and equipment for device fabrication
- Interfaces and Chemical compatibility issues
- Modeling and simulation of materials and devices

CL-3 Applications

- Flexible electronics (e.g. roll-up displays, electronic paper)
- Transparent devices (TTFTs) and applications including TC active layers
- Photovoltaics
- Piezoelectrics
- Wide Bandgap Power Electronics
- OLED/OPV
- Advances in smart /functional applications e.g. photo-catalytic/active/protective coatings, smart windows, etc.
- Other advanced/novel/emerging applications
- Building applications
- Multifunctional materials including porous materials

Symposium CM

Inorganic Materials Systems for Advanced Photonics and Energy

Ceramics, composites, glasses are keystone materials for developing a novel photonics devoted to the progress of enabling technologies allowing to successfully face technological, scientific, socio- economic challenges and give effective solutions in many fields going from production and saving energy to efficient and clean industrial cycles, from environmental protection to fast efficient novel communication systems, from structural monitoring to quantum technologies, to the broad spectrum of lighting applications and healthcare crucial needs.
This Symposium, that follows the several ones on similar subject held at previous CIMTEC conferences, is to provide latest insights on fabrication, characterization and exploitation of photonic structures based on ceramics (oxides, oxynitrides, fluorides, sulphides, chalcogenides, etc...) inorganic non-metallic glasses, glass- ceramics, and cermets in the form of nanostructured, bulk and graded materials and coatings, fibres, thin films, superlattices and other small confined systems, resonators, photonic crystals, nanomaterials, nanocomposites and functional nanoparticles.
Focus will be on theory, AI and deep learning based modelling and simulation of materials and processes, green and advanced fabrication protocols (self assembly, light and ion irradiation, micromachining, colloidal processing, composites, glass-ceramics) digital light processing, additive manufacturing and up-to-date characterization of structure, non-linear optical properties, tunability, nanosize effects etc. of novel inorganic photonic materials systems for light generation, detection, and manipulation including e.g. luminescent and laser materials, smart optical fibres, active plasmonic heterostructures, novel confined nano-micro structures etc. chromogenic materials, covering the UHV-IR electromagnetic spectrum.
Contributions from Academia and industry on upgraded or novel application and prospective new approaches to photonic-based technologies are also strongly encouraged.

Session Topics

CM-1 Photonic nanomaterials and nanostructures for photonics and energy

- Optically active colloidal nanoparticles, nanowires,1D and 2-D nanomaterials,
- Nano/micro cavities
- Optically active nanostructured materials
- Plasmonic nanostructures
- Nanophotonics
- Photonic crystals
- Photovoltaic systems
- Ferroelectric materials

- 2D materials for nanophotonics
- Photocatalists for water splitting

CM-2 Luminescent and chromogenic ceramics and glass systems

- Phosphors
- Scintillators
- Other luminescent materials
- Chromogenic materials
- UV-Vis-NIR-MIR-optical materials
- Confined systems

CM-3 Electro-optical magneto-optical and piezoelectric materials

- Electro-optical and magneto-optical ceramics
- Electro-optical and magneto-optical functionalized glass systems
- Piezoceramics
- Nano-photoelectrochemistry

CM-4 Laser materials

- Fiber laser
- UV-Vis-NIR-MIR-laser materials
- Photonic crystals for laser applications
- Mid-infrared laser Sources
- Novel visible lasers
- Solar-pumped lasers

CM-5 Inorganic optical fiber

- Passive, low-loss optical fibers
- Active and smart optical fibers
- Non-linear Fibers
- Fiber lasers (CW, Raman, and pulsed)
- Fiber and waveguide amplifiers (including Raman)
- Ultrafast lasers
- Continuum sources

CM-6 Photons management

- Lasers
- Waveguides
- Luminescent systems
- Frequency conversion
- Switches, modulators
- Sensing
- Imaging
- Single photon sources and detectors
- Integrated optics
- Rare-earth activated LEDs
- Digital Light Processing

CM-7 Advances in fabrication and characterization techniques

- Synchroton radiation based technologies (NEXFAS, XANES, XPS,..)
- Scanning probe microscopies, confocal microscopy, SNOM
- Interferometer techniques for imaging and testing
- SERS, CARS, Raman, TERS, Brillouin and optical spectroscopies
- THz spectroscopies
- Advanced imaging techniques and innovative tools
- Additive manufacturing
- Digital Light Processing

CM-8 Ongoing applications and forecasts

- Solid state lighting, displays

- Optical communications
- Quantum technologies
- Bioimaging
- Healthcare
- Clean energy
- Aerospace, defense, security
- Structural health monitoring
- Laser-assisted manufacturing and micro/nano fabrication
- Ceramics for catalysts and photocatalysts

Symposium CN

Science and Technology for Silicate Ceramics

The Silicate Ceramics industry uses large amounts of primary mineral raw materials that belong to non-renewable natural resources. Future expansion can be easily predictable given by on rising demand of improved life standards and demographic growth. Roadmaps urged by the European Commission for ceramic industry define ambitious long-term objectives for resource efficiency, energy savings and a low-carbon economy. The need to replace critical raw materials leads to a shift towards alternative sources and resilient supply chains. Furthermore, continuous industrial production growth generates a huge amount of waste from different manufactures, which are interesting as substitutes for raw materials. The suitability of waste materials for various uses can be widely affected, depending on the economic, technological and legal framework. The industry is even more demanding to develop innovative processes that allow, also through AI implementation, to reduce the global impact and maximize the sustainability of ceramic production. However, the replacement of some of the traditional raw materials may be associated with changes in the molding and firing of the new ceramics. So, the purpose of this symposium is to focus interest on ongoing R&D activities on silicate ceramics: wall and floor tiles, geopolymers, glazes, pigments and raw materials. Matter will cover research work on new raw and secondary materials, the properties and behavior of materials, development of new ceramic products, innovative manufacturing technologies, surface decoration and functionalization environmental impact issues.

Session Topics

CN-1 Green and sustainable silicate ceramics

The continuous growth of world ceramic production is still increasing the natural raw materials consumption. In addition, the evolution of the global geopolitical scenarios requires a diversification in materials supply chains, and also new thinking on building materials. Furthermore, the possibility of introducing waste materials, using ceramisation processes as inertizing systems for dangerous components, is generating increasing interest. This session will explore the possibility of formulation and processes changes by the introduction of both alternative raw materials and industrial or urban wastes. Particular attention will be focused not only on material properties variation but also on the resulting environmental and social impact.

CN-2 Glasses, glazes and pigments

The decoration of silicate ceramics plays a key role for aesthetic and technical purposes. The digital decoration technology does not involve only pigments and dyes applications but is increasingly addressed to a full

digital application. The development of materials and processes for digital printing suitable systems are therefore of fundamental importance. In addition, competition from other markets in critical raw materials supply requires the development of alternative decoration materials. This session will cover the development and behaviour of decoration materials, assessing environmental sustainability aspects and green chemistry.

CN-3 Innovative processing

The modern ceramic industry is increasingly confronted with problems related to production flexibility and innovation in terms of process, formats and specific functionalities. This session will focus on innovative production of silicate ceramics in terms of forming (including large slabs, 3D printing, new granulation systems, etc.), surface functionalization (self-cleaning, bacteriostatic or high reflectivity, controlled take-up, wear resistance, magnetic shielding, thermo-hygrometric comfort or energy collection), process efficiency or implementation of technological properties.

Symposium CO

Refractory Materials Challenges to Meet Current and Future Industry Needs

This symposium will continue to focus on the development of "state-of-the-art" refractory materials, emphasizing advancements driven by evolving industrial processes or the introduction of novel technologies. Key drivers of change - such as innovations in raw material, environmental concerns, energy efficiency and the need for improved material performance - will be addressed. Topics will include sustainable refractory raw materials and product development; installation practices and evaluation of finished material properties; analysis of refractory wear and failure; thermal management; computational modeling; and strategies for addressing the education needs in the area. Contributed papers will highlight achievements and challenges from the perspectives of refractory producers, end-users and academia. Focus will be placed on both shaped and unshaped (monolithic) refractories, utilizing natural and/or synthetic raw materials.

Session Topics

CO-1 Raw materials

- Natural raw material and their characterization and performance – including changing industry needs, reductions in energy consumption to produce raw materials and raw material sustainability
- Novel/improved refractory raw materials and additives (natural and synthetic) to meet changes in refractory performance needs (wear, corrosion, or thermal management/insulation)
- Raw material phase relationships and reactions occurring during product installation, sintering, or use that impacts microstructure development and/or product performance
- Application of spent refractory reuse/recycling and their characterization after second life
- Novel binder systems

CO-2 Product testing and quality control

- Testing and improving physical properties; such as thermal shock, spalling, hot strength, toughness, creep, thermal conductivity and MOE

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- Quality control and analytical tools used to improve refractory product quality, consistency, performance, etc
- Evaluating and controlling monolithic materials property changes that occur during storage, mixing, installation, drying and firing; including those caused by composition and additives
- Monitoring process variables and/or material properties related to refractory failure during service
- Microstructure analysis or phase changes as it relates to material performance (using SEM, TEM, cathodoluminescence, high-temperature confocal laser microscopy, optical microscopy, or other analytical tools)
- Advances in refractory manufacture, installation and/or system repair/maintenance

CO-3 Specialized refractory applications

- Iron and steel
- Non-ferrous metals
- Cement
- Glass and ceramics industry
- Petrochemical, gasification and waste incineration
- Industry wide environmental and recycling issues
- Needs in energy management

CO-4 Modelling and simulation of the process and materials

- Thermodynamic modelling and its use to understand/control refractory properties/ performance through predictions of material interactions
- Thermal and stress management via modelling (thermal profile, materials diffusion, crack propagation, sintering, grain boundary motion, phase transformation, etc.)
- Data analysis and AI applications

CO-5 Refractory failure analysis

- Analysis of refractory corrosion/wear caused by slag, molten glass, metal, hot gases, particulates, or combinations of them targeting improved refractory performance
- Determining the causes of refractory failure and the use of that information to carry out the required system changes

CO-6 Refractory materials for novel or advanced applications

- Fabrication and performance of ceramic materials made by additive manufacture
- The use of refractory grain as a stable structure for catalyst process or as oxygen carriers in chemical looping combustion
- Other novel applications requiring high-temperature severe service materials or protective barriers (including battery materials, high-temperature microwave processes, or ultra-high temperature applications)

CO-7 Refractory education needs (producers, end-users and academia)

- Refractory education needs brought about by the changing workforce, industrial environments, or changing process environments – what training/education is needed to meet those needs?
- How can the new generation be attracted to the refractory area?

CO-8 Refractory materials and manufacturing process changes related to global decarbonization

- Iron and steelmaking practices shifting from the blast furnace/basic oxygen furnace process route to a direct reduced iron/electric arc furnace route.
- Other carbo-thermal/non-carbo-thermal processes being studied for potential CO2 reductions, along with their likely impact on containment material needs. This would include processes for producing Al, Cu, glass, and/or cement.
- Industrial chemical processes, such as those used to synthesize gas for chemical and power generation for lower temperature processing or for using non-fossil energy carbon sources.
- Strategies for the electrification of the manufacturing process of ceramics using electrodes, microwaves, induction heating or plasma burners

INTERNATIONAL CONFERENCES

IC-1 - 10th International Conference

Advanced Inorganic Particulates and Fibre Composites for Structural and Thermal Management Applications

Advanced inorganic composites are enabling materials for a number of energy efficient and eco-friendly applications in aerospace, power generation, ground transportation, chemical, and nuclear energy applications. These composites have been developed with a wide variety of reinforcements. However, despite the considerable progress made in recent years in the fundamental understanding of inorganic composites, a lot still remain to be done to fully utilize the excellent capabilities of these materials. A deeper insight of the mechanisms governing composite behaviour in demanding situations, the development of reliable life prediction methodologies, design tools, and improved or innovative approaches to low cost manufacturing are among the many priorities for research and industry.

This conference (which follows the several ones on a similar subject held at previous CIMTEC editions) will feature latest achievements in the basic physico-chemical principles of inorganic composite technology and processing science, bulk and interface characterization, property assessment, and fiber composite design and production. Modelling of properties and behaviour, and application engineering studies in severe thermomechanical and aggressive environments are among its scope, as well as exploiting factors affecting reliability and low cost processing.

Ceramic (Refractory, Glass, Glass-Ceramic) Matrix Composites (CMCs), Ultra High Temperature Ceramic Composites (UHTCCs), Carbon-Carbon (C/C) composites, and Metal Matrix Composites (MMCs) are of great interest. In addition, new developments in the processing and manufacturing as well as characterization of reinforcements such as particulates, long and short fibres, filaments, nanofibers, nanotubes, and in-situ composites will also be covered.

Session Topics

IC-1.A Production and properties of reinforcements, preforms, and matrix materials

- Manufacturing, processing, properties
- Fiber architecture: laminates, weaves, braids
- Preforming methods and technologies
- Nanoreinforcements (nanofibers, nanotubes, nanorods, nanowires, etc.)
- Development and testing of new inorganic fibers

IC-1.B Interfaces/interphase

- Fiber coating, interfacial bond control
- Structure and microstructure of interfaces
- Computational modeling of interfaces/interphases

IC-1.C Processing and fabrication of MMCS, CMCS, and C/C composites

- Solidification processing, extrusion, rolling, electro-deposition, etc.
- Reaction bonding, diffusion bonding, chemical vapour infiltration, melt infiltration, sintering, hot pressing, HIPing, spark plasma sintering, colloidal processing, etc.
- Net shape processes, computer-aided component design and fabrication, rapid prototyping, process modelling
- Additive manufacturing technologies
- Green and eco-friendly processing and manufacturing technologies
- Joining, attachment, machining, and repair technologies

IC-1.D Ultrahigh Temperature Ceramic Composites (UHTCCs) and Laminated Composite Structures

- Processing and fabrication of UHTC composites with refractory boride, carbide, nitride matrices
- Interfacial and thermomechanical characterization
- Testing and integration technologies for UHTCCs
- Design criteria for laminated composites
- Structural analysis and delamination mechanisms

IC-1.E Property, modeling and characterization

- Microstructural characterization, influence of processing on the microstructure
- Thermomechanical properties, static and dynamic characterization
- Micromechanics and interfaces
- Fracture, fatigue and creep mechanisms, plastic and superplastic behaviour.
- Wear and friction behavior
- Effect of strain, temperature and environment on microstructure and properties,
- Modelling at micro-, meso- and macroscopic level including environmentally induced damage, mechanical damage, toughness
- Environmental durability and life prediction

IC-1.F Composites for thermal management

- Design, development, and testing of thermal protection systems (TPS)
- Light weight, high conductivity materials for thermal management (C/C and CNT composites, Al/SiC, Cu-based systems, Si3N4 in-situ composites, etc.)
- Bonding and integration technologies, thermal contact materials
- Nondestructive evaluation, quality assessment, health monitoring, etc.

IC-1.G Applications

- Aeronautics, space transportation systems, and space structures
- Aircraft and automobile brakes, friction components
- Power generation, fuel cells, microturbines
- Automotive and ground transportation, armors and shields
- Environmental and waste remediation, nuclear industries
- Chemical and process industries

IC-2 - 10th International Conference

Science and Engineering of Novel Superconductors

Superconductivity is a fascinating macroscopic quantum phenomenon with numerous useful applications, and it is of major interest both for fundamental and technological reasons. The discovery of high-temperature superconductivity in cuprates generated an outburst of research activity that led to unprecedented advances in materials development, experimental techniques and theoretical models. Many new superconductors and several new classes of superconductors have since been discovered, including iron-based pnictides and chalcogenides, ruthenates, bismuthates, cobaltates, borides, borocarbides, carbon-based materials such as fullerenes and nanotubes, organic compounds, heavy-fermion intermetallics, hydrides, graphene bilayers, nickelates and so on.

The discoveries of new materials have been followed by in-depth characterization of their physical properties by means of a variety of experimental approaches and, often, by successful applications in wires, tapes, power cables, fault current limiters, processing in electronics and in novel nano-structured technological devices. Nonetheless, the mechanisms of (un)conventional superconductivity at play in many materials of interest for industry are still under debate and a comprehensive understanding is far from being achieved.

This Conference follows those on the analogous topics in 1990, 1994, 1998, 2002, 2006, 2010, 2014, 2018 and 2022, organized in the frame of CIMTEC. On one side it will highlight the progress achieved along the last years in the various issues of fundamental and technological character of the already known superconducting materials. On another side, the Conference will be focused on the recently discovered materials, their characterization, synthesis and processing and the prospective applications. Following the mission of the previous conferences of this type, the focus will be on novel aspects, issues and systems, but attention will be paid as well to all superconducting-related topics, including fundamental aspects of theory, advances in synthesis, functionalization and processing and the latest progress in the areas of small-scale and large-scale devices.

Session Topics

IC-2.A Structure, dimensionality, physical chemistry and general properties

- Experimental study of average and local properties (XRD, neutron diffraction, electron diffraction, EXAFS, XANES, STM, TEM, AFM)
- Proximity-induced superconductivity
- Superconductivity induced by epitaxial strain
- Low-dimensionality effects: intrinsic & nanostructured
- Superconducting heterostructures: superlattices & multilayers
- New phases and metastable superconducting high-Tc materials
- Intercalation and decoration of layered materials
- Functionalized materials

IC-2.B Properties of superconductors (of any type)

- Resonant x-ray spectroscopy
- IR, Raman and acoustic spectroscopy of superconductors
- Inelastic neutron scattering of superconductors
- NMR, ESR, μSR, Mössbauer spectroscopy
- Photoemission and ARPES
- Ultrafast terahertz spectroscopy of superconductors
- SQUID, tunneling and point-contact spectroscopies
- Thermal, magnetic, thermodynamic and electrical properties
- Electric field effect, structures and devices

IC-2.C Mechanisms (for normal and superconducting states)

- Correlation effects, spin liquids and quantum criticality
- Heavy-fermion superconductors
- Phonons, spin excitations and strong coupling
- Inhomogeneous order parameters
- Stripes, phases separation and granularity effects
- Pressure induced superconductivity
- CDW, SDW and superconductivity competition; coexistence of magnetism and superconductivity
- Unconventional superconductors: phenomenology and theory
- Order parameters, pseudogap, tunnelling, Andreev reflection and related experiments
- Multiband / multiorbital character and related effects
- Superconducting fluctuations and related effects

IC-2.D Vortex lattice physics

- Vortex dynamics
- Understanding and control of flux pinning
- Electromagnetic characterization of superconductors over wide parameters ranges
- Vortex-defect interactions, defect structures, vortex penetration
- Complex vortex phases and related phenomena
- Magnetic screening

IC-2.E Synthesis and processing

- New superconducting materials in bulk form
- Films, multilayer, wires, tapes and coated conductors
- Heterostructures and interface nanoengineering
- Josephson junctions and JJ arrays
- Nanostructured superconductors
- Superconducting inks
- Proximity and interface effects, hybrid structures
- Novel synthesis processes
- High-pressure materials
- Intercalation and doping

IC-2.F Power applications

- Cables, transformers, motors and generators, current limiters and magnets
- Magnetic energy storage, high field magnets, accelerator and nuclear fusion technology
- MRI and MEG novel devices
- New prospective applications
- Aerospace & lunar applications

IC-2.G Low-power applications and superconducting electronics

- Microwave filters and passive devices
- Josephson and digital devices
- Novel SQUID systems, hybrid electronic devices
- Superconducting qubits
- Spin impurities & flux noise in quantum processors
- Superconducting spintronic devices
- Superconducting nanowires single photon detectors (SNSPD)

IC-2.H Topological superconductivity & spin-orbit effects

- Intercalated topological insulators
- Fe-based chalcogenides
- Majorana Fermions in vortex cores
- Proximity effects in heterostructures
- Chiral p-wave superconductors
- Ising superconductors

IC-2.I Superconductivity in two-dimensional and layered materials

- Transition metal chalcogenides
- Superconductivity in MXenes
- Misfit compounds
- Multilayer superconductors
- Moiré superconductivity and twistronics
- 2D electron gases and interfacial superconductivity
- Gate-induced superconductivity

IC-3 - 14th International Conference

Advanced Biomaterials and Nano-biotechnology for Medicine

The convergences of materials, electronics and biological systems at the nanoscale are fuelling unprecedented opportunities in the biomedical field through groundbreaking inventions / innovations in diagnosis and therapy. Major objectives of this conference, which follows the conferences on the same subject held in previous CIMTEC editions, is to provide a synergic approach covering applied chemistry and physics, materials science, electronics, biochemistry and medicine to enlighten how deeper insights into biological events and their interplays with nanotechnology can support the development of new generations of materials, micro- or nano-devices, molecular level approaches and advanced characterizations to address major medical problems.

The conference particularly aims to report recent progress in the synthesis and characterization of new or creatively modified stimuli-responsive, active and multifunctional metals, ceramics, glasses, glass-ceramics, polymers, gels; smart nanoparticles, functionalized l-D and 2-D nanostructures, Q-dots; hybrids, composites, self-organized materials, hierarchical bio-nanostructures; as well as the potential for their implementation in selected challenging areas of nanomedicine such as (i) multi-scale approaches to regenerate and engineer new soft tissues and hard tissues, (ii) innovative targeted drug delivery and release platforms, and (iii) new materials and systems for medical diagnosis and therapy including multi-modal theranostics.

A Special Session on latest developments on implantable neural interfaces (IC-3.F) will complement the Conference programme.

Overall, the study of systemic interactions in the body environment such as side effects, biocompatibility and biofunctionality will be essential issues to promote the discussion for bioinspired strategies in materials and device design to be effectively implemented into clinical practice.

Session Topics

IC-3.A Advances in biomaterials: synthesis, processing, characterization, functionalization, finalization

- Bioactive, biodegradable, multifunctional ceramics, glasses, and metals
- Bioactive, biodegradable, stimuli-responsive, multifunctional polymers, gels, and elastomers, liquid crystalline polymers, composites, and hybrids

- Bioinspired, biomimetic, self-organized, hierarchical materials
- Microbiome-supporting and immunomodulatory material
- Multifunctional nanostructures and nanoparticles
- Surface tailoring of biomaterials
- Modeling of biomaterials and their functions
- Biocompatibility and regulatory issues

IC-3.B Regenerative engineering and translational medicine

- Biofabrication of cells and tissue constructs, multi-phase and multi-functional scaffolds, microfabrication techniques
- Vascularization of tissue engineered constructs
- Biomaterials for the prevention of surgical site infections
- Biomaterials for tissue interface regeneration (ligament/tendon/cartilage-to-bone)
- Biomaterials for modulating stem cell microenvironment
- Growth factor delivery vehicles
- Mechanistic effects of materials, cell attachment, proliferation, differentiation
- Biomimetic materials for engineering load-bearing tissues, self-healing mechanisms
- Biomechanics of soft tissues and hard tissues
- Evaluation of tissue engineering constructs in laboratory and/or pre-clinical settings

IC-3.C New therapeutics and intelligent drug/biomolecule/gene delivery systems

- Advances in system-responsive materials for delivery systems. Controlled release systems, triggering mechanisms
- Drug targeting, targeting and imaging agents to site-specific delivery
- Biomaterials constructs for temporally controlled release of multiple factors
- Progress in imprinted recognition release systems and implantable micro- or nano-delivery devices
- In vitro and in vivo studies, models for drug transport, absorption metabolism, retention mechanisms and toxicological issues

IC-3.D Bio-imaging and theranostics

- Inorganic and organic nanoparticulate systems for bio-imaging
- Functionalized agents/devices for in vitro and in vivo imaging and diagnostics
- Theranostic nanocarriers, multimodal theranostic agents
- Multifunctional theranostic nanoplatforms
- Biomedical imaging (MRI, MPI, PET, SPECT, ...)

IC-3.E Clinical translations

- Muscoloskeletal, cardiovascular, nervous system, dentistry, ENT surgery, etc
- Modelling of tissue/implant system
- Biocompatibility, biodegradation, host response
- Qualification and testing methods
- Studies on retrieval implants

Special Session IC-3.F

State-of-the-art Biomaterials and Bioelectronics for Next Generation Implantable Neural Interfaces

The development of implantable neural interfaces enables large-scale and high-resolution recording of neural populations in vivo and offers new application perspectives for neuroscience and for the therapy of neurological disorders. If, on one hand, a new investigation window has been opened on brain function by getting better access to brain microcircuits, on the other hand these novel neural interfaces may represent a means to partially restore lost functions in the nervous system of neurological patients. The reliability and endurance of the implant, the degradation with time of neural functions caused by implant/tissue mismatches in stiffness, insertion-associated injuries and foreign body reactions represent all serious problems to be overcome. Further on, other complex challenges have to be faced along this route, including the stable sensing of weak signals from individual or a few neurons for long periods, the implementation of microstimulation paths for two-way control of neurons activity, and to embody signal processing capabilities in the implant at low power consumption.

New achievements in biomaterials and bioelectronics towards neural interfaces with low impedance, flexibility and conformability, minimal invasiveness, cell-type specificity, high spatiotemporal resolution and long term stability may play a fundamental role in the development of new neural interfacing systems for neural recording and modulation to enable the design of nanoscale devices and architectures allowing for an efficient and smart bi-directional interfacing with the nervous tissue and providing a high degree of biocompatibility that are a key for their successful application.

This Special Session, that follows the ones on the same subject held at previous CIMTEC Conferences, will feature recent progress in this challenging research field whose breakthroughs are expected to have relevant impact on the treatment of disorders of the nervous system such as e.g. spinal cord injuries, neurovegetative diseases such as e.g. Parkinson's, autism, severe mental illness, and visual cortex and retina diseases.

Topics will include:

- Conductive polymers for neural interfaces
- Stimuli-responsive nanomaterials for neuromodulation
- Drug/gene delivery vectors for neural interfacing
- Axon pathfinding to target; neural tissue engineering; bioactive scaffolds for nerve regeneration
- Flexible conformable and thin film bioelectronics
- Substrate micro-nano structuring and functionalization for neural development
- Nano-, micro-devices for neural signal processing: signal management, reliability, long-term stability
- Mechanical and electronic properties of implantable neural recording and stimulating devices
- Minimally invasive interfacing and systemic response to implanted neural interfaces
- In-vitro neural interfacing studies; lab-on-chip devices
- Achievements in clinical translations (treatment of neurodegenerative diseases, brain and spinal cord injuries, artificial retina….)

Symposium FA

From Fossil Fuels to Tomorrow Powerplants: Materials and Technology Demand to Govern the Transition

The world general trend for power plants is to gradually replace fossil fuels with more environmentally responsible solutions based on e.g. concentrated solar power, nuclear and hydrogen as these are developed and realized at commercial scale.
However, due to the ever-increasing energy demand, a number of countries have little choice but to continue generating power with fossil fuels and will be unable to comply with IEA's net zero emission for the year 2050. Therefore it is expected electric power generated from fossil fuels will continue to be a significant, although gradually decreasing energy source in the decades to come.
Within this transition period industry is expected to further develop and deploy more advanced combustion technologies and gasification-based systems to increase the efficiency and decrease the environmental impact associated with producing energy from carbon-containing materials as well as provide an opportunity for C02 capture and sequestration and exploit the chances offered by the produced synthesis gas as source for e-fuels and hydrogen.
The above technology implementations will not occur without simultaneous advances in materials science and engineering. Higher efficiencies in combustion and gasification processes for PCC and IGCC plants mean higher operating temperature and more aggressive service environments, placing a huge stress on construction materials. Furthermore, mixed feedstock requires more robust, impurity tolerant membrane materials and catalysts. Meetings these requirements will call for new, high-performance materials or protection strategies to extend their service life. Moreover, novel catalysts for the e-fuels production, ammonia decomposition etc.; high throughput and selectivity sulphur, ammonia and chloride-tolerant hydrogen separation membranes; high-performance, defect-free C02 selective membranes are relevant research targets.
This symposium will cover significant advances in steam power including USC power plants (HRSG, boilers, steam turbines) and gas turbine to address the aforementioned issues aimed at reliably maintain the conversion of carbon-containing materials to energy in an efficient and environmentally benign way.
Materials for the new technologies, such as electrolisers, involved in energy production will contribute to novel solution to reduce the utilization of fossil fuels. Sessions will encompass major aspects concerning the science and characterization of materials, advanced processing technologies to produce components at the required scale and complexity, and their evaluation in service, MODELING AND SIMULATION OF MATERIALS AND PROCESSES; linked to a deeper understanding of the underlying physics and chemistry of the materials, such as catalysis, membrane separation mechanisms and materials/environment interactions.

Session Topics

FOSSIL FUEL COMBUSTION

FA-1 Advances in intermediate and high temperature structural materials: stainless steels, CSEF steels, ODS alloys, superalloy, intermetallics, aluminides, oxide and non-oxide ceramics, ceramic-or-metal-matrix composites, other emerging materials

FA-2 Membranes for oxygen separation; Adsorbents for CO2 capture

FA-3 Joining; Coatings (metallic, TBC, EBC) and claddings; Repair

FA-4 Damage mechanisms and properties: creep, fatigue, oxidation, corrosion, erosion, wear…

FA-5 New designs and advanced manufacturing routes for components

FA-6 Reliability and in-service performance

GASIFICATION AND GAS CLEAN-UP

FA-7 Improved or new materials. Materials to enable fuel flexibility. Injector systems

FA-8 Catalysts for water-gas shift and catalysts for fuel production

FA-9 Membranes for H2 separation and CO2 selective membranes

FA-10 High temperature seals for membrane moduli assembly

FA-11 High temperature corrosion-resistant gas sensors

FA-12 Component lifetime, in-service performance, case studies

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Symposium FB

Carbon Capture & Utilization: Advances in Materials and Processes for Technology Scaling-up

Over the last decade, CO2 capture and utilization (CCU) has emerged as a paramount tool to counteract greenhouse effect by limiting emission of gas responsible of global warming and to open the door for captured CO2 to a variety of value-added products such as fuels and chemicals. Contribution of new or improved materials is crucial for exploiting economically viable solutions to limit emissions from power generation plants and steel or cement production industries, or coming from other emitters such as chemical plants and waste incinerators, or even to capture CO2 naturally present in air atmosphere (Direct Air Capture).

Focus of symposium will be on:

- current research trends to develop efficient CO2 adsorbents and CO2 selective inorganic, composite or mixed-matrix membranes to tailor structure and chemistries for optimized adsorption/desorption, separation properties, chemical and thermal stability, mechanical properties, regeneration capacity, lifetime and cost to satisfy criteria for industrial scale applications, and
- explore the number of processes reimagining CO2 from pollutant to reagent including effective materials strategies of defect engineering, surface functionalization, hybrid structures ,new catalysts and heterojunctions for CO2 activation.

The symposium aims to bring together scientists and engineers drawing inspiration from both physical, chemical, engineering and environmental sciences. Contributions are solicited on mechanistic studies of chemistry processes and physics involved in capture, separation and catalysis reaction pathways of CCU, and on the synthesis and processing of functional materials

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by tailoring structure .and properties appropriate to scalable industrial solutions. The above on the basis of a deep understanding of the underlying fundamental chemical and physical processes and the proper use of advanced theoretical, data science and experimental tools.

Session Topics

MATERIALS AND PROCESSES FOR CARBON CAPTURE AND SEPARATION

FB-1 Pre-combustion
- CO2 removal from biogas or syngas
- H2 production by gasification of hydrocarbon feedstock
- H2 production by gasification of wastes

FB-2 During-combustion
- Oxy-fuel combustion: Chemical looping

FB-3 Post-combustion
- CO2 absorption; CO2 Adsorption; Membrane separation; Calcium looping

FB-4 Direct air capture

MATERIALS AND PROCESSES FOR CARBON CONVERSION TO FUELS AND CHEMICALS

FB-5 Catalytic conversion

FB-6 Photocatalytic conversion

FB-7 Electrochemical and photo electrochemical conversion

FB-8 Photo-thermal and photochemical conversion

FB-9 Bioconversion

FB-10 CO2 mineralization

Symposium FC

Materials and Process Innovation for Hydrogen Production and Storage

Hydrogen represents a promising solution as a clean, abundant, safe, and cost-effective energy carrier for grid, transportation, and industrial use. It is also highly versatile can be produced from either renewable or baseload energy sources. Moreover, coupling with the carbon or nitrogen cycles, hydrogen can be readily thermo-chemically processed to generate fuels and chemical products. Despite its potential, practical implementation of a competitive hydrogen infrastructure has often been limited by key challenges in cost-effective production, distribution, and storage. Breakthroughs at all levels of implementation—from materials research to device design to system engineering—are a priority. In addition, there are many fundamental aspects of hydrogen-materials interactions that remain poorly understood. Opportunities abound to exploit the enormous potential of novel synthesis approaches, multiscale modelling and simulation, data science and machine learning, characterization tools, and manufacturing advances to design new hydrogen materials and processes.
“Materials and Process Innovation in Hydrogen Production and Storage” will bring together researchers from physics, chemistry, materials science, and engineering disciplines to share scientific and technical advances and to highlight outstanding problems and guidelines for future research. Topics will span both fundamentals and applications, including (but not limited to) (photo) electrochemistry, catalysis, membranes, separation and

purification; hydrogen compression and liquefaction; gas, liquid, and solid-state storage; and system engineering, scale-up, and performance evaluation, including safety, durability, and economic issues. Contributions covering multiscale modelling, in situ and operando characterization, materials synthesis, processing and manufacturing, and systems design will be featured.

Session Topics

HYDROGEN PRODUCTION

FC-1 Fossil fuel reforming

FC-2 Biomass gasification

FC-3 Advanced coal gasification

FC-4 Photocatalysis and photoelectrochemistry

FC-5 Thermochemical water splitting

FC-6 Renewable electrolysis

FC-7 High-temperature electrolysis and hybrid cycles

FC-8 Photobiological and photo-biomimetic

FC-9 System design and market/environmental considerations

HYDROGEN STORAGE AND DISTRIBUTION

FC-10 Gaseous and cryogenic storage

FC-11 Compression and liquefaction

FC-12 Metal hydrides

FC-13 Complex hydrides

FC-14 Chemical hydrides and liquid carriers

FC-15 High surface-area sorbent materials

FC-16 Tank design, safety and market considerations

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Symposium FD

Fuel Cells and Water Electrolysis: Materials and Technology Challenges

The need to address the Climate Change and its related issues by individuating both near- and especially long-term solutions is now becoming urgent. The main approach requires to radically lower green-house gases (GHG) emissions in the shortest time to avoid major climate impact.
Achieving the required energy transition would need developing clean hydrogen technologies at large scale. Clean hydrogen is widely considered as an appropriate energy vector for sustainable development and, especially, it can allow for a deep decarbonisation of transport, buildings, and industry.
Accordingly, a wide use of clean hydrogen mediating between renewable energy sources and final uses constitutes a crucial step towards enabling the decarbonisation of the energy system and encouraging the pursuit of climate neutrality. The technological areas relating to the clean hydrogen are numerous and to encourage homogeneous

and widespread penetration. Electrolysis and fuel cells operating at high, intermediate and low temperature can provide solutions to address the different challenges for clean hydrogen production and utilisation.

The International Symposium "Fuel Cells and Water Electrolysis: Materials and Technology Challenges", through the contribution of experiences coming from several different disciplines, will focus on major advances in materials science, process and technology development, processing and device manufacturing of the different electrolysis and fuel cells technologies.

Original papers are solicited on all types of electrolysers and fuel cells. Of particular interest are recent developments of advanced materials, novel processes, novel stack designs, emerging electrochemical cell technologies including co-electrolysis of CO2 and water, fuel cells for automotive, portable, and CHP applications, optimization and breakthroughs in performance and durability, protocols for testing these electrochemical systems and field-testing activities for technology validation at different TRLs. Reviews of the state-of-the-art electrolysers and fuel cells performance and durability for specific applications, including consumer devices, electric vehicles, distributed energy systems and the hard-to abate sector may also be submitted.

Session Topics

FD-1 Solid Oxide Fuel Cells (SOFCs) and Electrolysers (SOECs)

- High and intermediate temperature solid oxide fuel cells
- High and intermediate temperature solid oxide electrolysers
- Reversible solid-oxide fuel cells
- Materials issues in solid oxide fuel cells and electrolysers
  - Oxygen ion, proton and mixed conductors: conduction mechanisms
  - Ceramic and metallic interconnects; sealing materials
  - Mechanical and thermal properties; Surface and interface reactions
- New frontiers in solid oxide fuel cells
  - Additive manufacturing, automated stack assembling, 3D printing t.
- SOFC & SOEC cell and stack design, electrochemical performance, reliability, degradability, fuel versatility
- Modelling of materials, devices and processes

FD-2 Proton-conducting Polymer Electrolyte Membrane Fuel Cells (PEMFCs) and Electrolysers (PEMWEs)

- New and improved proton-conducting polymer membranes including fluorine-free membranes
  - Hybrid organic-inorganic materials, polyaromatic polymers, nanocomposites….
- Electrode materials and electrocatalysts
- Electrode membrane assembly
- PEM FC stacks for automotive & stationary generation
- Modelling of materials, fuel cell and electrolysers performance & durability

FD-3 Alkaline and Anion-Excahnge Electrolyte Membrane Fuel Cells (AFCs, AEMFCs) and Electrolysers (AELs, AEMWEs)

- Advanced alkaline fuel cells and eletrolysers
- Novel and improved anion-conducting polymer membranes
- Electrode materials and electrocatalysts
- Electrode membrane assembly
- AFCs, AEMFCs, AELs, AEMWEs cells and stacks
- Modelling of materials, fuel cells and electrolysers performance & durability

FD-4 Direct Fuel Cells & e-Fuels production

- Electrocatalysts for alcohol oxidation
- Methanol/ethanol tolerant cathode electrocatalysts
- Non-noble metal catalysts
- Methanol/ethanol impermeable membranes
- Direct methanol and direct ethanol FCs for portable and assisted power unit (APU) applications
- High & low temperature CO2-water co-electrolysis and e-fuels production
- Direct oxidation of renewable organic fuels in high temperature fuel cells
- Direct ammonia fuel cells

FD-5 State-of-the-art application engineering and demonstrations

- Combined heat and power (CHP)
- Distributed power generation
- Transport
- Portable power
- Demonstration of high temperature fuel cell & electrolysis systems and field testing
- Demonstration of PEMFC & PEMWE systems and field testing
- Testing protocols

Symposium FE

Next Generation Electrochemical Energy Storage Materials and Systems

Electrochemical energy storage has witnessed extraordinary growth over the past two decades as the need for energy storage solutions now extends from small sizes for mobile electronics to medium sizes for transportation to large sizes for grid storage. The demand to improve materials and energy storage is expected to continue unabated in order to implement renewable energy sources and achieve the goal of net zero carbon emissions.

This symposium addresses the energy storage challenge by focusing on new and emerging materials science and engineering directions which are expected to enhance energy storage characteristics, increase stability, improve safety, and reduce the cost of electrochemical energy storage technologies. The most promising and latest solutions for the efficient storage of electrical energy will be emphasized as we intend to cover the most recent materials developments for high energy and high power rechargeable batteries, high rate energy storage, electrochemical capacitors, hybrid devices, and related technologies. Highlighted areas include the design and synthesis of new electrode and electrolyte materials for Li-ion, Na-ion, K-ion and solid-state batteries, redox-based electrochemical capacitors, advanced characterization methodologies including in situ techniques, and computational analysis to predict material behavior and guide the design of new materials. The infusion of new approaches is essential if improved materials for electrochemical energy-storage solutions for transportation, grid energy storage, and portable devices are to be achieved. Papers pertaining to the discovery of novel materials via AI/ML and the integration of theory and simulation are an integral part of this symposium as are advances in electrode and electrolyte materials, the development of new cell chemistries and configurations, novel electrode architectures and

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advanced characterization including in-operando approaches. Taken together, these topics represent the basis for the development of next generation energy storage materials and systems.

Session Topics

FE-1 Batteries

- Rechargeable batteries: anodes, cathodes, and electrolytes
- Cell chemistries: Li-ion, Li-S, Li-air, Na-ion, Mg-ion, Al-ion, all solid-state, redox flow, etc.
- Bulk, surface, and interfacial characterizations
- Computational modeling
- Novel Materials via AI/ML
- Cell design
- Application engineering

FD-2 Supercapacitors

- Supercapacitors
- Pseudocapacitors and hybrid devices
- Electrodes and electrolytes
- Cell design

Symposium FF

Towards Next Generation Solar Cells: Emerging Materials, Phenomena and Device Architectures

The panorama of photovoltaic technologies includes a series of devices based on diversified materials, photoconversion processes, efficiencies, and costs. Depending on the end-user application, various technology platforms are available. Thin-film technologies include chalcogenide semiconductors, amorphous/micromorphous silicon, and nano/micro/poly-Si. They are fast becoming highly interesting to the market, thanks to their outstanding functionality in integrated devices. Other emerging technologies are represented by perovskite solar cells, and organic and quantum dot solar cells, which offer increasingly high photoconversion efficiency, while maintaining highly competitive costs, with interesting progress toward device stability, mainly based on tailored materials fabrication.

New physical effects are also investigated to push the photoconversion efficiency above the Shockley-Queisser limit: intermediate bands, multiple exciton generation, hot carriers, and up/down conversion.

The success of the above emerging and prospective solutions calls for the availability of reliable materials systems and device architectures capable of efficiently harvesting the full spectrum of solar energy.

The Symposium *"Towards Next Generation Solar Cells: Emerging Materials, Phenomena and Device Architectures"*, which follows those on similar topics held in previous CIMTEC Conferences, provides a forum for materials scientists and experts from industry to discuss major advances in the aforementioned fields, from latest developments in inorganic thin film/perovskite/organic/hybrid devices to new findings and approaches for next-generation solar cells, focusing on fundamental materials science and processing, on new concepts and theories for light management, and on device physics, manufacturing, reliability, and long-term stability.

A Special Session covering last achievements in concentrated photovoltaics will complement the Symposium.

Session Topics

FF-1 Thin-film photovoltaics

- Silicon thin films and multi-junction Si solar cells
- CIGS (and related compounds) and CdTe solar cells
- Kesterite and other novel materials/concepts for inorganic thin film PV

FF-2 III-V solar cells
- III-V tandem solar cells (inc. III-V tandems on Si)
- III-V QW and QD solar cells

FF-3 Organic, dye sensitised and nanoparticle phovoltaics
- Small organic molecule and polymeric solar cells
- Perovskite solar cells
- Quantum dot solar cells

FF-4 Multiple energy level devices
- Intermediate band solar cells
- Up or down conversion for solar cells

FF-5 Excited state enhanced solar cells
- Hot-carrier solar cells
- Multi-exciton generation
- Hot luminescence devices
- Other novel concepts

FF-6 Advanced light trapping for photovoltaic devices
- Plasmonic coupling
- Photonic and nanophotonic light trapping

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Special Session FF-7

State-of-the Art Development of Concentrated Photovoltaics

Despite concentrated photovoltaics (CPV) based on III-V multi-junction solar cells and of optics to concentrate solar light may reach the highest efficiency and lower energy payback time of all photovoltaic technologies today available and with module conversion efficiency over 40%, its large-scale entry into the market is hampered by the higher manufacturing and operational costs compared to silicon photovoltaics. Therefore, interest in CPV shifted in recent years towards the design of new system architectures either for low-power density applications such as luminescent solar concentrators (LSCs) based on new inorganic (quantum dots) or organic (carbon dots) luminophores, which are highly interesting for applications such as the so-called building integrated photovoltaics (BIPV) or greenhouse technologies, or to realize high power density CPV modules required by the fast-growing markets of space-restricted applications such as vehicle-integrated PVs, space solar, mobile chargers, off-grid power systems, robotics and other. Among these, an attractive, although very challenging approach, is being actively pursued by some research groups (the so-called Micro-CPV). This approach, also based on borrowing experience and synergy from market-consolidated industrial sectors such as microelectronics, MEMS, optics, and optoelectronics, is expected to allow high efficiency and cost reduction at both module and system level if combined with silicon PV in hybrid architectures.

This special session aims to discuss the latest advances in the above fields, from laboratory studies to prototype demonstrations and practical applications.

Session topics

- Novel materials for concentrator solar cells
- Device architecture and optimization for CPV
- Micro-CPV
- Device architecture and optimization for LSCs for BIPV and greenhouses
- Standardization for in-field tests

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Symposium FG

Thermal Energy Storage: State-of-the-art Materials and Technologies Towards a Low-carbon Society

Thermal energy storage (TES) technologies that can store and release energy produced by renewables or waste heat in a wide range of temperature and time, are at the forefront to achieve the goal of near zero carbon emissions in 2050 and offer a solution to intermittency or seasonal problems of renewable energy generation. TES may play a significant role across various sectors including energy-intensive industries, buildings and power. Extended research performed in the last decades on sensible (SHS) and latent (LTHS) thermal energy storage and most recently on thermochemical heat storage technologies, credit LTHS of several advantages on SHS including high energy density, a wide range of phase change temperature, chemical stability and affordable prize. However LTHS suffers from various shortcomings. low thermal conduction, poor thermal stability, corrosiveness and leakage in the molten state being among the most critical. Thermochemical solutions, which hold great potential for promoting the development of next generation CSP plants working at temperatures also exceeding 1.000°C, can achieve energy densities higher than SHS, are able to operate under harsher conditions, show good reversibility and quick response in a broad range of conditions, but their insufficient heat and mass transfer performance and overall operation costs are today main drawbacks for its effective introduction into the market.

Further progress in TES technologies critically rely on the availability of improved/new materials, on how their performances may be optimized by a deeper understanding of working physical chemical processes, on advanced storage concepts and innovative reactor designs. The research process for novel materials has historically been a protracted and arduous undertaking, characterised by iterative experimentation and costly testing, but the recent advancements in AI models (machine learning and deep learning models) have demonstrated the potential for these methodologies to overcome these difficulties, and then to expedite the innovation also in this sector.

Recently, Europe was nominated to become the first regional area with a zero-climate impact in terms of social, economic, and production dimensions by the year 2050. Achieving this objective necessitates a comprehensive transformation of the energy system, encompassing the modernization and implementation of advanced energy infrastructures. These infrastructures are defined by characteristics of smartness, reliability, flexibility, and resilience. Addressing these challenges necessitates the integration of diverse energy processes, a concept referred to as sector coupling or integration. TES technologies, in this regard, find application as intelligent systems for interfacing diverse energy processes. Carnot batteries serve as a prime illustration of this integration.

This symposium aims to bring together researchers and experts from academy and industry to discuss recent advances and new trends of thermal energy storage at both the materials and system levels. Theory and experiment; machine driving approaches such as deep learning and data mining; the progress in TES solutions for renewable energy systems for CSP, in various industrial sectors and for thermal storage in buildings will be object of discussion.

Session Topics

FG-1 Development of new/ improved TES media; thermal, physical and chemical properties and performance optimization; advances in methods for testing and characterization for:
- Sensible heat storage materials (SHS)
- Latent heat storage materials (LTHS)
- Thermochemical heat storage

FG-2 Nano, -micro- and-macro encapsulation methods

FG-3 Kinetics of reactions, reversibility, cycle repeatability, energy density and heat transfer processes in solid-gas, solid-liquid, solid-solid and liquid-gas systems

FG-4 Selection criteria for TES media and for structural and containment materials such as tanks and pipelines working in extreme environments

FG-5 Multiscale modelling, numerical models, experimental validations

FG-6 Relevant-scale prototyping for sensible, latent and thermochemical storage

FG-7 TES in renewable energy systems

FG-8 TES in buildings

FG-9 TES in industry

FG-10 Novel thermal energy storage concepts and expected trends

Symposium FH

Concentrating Solar Thermal: Materials and Technology Challenges and Opportunities

Concentrating Solar Thermal (CST) technology is the focus of intense research and development activities worldwide due to its potential in generating renewable energy and decarbonising industrial processes and it is expected to contribute significantly to future sustainable energy mix.

As a renewable source of electricity, CST uses the energy generated by concentrated solar radiation to power a steam or a gas turbine; or else, the heat produced can be appropriately stored for off-sun electricity generation at a lower cost than traditional batteries utilized in PV systems. Moreover CST can be used for the production of hydrogen, fuels or chemicals by high temperature “green” processes and for decarbonation of industrial cycles.

A main challenge for increased system efficiency is to achieve operating temperatures (currently up to - 600 °C) to exceed 1000 °C which implies increased demands on structural materials and coatings for their thermomechanical and chemical stability, reliability and lifetime. Moreover, advances in functional properties in optical materials for absorbers and reflectors are critical for efficiency improvements and cost reductions. Heat-resistant materials with higher stability and storage capacity and appropriate thermal transport properties are required for thermal storage systems, whereas improved materials are on demand to drive small-scale thermochemical reactions such as water splitting, hydrogen and fuel production, and for industrial decarbonation.

This symposium aims to bring together experts of diverse backgrounds to present latest research results and debate challenges, ongoing developments and perspectives for competitiveness, efficiency, reliability and safety of CST technology in its broad application fields.

Session Topics

FH-1 Developments in concentrators and heat collecting elements
Reflectors, absorbers, receivers, mirrors, coatings, high-temperature construction and isolation materials; advances in materials synthesis, processing and characterization; components design and manufacturing, novel coating deposition methods, surface modification…

FH-2 Thermal energy storage materials, media and systems
PCMs, TCMs, sensible heat storage materials

FH-3 Solar production of hydrogen, fuels and chemicals
Metal oxide-based redox materials, catalysts, Sulfur-based and Cu-Cl cycles…

FH-4 Solar thermal methods and materials for decarbonization of industrial processes

FH-5 Computational modelling and high throughput data screening of novel structural and functional materials for CST technology

FH-6 Advanced in-situ and ex-situ testing of materials and components (mechanical, thermal, optical, corrosion, stability, durability, aging…)

FH-7 CST prospects in a rapid changing and competitive energy world

Symposium FI

Advanced Membrane and Materials Technologies for Energy and the Environment

Membranes are at the forefront of technological advancements addressing critical challenges in clean and sustainable technologies. With their unique ability to selectively separate, purify, and convert substances, membranes have become key in addressing global challenges such as energy sustainability, water scarcity, and environmental degradation. These versatile systems are enabling breakthroughs in areas such as renewable energy production, advanced water treatment, and industrial process efficiency. By harnessing cutting-edge advancements in material science, processing techniques, and computational modelling, membrane technologies are paving the way for a cleaner, greener future.

In response to the increasing demand for environmental and energy solutions, this symposium will showcase the latest advancements in membrane science, bridging fundamental research with practical applications, from researchers and industry experts to share pioneering research. We call for contributions exploring the synthesis, physical chemistry, properties, functionality, and performance of membranes, as well as their diverse applications. Studies on performance across various applications and insights into the relationships between composition, structure, properties, and performance are also of particular interest.

We welcome submissions addressing both fundamental and applied research across the following thematic hot topics:

Advanced Materials for Membranes, e.g. synthesis of novel materials for inorganic and organic membranes, innovative systems, including carbon-based membranes, ceramics, polymers, metals, nanomaterials, 2D materials and Metal-Organic Framework (MOF)-based membranes.

Membrane Fabrication and Processing, e. g. innovations in fabrication techniques such as forming, sintering, and advanced processing and shaping methods, studies on physical chemistry, structural optimization, and performance enhancement of membranes.

Applications of Membranes in Clean Technologies, e. g. membranes for energy storage and conversion, membranes for gas separation, purification and conversion, cutting-edge applications in water treatment, desalination, and production of eco-friendly synthetic fuels, membrane-based actuators and devices for advanced industrial applications.

Membrane Behaviour under Harsh Conditions, e.g. investigation of material and process performance under extreme environments, including high temperatures, pressures, and corrosive conditions, studies on deterioration mechanisms, lifetime prediction, and resilience of membranes in challenging applications.

Computational and Data-Driven Approaches, Integration of computational modeling, data analytics, and machine learning for designing advanced membrane materials, predictive simulations of functional properties and performance for improved efficiency.

Session Topics

FI-1 New materials synthesis, membrane processing and shaping, characterization

FI-2 Physical chemistry of membranes

FI-3 Membranes and separators in electrochemical energy systems (fuel cell, electrolyser, battery...)

FI-4 Membranes for gas separation and toward production of synthetic fuels (CO2, H2, NH3…)

FI-5 Water purification and desalination membranes

FI-6 Catalytic membranes

FI-7 Membrane actuators

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Symposium FJ

Advanced Photo/Electro Catalytic Materials for a Low-Carbon and Resilient Transition

The use of renewable energy to drive the chemical and energy processes and the chemical storage of renewable energy is a crucial element of moving to a low-carbon and resilient economy, developing a sustainable society and fostering the transition in energy and chemistry. There is a fast-growing scientific interest in this subject, with emerging new directions and applications also at the industrial level. The development of advanced photo/electrocatalytic materials, and in general, materials able to use renewable energy sources to drive the conversion of small molecules such as CO2, N2, H2O and CH4 to produce fuels and chemicals (e-refinery and e-chemistry) is a key topic of fast-growing interest. These technologies, often identified with the term Solar-to-X or artificial photosynthesis or leaf-type, are crucial for realizing distributed production technologies and implementing net-zero communities.

Realizing this challenge requires the development of new ideas, concepts and innovative photo/electrocatalytic materials as well as other contiguous areas such as plasma catalysis. However, there is also the need to rethink the current approaches because it is emerging how accelerating the progress in this area requires the development of new concepts and ideas largely beyond the current ones investigated. It is thus of foremost relevance the possibility of an open discussion and exchange of ideas to stimulate a creative and novel understanding, explore new directions and possibilities, and also revise the fundaments to understand better the peculiarities of designing photo/electro or plasma catalytic materials and how they differentiate from conventional catalysis.

These materials are also widely utilized to clean and remediate our environment. Semiconducting photocatalytic materials possess multi-functional properties, which allow their use in various areas, from photocatalytic environmental remediation, water splitting for hydrogen fuel, CO2 reduction, self-cleaning coatings, electrochromic devices and sensors, and low-cost solar cells. New emerging areas will include the development of new technologies to convert small molecules such as O2, N2 and CH4 and the coupling between photocatalysis and non-thermal plasma chemistry. The nano-architecture design of these materials is of crucial relevance to achieve these different functional characteristics and realize an efficient energy conversion. There is a need to gather together multiple competencies to accelerate the development of these nanomaterials for solar energy and environmental applications. At the same time, electrocatalytic materials are a complementary area of increasing relevance, both integrated with solar materials to realize PEC or PV/EC devices or as electrocatalytic technology for a wide range of applications, from the electrolysis of small molecules to the conversion of biomass or other already functionalized substrates. The large range of applications and new solutions is only starting to be explored. Still, the development of advanced electrodes/electrocatalysts is the turning point to pass from lab to industrial scale.

This symposium aims to provide a multi-disciplinary forum for scientists, engineers, and industry experts to break new ground in the discussion, realize cross-fertilization, and progress in understanding the design criteria for their use. Among the recent developments that will be highlighted in the symposium are advances in the synthesis of novel materials with tailored nano-architecture, the preparation of thin films and nanostructures, the advanced characterization by experimental and theoretical methods of these materials and of their structure-performance relationships, processing techniques, device fabrication and stability; advances in environmental applications and

air quality improvement; novel concepts, technologies and materials for photo/electro catalysis and their use in Solar-to-X or artificial photosynthesis/leaf-type technologies.

Session Topics

FJ-1 Advanced concepts for the design of photo/electro-functional materials

- Band-gap engineering of photocatalysts: optical, electronic, and catalytic modifications
- Multiphoton band-gap engineering, photonic materials, hot carriers
- Emerging photoelectronic materials such as nanoscale plasmonic metal particles, quantum dots, and 2D materials
- Hybrid photocatalytic nanomaterials, heterojunctions
- Nanostructured electrodes and electrocatalytic materials
- Structure-activity relations for an advanced design
- Single-atom electrodes
- Optimizing interfaces in multilayer systems
- Photocharges transport and semiconductor architecture
- New types of quantum dots and robust sensitizers, antenna effects
- 2D and 3D printing of electrodes and tailored surfaces

FJ-2 Understanding fundaments of charge-induced processes and charge transport

- Charge transfer and recombination
- Charge-induced surface processes in photo- and electro-catalysis
- Charge confinement, stabilization, and electrical field-induced processes at the interface
- Role of charge transport in controlling performances and selectivity
- Charges transport and electric bias
- Theoretical and computational investigation
- Computational screening of new photo/electro materials
- Relation between nanostructure and functional behaviour, control of the selectivity
- Photoelectrochemical devices
- Use of AI in discovery and understanding photo/electro materials
- Multiscale modelling in Solar-to-X devices
- Modelling electrolyte and electrode-electrolyte interfaces
- Modelling nanostructures electrodes

FJ-3 Design approaches for advanced applications

- Development of high surface area and porous photocatalytic materials and photoanodes
- Photoactive nanodevices, hierarchical photoactive materials
- Innovative materials for third-generation solar cells (dye sensitized solar cells, quantum dot cells, tandem/multi-junction cells, hot-carrier cells, etc.)
- Advanced devices for photo/electro catalytic solar fuel (H2, CO2 reduction, N2 fixation)
- Photo/electro catalytic activation of small molecules (O2, N2, H2O, CH4)
- Selective photo-oxidations for organic synthesis, tandem systems
- Tandem and paired photo/electro catalytic advanced applications
- Environmental applications: air / water treatment, anti-bacterial surfaces
- Photocatalytic fuel cells, artificial leaf and tree
- Designing elements to improve stability, scalability, and cost
- Metal-free photocatalysis
- Superhydrophilic, amphiphilic and antifogging surfaces
- Hybdrid photo/electro systems with micro-organisms

Symposium FK

Thermoelectrics: Materials Research and Application Technologies

Thermoelectric technology enables the direct conversion between heat and electricity, offering a cutting-edge clean energy solution that boosts energy efficiency and mitigates environmental pollution, with key applications in solid-state power generation and cooling. Recent advancements in thermoelectric research have been remarkable, including advancements in nanomaterial synthesis and a deeper understanding of electron and phonon transport at the nanoscale; the use of machine learning-assisted data mining, along with high-throughput computation and characterization, which accelerates the development of efficient thermoelectric materials; the exploration of new materials, including flexible and plastic ones, which has become a research focal point; and the discovery of novel thermoelectric phenomena, such as topological and strongly correlated effects. Thermoelectric materials now encompass a diverse range, including inorganics, oxides, polymers, and materials with topological and strong correlation properties, etc. Furthermore, there has been a growing body of research dedicated to the design, assembly, and evaluation of thermoelectric modules for practical applications.

The symposium is set to explore cutting-edge research encompassing thermoelectric materials, device manufacturing, and their applications, as well as the underlying physics. A key focus area will be on the progress in material science. This focus area will include sessions on the design, synthesis, and characterization of various materials, in addition to groundbreaking thermoelectric phenomena. This symposium will also focus on the development of device research. Discussions addressing the technological challenges associated with device design and fabrication, as well as the modelling and simulation aspects, will be welcomed. Additionally, converter technologies and applications will be another focus area, covering design, modelling, characterization, advanced processing, metrology and standardization.

Session Topics

FK-1 Thermoelectric materials research & characterization

- Computationally-guided design and discovery
- Bulk inorganic materials, including nanostructures and composites
- Organic and polymeric materials
- Low dimensional materials
- Flexible/ductile materials
- Magneto-thermoelectric and topological thermoelectric effects

FK-2 Device research and modeling

- Energy conversion mechanisms
- Thermoelectric device design & architectures
- Device modeling and simulation

FK-3 Converter technologies and applications

- Terrestrial and space applications opportunities
- Advanced manufacturing and rapid prototyping approaches
- Device, converter technology development and infusion demonstrations
- Converter and system modeling and simulation
- Metrology and standardization

Symposium FL

Caloric and Multicaloric Materials and Effects: from Fundamentals to Applications

Caloric effects refer to the reversible thermal responses of solids under the application (or removal) of one or more external fields. These effects can be significantly amplified near a phase transition. In recent years, the research on magnetocaloric, electrocaloric, mechanocaloric, and multicaloric materials and devices has greatly increased, driven by the demand for sustainable solutions for heating and cooling. Solid-state refrigerators and heat pumps based on caloric and multicaloric materials are promising alternatives to the conventional technologies of vapor compression and gas combustion. These materials have also been recently proposed for cryogenic applications in hydrogen liquefaction.

Session Topics

FL-1 Theory, simulation and modeling of caloric materials

FL-2 Preparation and characterization of caloric materials (bulk, nanostructured, composites)

FL-3 Functional characterization of caloric materials

FL-4 Devices for solid state refrigeration, heat pumps and other energy related applications

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Symposium FM

High-entropy Energy Harvesting: Theory, State-of-the-art Materials, Nanogenerators and Self-powered Systems

Our ability to scavenge and convert ambient energy into electricity offers an unprecedented opportunity for powering various electronics systems and sensors, and to build an integrated system capable of battery-free operations. Triboelectric nanogenerators that use triboelectrification and electrostatic induction to recover electrical energy from mechanical vibrations have been proved as a new way to generate electricity. Piezoelectronic nanogenerators have also attracted rising interests in the past decade. The integration of the triboelectric nanogenerators/

piezoelectronic nanogenerators and energy storage units gives the opportunity for making various types of self-powered sensors for application in electronics, biosensors, nanorobotics, biomedical sensors, etc.
This symposium aims to advance our fundamental understanding and technology development of nanoscale mechanical energy conversion materials and systems based on triboelectric, and piezoelectronic and thermoelectric nanogenerators. Abstracts may cover theoretical and experimental studies of dielectric materials; research and applications of nanogenerators for self-powered devices or hybrid nanogenerators. Interdisciplinary works that combines nanogenerators and other areas such as deep learning, artificial intelligence are particularly encouraged.

Session Topics

FM-1 Mechanism of triboelectrification and piezoelectric effects
- electron/photon/phonon generation
- transport and interaction processes
- computational and machine learning-driven approaches

FM-2 High-entropy energy harvesting materials
- synthesis
- processing
- characterization

FM-3 Nanogenerators and self-powered systems: processing (deposition, surface modification, patterning, soft and flexible technologies); nanogenerators/energy storage units' hybridization; electrical circuits for power management: energy harvesting and conversion efficiency
- Triboelectric nanogenerators (TENGs)
- Piezoelectric nanogenerators (PENG)
- Thermoelectric (TEGs) and Pyroelectric generators (PyENGs)
- Piezotronics, flexoelectronics, tribotronics and Semiconductor Devices
- Energy Storage and Self-Charging Power Systems

FM-4 Cutting-edge applications
- Self-powered sensors and systems
- Self-powered implantable devices
- Wearable electronics, nanorobotics and artificial intelligence
- Blue Energy and Internet of Things (IoT)
- Other applications (Contact-electro-catalysis, photo-electrochemistry, photovoltaics, thermoelectric…)

Symposium FN

Exploring Cutting-Edge Innovations in Luminescent Materials and Technologies for Display, Lighting and Emerging Photonic Applications

The symposium will highlight the latest advancements in luminescent materials and their transformative applications across a broad range of photonic fields. Luminescent materials, which include organic and inorganic phosphors, quantum dots, and perovskites, are playing a pivotal role in improving the efficiency and performance of displays, lighting systems, and a growing array of emerging photonic technologies. These materials offer significant potential to address critical challenges in energy efficiency, sustainability, and performance in consumer electronics, smart devices, and advanced lighting solutions. The symposium will bring together leading experts from academia, industry, and research institutions to share their insights into the design, synthesis, and application of these materials. With an emphasis on cutting-edge innovations, the symposium will explore the latest trends in light-emitting diodes (LEDs), organic light-emitting diodes (OLEDs), quantum dots, laser sources, and next-generation photonic systems. Special attention will be given to emerging applications such as micro-displays, energy-efficient lighting, and new laser technologies that are poised to drive the future of consumer electronics and industrial photonics. By fostering meaningful collaboration and knowledge exchange, the symposium will provide a platform for addressing the pressing challenges in the field of luminescent materials. Participants will have the opportunity to engage in discussions on the latest research, industry developments, and future directions for photonic technologies, while also identifying new avenues for innovation and commercialization. This symposium promises to be an essential gathering for anyone involved in the design, development, and application of luminescent materials and photonic systems.

Topics of interest include (but are not limited to):

- Advances in Inorganic and Organic Light-emitting Diodes
- Quantum Dots: Synthesis, Characterization, and Applications
- Perovskite-based Luminescent Materials for Next-generation Displays
- High-efficiency Phosphors for Displays and Solid-state Lighting
- Micro-displays for AR/VR Applications
- Nano-engineered Photonic Materials for Energy-efficient Lighting
- Emerging Trends in Laser Sources and their Applications
- Light Emission from 2D Materials: Opportunities and Challenges
- Hybrid Organic-inorganic Photonic Materials
- Quantum-enhanced Photonics: From Materials to Devices
- Photonic Materials for Wearable and IoT-enabled Devices
- Sustainability and Environmental Impact of Luminescent Materials in Photonics

Session Topics

FN-1 Material design and processing

FN-2 Processes for optoelectronic and photonic applications

FN-3 Characterization of electro-optical-structural properties

FN-4 Device architectures and system integration

Symposium FO

Advanced Characterization Methods for Energy Materials Design

Advances in energy technologies critically depend on the availability of novel functional materials (dielectrics, semiconductors, ion conductors, catalysts, absorbents, structural materials, nuclear fuels …) whose properties are optimized and tailored to a specific task.

This symposium will analyse how the broad range of advanced microscopy, spectroscopy, spectrometry and other advanced characterization techniques now available, the use of machine learning, of automated experimentation as well as of the time-dependent data obtained from In Situ/Operando methods applied to functional materials and devices under the influence of a controlled excitation/probe (stress, light, heat, electro-magnetic, chemical….), may allow obtaining useful information, down to the atomic scale, of composition, morphology, structure and on the variety of chemical and physical dynamic processes involved inside a material at its surface and interfaces, so to create a path to accelerate their implementation in selected areas of energy technologies. The combination of different advanced techniques, providing a feedback loop between device design and performance optimization, gives rise to new insights in the field, where a multi-physics/multiscale approach is mandatory.

Ultimately, this symposium aims to present the most recent and challenging research on materials in the field of energy, focusing on the importance of using cross-characterization techniques, especially those that are currently at the forefront of research worldwide.

Session Topics

FO-1 Electrochemical energy conversion/storage and fuel cells

FO-2 Gas production/capture/separation/storage/utilization (e.g CO_2, H_2)

FO-3 Solar technologies (photovoltaics, solar thermal, solar fuels)

FO-4 Thermal energy storage

FO-5 Small scale energy harvesting, nanogenerators, self-powered devices

FO-6 Thermoelectric and caloric systems

FO-7 Nuclear technologies (fission, fusion, waste management)

FO-8 High and low-power superconductivity and energy-efficient unconventional information technologies (e.g. novel materials for neuromorphic and quantum computing)

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Symposium FP

Computational-aided Energy Materials Design

Computational materials science has demonstrated its power in modelling structure and functional properties of real materials, and in predicting novel materials with improved performance. It naturally is cross - disciplinary as it is based on physics, chemistry, engineering, data science, and even biology. It addresses properties of materials that span several length and time scales, and as such it often takes advantage of multiscale computing strategies. In the last decades computational materials science has increased tis predictive power and scope for materials development because of progress in methods and in computational power. More recently, it has received a further boost from the emergence of machine learning and data science.

This Symposium is devoted to advances in development and application of computational methods, including multiscale computing strategies and machine learning methods, for predicting materials properties, with applications in energy systems. Appropriate are studies that combine data- and physics-driven models for the identification of structure-property relationships and the predictive design, possibly experimentally validated, of novel energy materials.

The methods may range from high-accuracy electronic structure techniques for atomistic simulations, through mesoscopic simulations, to continuum models, with particular interest in integrated multi-scale modelling. All materials for energy applications are relevant for the symposium, ranging from nanostructured functional inorganic materials through solid/liquid interfaces and bio-inspired materials to structural materials.

Session Topics

FP-1 Solar technologies (photovoltaics, solar fuels, solar thermal)

FP-2 Electrochemical energy systems (batteries, supercapacitors, fuel cells)

FP-3 Catalysts for energy conversion and storage

FP-4 Materials for production, capture, separation, storage, and utilization of gases

FP-5 Thermal energy storage

FP-6 Thermoelectrics, energy harvesting materials and nanogenerators

FP-7 Permanent magnets for electric generators and motors

FP-8 Nuclear materials for fission and fusion: fuels, plants, and waste

FP-9 Data science and artificial intelligence for materials development

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Symposium FQ

Innovations and Green Nanomaterials for Advanced Chemical Sensors and Biosensors

The development of advanced gas and chemical sensors and biosensors has been significantly enhanced in the last years, due to their noteworthy importance for the detection of gas and chemical substances in many advanced applications. This Symposium aims to explore the latest innovations in inorganic, organic, and hetero-structured nanomaterials, for chemical- and bio-sensor applications, with special focus on their optical, electrical, and electrochemical properties. Heterostructure-based gas sensors and bio-sensors are at the forefront of environmental monitoring and medical diagnostics, providing enhanced stability and responsiveness and offering innovative solutions for detecting a wide range of toxic gases and biochemical markers, respectively.
The use of sustainable materials in chemical sensing is also emphasized, showcasing the environmental benefits and life cycle advantages of green nanomaterials. Green and natural dyes have shown great promise in optical sensing due to their unique optical properties and tunability. Green nanocomposites, derived from environmentally friendly materials, are being developed for gas sensing and electrochemical applications, too, offering a sustainable alternative with excellent performance metrics.
While presenting and discussing the fundamental principles, synthesis, and characterization of these advanced materials, along with their practical applications in various sensing technologies, future trends and challenges in the commercialization and large-scale production of these sensors will also be discussed, providing a comprehensive overview of the current state and future potential of nanomaterial-based chemical sensor and biosensors.

Matter covered includes:

Green Nanomaterials
- Basic properties, synthesis and characterization of green nanomaterials.

Optical Sensing
- Mechanisms of optical sensing using ecofriendly and natural dyes.
- Applications of colorimetric and fluorescent sensors in environmental monitoring and healthcare.

Gas Sensing
- Development of gas sensors using novel nanomaterials.
- Performance metrics and real-world applications.

Electrochemical Sensing
- Innovations in electrochemical enzyme-free sensors based on electroactive nanostructures.

Chemical and Bio-sensors Applications
- Design and application biosensors in medical diagnostics, food safety, and environmental monitoring.
- Integration with electronic devices and data analysis techniques.
- Challenges in commercialization and large-scale production.

Sustainability and Environmental Impact
- Role of sustainable materials in chemical and bio-sensor technology.
- Life cycle analysis and environmental benefits of using green materials.

Session Topics

FQ-1 Chemical and Bio-Sensing Fundamentals and Applications

FQ-2 Enzyme-free Electrochemical Sensors Based on Hybrid Nanostructures

FQ-3 Ecofriendly and Natural dyes for Optical Sensing

FQ-4 Heterostructures-based Sensors for Environmental and Biomedical Applications

FQ-5 Innovation in Sustainable Materials for Chemical Sensing

FQ-6 AI - Enhanced Sensing Technologies: Transforming Sensor Capabilities

Symposium FR

Living Materials: From Electronics to Biomedicine

The rising demand of environmentally friendly solutions in technology development affects various fields, including materials science, biomedicine, and bioremediation. Creating biohybrid systems requires green and biocompatible chemical methods applicable to living cell systems like bacteria, yeasts, and microalgae. These organisms have evolved mechanisms to perform complex functions efficiently, including biochemical transformations and interactions with light, supported by diverse molecular and supramolecular structures. In addition to the development of new systems, and in accordance with the principles of green and sustainable chemistry, there is a growing emphasis on the use of materials derived from photosynthetic organisms, such as pigments and plants. This also includes biological polymers, notably silk (alongside cellulose and lignin), melanin-like pigments as well as bio-inorganic materials such as biosilica. The integration of these advanced materials presents new opportunities not only for the synthesis of sustainable materials but also for the development of innovative biocatalysts. These biocatalysts have the potential to significantly enhance traditional synthetic processes by employing environmentally friendly and sustainable methodologies.

The symposium entitled “Living Materials: From Electronics to Biomedicine” will explore various types of biological and bio-inspired materials, such as those derived from photosynthetic organisms, biological polymers, and bio-inorganic materials.

While the focus will be on these materials, including both innovative synthetic strategies and envisaging characterization, discussions will also cover relevant optoelectronic and biomedical applications. This symposium aims to create a collaborative platform that brings together researchers from materials science, biology, and biotechnology to explore new methodologies for advancing this exciting field.

Researchers are invited present research topics emphasizing sustainable and biocompatible chemical methods aiming to produce highly performing living materials and including high-performance biocatalysts.

We welcome innovative studies on living or bio-inspired functional materials derived from microorganisms or enhanced living cells, showcasing unique properties like adhesion, resistance, or metabolic outputs.

Session Topics

FR-1 Classes of materials for electronic devices with biological materials
- sensors and photodetectors
- transistors
- electronic interfaces with living materials

FR-2 Biomaterials and their synthesis, structure, chemical modifications and characterizations
- materials from plants and living organisms
- biosilica and bio-inorganic materials
- biopolymers (silk, cellulose, lignine)

FR-3 Biocatalysts and their applications
- biocatalysts functionalization
- biocatalysts doping
- chemical modification
- heterogeneous catalysis

FM-4 Innovative tools for bioremediation and biomedicine
- Chemical potentiation of remediating microorganisms
- Envisaging materials
- New remediation processes

INTERNATIONAL CONFERENCES

IC-4 - 6th International Conference

Materials and Devices Technologies for Energy-efficient Neuromorphic and Unconventional Computing

In the modern world where sustainability and energy efficiency have become global priorities, future computing systems are expected to embrace these challenges. In the last decades, substantial advancements in device miniaturization and on the overall performance of classical computers have been achieved, also thanks to advancements in materials science and nanotechnology. Today information and communication technology (ICT), which is affecting almost all aspects of our society, consumes a significative percentage of global electric power resources. In this field, energy consumption is expected to increase in the coming years, making many applications, including those based on artificial intelligence, unsustainable. Within this framework, emerging inorganic and organic materials and memristive device technologies are key players in enabling the development of energy-efficient future unconventional computing paradigms, including in-memory computing approaches, neuromoprhic systems inspired by the brain functionality, and bioinspired information processing at the edge of biology.

This conference aims at bringing together an interdisciplinary community to discuss recent advancements in research within the fields of materials science, memory and memristive device technologies, modelling and simulation of materials and device properties, and novel computing applications.

Session Topics

IC-4.A Advances in memory and memristive technologies for computing: materials synthesis, device fabrication, advanced characterization and modelling

- Memory devices for low-energy computing: RRAM, PCRAM, MRAM, FeRAM, FTJ, Electrochemical Random-Access Memory (ECRAM), …
- Emerging memristive devices concepts based on dielectric-, ferroelectric-, magnetic-, multiferroic-, organic-, molecular-, perovskite-, chalcogenide-, topological insulators, 2D- materials, …
- Recent developments in characterization methods for materials and devices at the nanoscale
- Advances in theory, modelling and simulation of memristive materials and devices

IC-4.B Devices for neuromorphic and unconventional computing: from devices to applications

- 2- and 3-terminal devices implementing low-power artificial synapses and neurons
- Self-assembled networks, nanomaterials and unconventional substrates for energy-efficient computing
- Photonic devices for computing
- Devices for emerging applications: in-memory computing, in-sensor computing, analogue computing, reservoir computing, spiking neural networks, deep neural networks, oscillatory neural networks….
- Flexible and printable devices for low-energy and sustainable computing
- Novel algorithms for computing, and advances in theory of novel computing paradigms

IC-4.C Bioinspired information processing at the edge of biology

- Materials and devices for bio-inspired information processing and biosensing
- Devices at the interface between biological and artificial neuronal systems
- Organic neuromorphic systems
- Bioelectronics, neuromorphic and memristive sensors
- Advances in hardware and algorithms co-design for neuro-inspired computing

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IC-5 - 5th International Conference

Materials Challenges for Sustainable Nuclear Fission and Fusion Technologies

Nuclear power, whether sourced from fusion or fission, is undergoing a resurgence in both academic and industrial interest driven primarily by the understood and pressing need to address combined global energy and environmental needs. As nuclear is now perceived as the most rational low-carbon baseload power option significant research into advanced systems, and investment in current available systems, is underway through both the private and government investment. To support this resurgence in activity the critical area of nuclear materials: structural materials, fuels, irradiation damage, etc. has also received increased attention.

This International Conference, which follows the ones on the same subject held in the frames of CIMTEC 2010, 2014, 2018 and 2022, will cover: i- processing, properties, modelling and simulation of nuclear fuels and of structural and functional materials for fission and fusion reactors; ii- radiation damage processes and characterization of irradiated materials; and iii- behaviour of materials during severe accident. Materials related aspects in component design, crosscutting materials issues and medium and long-term targets for nuclear fission and fusion systems will be relevant to the debate as well as the crucial problem of radioactive nuclear waste management that will be object of a parallel Focused Session.

Session Topics

IC-5.A Structural materials for nuclear fission and fusion applications

- Fusion Structural Alloys
- Fission Structural Alloys
- Fibrous and Particulate High Temperature Composites
- UHTC Ceramics and Composites

IC-5.B Materials for first wall components of nuclear fusion systems

- High Heat Flux Materials and Structures
- Plasma Interactive Materials
- Blanket Materials and Tritium Studies

IC-5.C Functional materials

- Insulators
- Superconducting magnets
- Coatings

IC-5.D Nuclear fuel materials

- Processing, microstructure, and properties relationship
- Oxide-based nuclear fuels
- Non-oxide-based nuclear fuels
- Metal-based nuclear fuels
- Thermomechanical modelling
- Recycle of nuclear fuels
- Advanced fuel cladding materials and coatings
- Materials behaviour in accidental condition

IC-5.E Modeling fundamental radiation effects

- Defect production fundamentals
- Microstructure evolution
- Mechanical property changes
- Helium, Hydrogen and Transmutation Science (Fusion Materials and Fuels)

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IC-5.F Materials modelling and database

- Modelling of performance
- System design and modelling including high-temperature design methodology
- Materials and mechanical properties database
- Small-specimen test technology

IC-5.G Crosscutting materials issues, present status, challenges and directions for nuclear fission and fusion science and technology

Focused Session IC-5.H

Materials Issues in Radioactive Nuclear Waste Treatment and Disposal

This session will focus on the treatment and disposal of low and high level nuclear wastes from commercial power generation, fuel reprocessing, and defence operations. Technologies for interim, short-term, and long-term storage and disposal are of interest, including mature processes as well as new and innovative technologies. The goal of the session will be to identify and provide solutions to materials issues in the global integration of waste treatment technologies.

Topics will include:

- Waste form development, including glass, ceramic, cement and metallic waste forms
- Challenging waste constituents, such as actinides, noble metals, and volatile species
- Waste form modeling, performance testing, and advanced characterization techniques
- Materials issues in the design and operation of waste immobilization facilities

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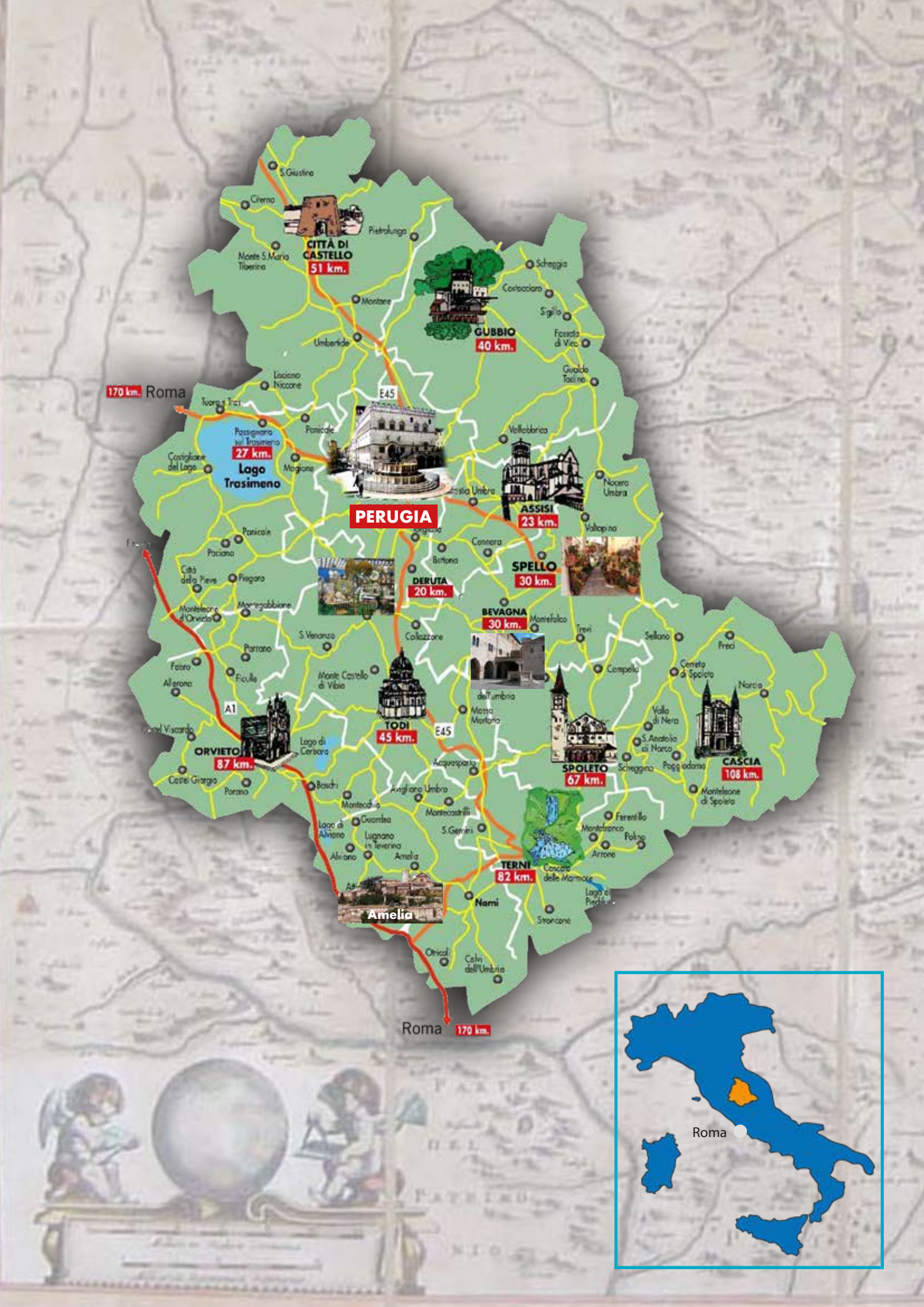
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