



## CALL FOR ABSTRACTS

The International Conference on Metallurgical Coatings and Thin Films (ICMCTF) is recognized as the premier international conference on thin film deposition, characterization, and advanced surface engineering. It provides a forum and networking venue for scientists, engineers, and technologists from academia, government laboratories, and industry. Attendees from all over the world come to present their findings, exchange ideas, share insights, make new friends, and renew old acquaintances. ICMCTF typically draws more than 800 attendees, covering over 50 oral technical sessions and a well-attended Thursday evening poster session.

ICMCTF 2023 will have eight technical symposia A through H and three topical symposia that pertain to the development of new coating materials and processes, novel methods of analysis and characterization, and approaches to scale-up for commercial applications. The conference will open with a plenary talk on Monday morning by Professor Li-Chyong Chen from the National Taiwan University (NTU), Taiwan, entitled, "Recent Trends In Artificial Photosynthesis: Atomistic/Surface Design and Probing of Nano-Photocatalysts." Another special highlight of the meeting is our Exhibitors Keynote Lecture, entitled, "Materials Challenges and Opportunities in the Aeroengine," presented by Dr. David Furrer, Senior Fellow, Discipline Lead, Materials & Processes Engineering, Pratt and Whitney, USA. Three Special Interest Lectures given by top specialists will be featured throughout the conference week. Professor Jia-Hong Huang from National Tsing Hua University, Taiwan, will speak on "Residual Stress Measurement on Hard Coatings and the Evaluation of Energy Relief Efficiency of Architected Coatings." Dr. Joerg Patscheider from Evatec AG, Switzerland, will speak on, "Nitride and Oxide Functional Thin Films – The Key to our Digital World," and Dr. Shimpei Yamaguchi from TEL, will speak on "Advanced Patterning Technologies for Future Device Scaling."

In addition to the technical program, the conference features a two-day industrial exhibition, showcasing the latest in equipment, materials and services used for the deposition, monitoring, and characterization of coatings and thin films. The exhibition, which will be held Tuesday and Wednesday, May 25-26, will be open to the public, as well as a Career Center where organizations may post jobs, and candidates may interview for positions throughout the week. An educational program of Short Courses and Focused Topical Sessions (FTS) will be offered throughout the week.

Each year, the R.F. Bunshah and Bill Sproul Award Laureates and three outstanding Graduate Student Award winners are celebrated during a special convocation late Wednesday afternoon, May 25, followed by a festive reception in the evening. In addition, we will be recognizing our 2021 awardees.

ICMCTF will again publish excellent scientific and technical work in peer-reviewed issues of the two Elsevier journals *Surface and Coatings Technology* ( $IF = 4.865$ ) and *Thin Solid Films* ( $IF = 2.358$ ), so we strongly encourage all authors to submit manuscripts for consideration by May 5, 2023.

The Town and Country Resort Hotel and Convention Center, located in sunny San Diego of Southern California, will be the official conference venue, providing a relaxing atmosphere for discussion and networking among attendees.

We welcome your participation and look forward to receiving your abstract submission by November 15, 2022!

Jyh-Wei (Jeff) Lee  
2023 Program Chair

Samir Aouadi  
2023 General Chair

## PROGRAM COMMITTEE

### PROGRAM CHAIR

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### SYMPOSIUM A: COATINGS FOR USE AT HIGH TEMPERATURES

Symposium Chairs:  
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Francisco Javier Pérez-Trujillo,  
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### A1. Coatings to Resist High- temperature Oxidation, Corrosion, and Fouling

Session Chairs:  
Gustavo García-Martín, REP-Energy  
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Justyna Kulczyk-Malecka, Manchester  
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### A2. Thermal and Environmental Barrier Coatings

Session Chairs:  
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Kang N. Lee, NASA Glenn Research  
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Pantcho Stoyanov, Concordia University,  
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### SYMPOSIUM B: HARD COATINGS AND VAPOR DEPOSITION TECHNOLOGIES

Symposium Chairs:  
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### B1. PVD Coatings and Technologies

Session Chairs:  
Vladimir Pankov, National Research  
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### B2. CVD Coatings and Technologies

Session Chairs:  
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Hiroki Kondo, Nagoya University, Japan,  
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### B3. Deposition Technologies and Applications for Carbon-based Coatings

Session Chairs:

Konrad Fadenberger, Robert Bosch  
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Ivan Kolev, IHI Hauzer Techno,  
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**B4. Properties and Characterization of  
Hard Coatings and Surfaces**

Session Chairs:  
Naureen Ghafoor, Linköping Univ., IFM,  
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Fan-Yi Ouyang, National Tsing Hua  
University, Taiwan,  
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### B5. Hard and Multifunctional Nanostructured Coatings

Session Chairs:  
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Tomas Kozak, University of West  
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### B6: Coating Design and Architectures

Session Chairs:  
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Davide Sangiovanni, Linköping  
University, Sweden,  
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Wan-Yu Wu, Da-Yeh University, Taiwan ,  
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### B7: Plasma Surface Interactions, Diagnostics and Growth Processes

Session Chairs:  
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Yin-Yu Chang, National Formosa  
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### B8: HiPIMS, Pulsed Plasmas and Energetic Deposition

Session Chairs:  
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Martin Rudolph, Leibniz Institute of  
Surface Engineering (IOM), Germany,  
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### SYMPOSIUM C: FUNCTIONAL THIN FILMS AND SURFACES

Symposium Chair:  
Peter Kelly, Manchester Metropolitan  
University, UK,  
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### **C1. Optical Materials and Thin Films**

Session Chairs:

Juan Antonio Zapien, City University of Hong Kong, apjajs@cityu.edu.hk

### **C2. Thin Films for Electronic Devices**

Session Chairs:

Julien Keraudy, Oerlikon Balzers, Oerlikon Surface Solution AG, Liechtenstein, julien.keraudy@oerlikon.com

Jörg Patscheider, Evatec AG, Switzerland, joerg.patscheider@evatecnet.com

### **C3. Thin Films and Novel Surfaces for Energy**

Session Chairs:

Clio Azina, RWTH Aachen, Germany, azina@mch.rwth-aachen.de

Carlos Jose Tavares, University of Minho, Portugal, ctavares@fisica.uminho.pt

### **SYMPOSIUM D: COATINGS FOR BIOMEDICAL AND HEALTHCARE APPLICATIONS**

Symposium Chairs:

Jessica Amber Jennings, University of Memphis, USA, jjinnings@memphis.edu

Kerstin Thorwarth, Empa, Swiss Federal Laboratories for Materials Science and Technology, Switzerland, kerstin.thorwarth@empa.ch

### **D1: Surface Coating and Modification for Use in Biological Environments**

Session Chairs:

Mathew T. Mathew, University of Illinois College of Medicine at Rockford and Rush University Medical Center, USA, mtmathew@uic.edu

Phaedra Silva-Bermudez, Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra, Mexico, phaedralilva@yahoo.com

### **D2: Medical Devices: Bio-Tribo-Corrosion, Diagnostics, 3D Printing**

Session Chairs:

Hamdy Ibrahim, University of Tennessee at Chattanooga, USA, Hamdy-Ibrahim@utc.edu

Margaret Stack, University of Strathclyde, UK, margaret.stack@strath.ac.uk

### **D3: Biointerfaces: Coatings to Promote Cell Adhesion while Inhibiting Microbial Growth**

Session Chairs:

Valentim Barão, University of Campinas (UNICAMP), Brazil, vbarao@unicamp.br

Sandra E. Rodil, Universidad Nacional Autónoma de México, srodil@unam.mx

Danieli B.C. Rodrigues, University of Texas at Dallas, USA, danieli@utdallas.edu

### **SYMPOSIUM E: TRIBOLOGY AND MECHANICAL BEHAVIOR OF COATINGS AND ENGINEERED SURFACES**

Symposium Chairs:

Carsten Gachot, Vienna University of Technology, Austria, carsten.gachot@tuwien.ac.at

Giovanni Ramirez, Zeiss Industrial Metrology, USA, Giovanni.Ramirez@outlook.com

### **E1: Friction, Wear, Lubrication Effects, and Modeling**

Session Chairs:

Michael Chandross, Sandia National Laboratories, USA, mechand@sandia.gov

Noora Manninen, Oerlikon Balzers, Oerlikon Surface Solutions AG, Liechtenstein, Noora.Manninen@oerlikon.com

Manel Rodriguez Ripoll, AC2T Research GmbH, Austria, ripoll@ac2t.at  
Andreas Rosenkranz, Universidad de Chile, arosenkranz@ing.uchile.cl

### **E2: Mechanical Properties and Adhesion**

Session Chairs:

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Bo-Shiuan Li, National Sun-Yat Sen University, Taiwan, bsli@mail.nsysu.edu.tw

### **E3: Tribology of Coatings and Surfaces for Industrial Applications**

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Philipp Grützmacher, Institute of Engineering Design and Product Development, Austria, philipp.gruetzmacher@tuwien.ac.at

### **SYMPOSIUM F: NEW HORIZONS IN COATINGS AND THIN FILMS**

Symposium Chairs:

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Konrad Fadenberger, Robert Bosch GmbH, Germany, konrad.fadenberger@de.bosch.com

### **F1: Nanomaterial-based Coatings and Structures**

Session Chairs:

Ondrej Kylian, Charles University, Czechia, ondrej.kylian@gmail.com  
Vladimir Popok, Aalborg University, Denmark, vp@mp.aau.dk

### **F2: High Entropy and Other Multi-principal-element Materials**

Session Chairs:

Erik Lewin, Uppsala University, Sweden, erik.lewin@kemi.uu.se  
Jean-Francois Pierson, Institut Jean Lamour - Université de Lorraine, France, jean-francois.pierson@univ-lorraine.fr

### **F3: 2D Materials: Synthesis, Characterization, and Applications**

Session Chairs:

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Chin-Yen Chen, National Sun Yat-sen University, Taiwan, cychen@mail.nsysu.edu.tw

### **F4: Boron-containing Coatings**

Session Chairs:

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Johanna Rosén, Linköping University, Sweden, johanna.rosen@liu.se

### **F5: Machine Learning and Process Modeling for Coating Design and Production**

Session Chairs:

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Petr Zikán, PlasmaSolve s.r.o., Czechia, zikan@plasmasolve.com

**SYMPOSIUM G: SURFACE  
ENGINEERING - APPLIED RESEARCH  
AND INDUSTRIAL APPLICATIONS**

Symposium Chairs:

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**G1: Advances in Application Driven  
Research: New Methods, Materials,  
and Equipment for PVD, CVD, and  
PECVD Processes**

Session Chairs:

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**G2: Surface Modification of  
Components in Automotive, Aerospace  
and Manufacturing Applications**

Session Chairs:

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**G3: Innovative Surface Engineering  
for Advanced Cutting and Forming  
Tool Applications**

Session Chairs:

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**G4: Hybrid Systems, Processes and  
Coatings**

Session Chairs:

Hana Baránková, Uppsala University,  
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SangYul Lee, Korea Aerospace  
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**SYMPOSIUM H: ADVANCED  
CHARACTERIZATION TECHNIQUES  
FOR COATINGS, THIN FILMS, AND  
SMALL VOLUMES**

Symposium Chairs:

Xavier Maeder, Empa, Swiss Federal  
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Technology, Switzerland,  
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Marco Sebastiani, University of Rome  
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**H1: Spatially-resolved and In-Situ  
Characterization of Thin Films and  
Engineered Surfaces**

Session Chair:

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Michael Tkadletz, Montanuniversität  
Leoben, Austria,  
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**H2: Advanced Mechanical Testing of  
Surfaces, Thin Films, Coatings and  
Small Volumes**

Session Chairs:

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Olivier Pierron, Georgia Institute of  
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**H3: Characterization of Coatings and  
Small Volumes in Extreme and Cyclic  
Conditions**

Session Chairs:

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**TOPICAL SYMPOSIA**

**TS1: Coatings for Energy Storage and  
Conversion – Batteries and Hydrogen  
Applications**

Symposium Chairs:

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**TS2: Sustainable Surface Solutions,  
Materials, Processes and Applications**

Symposium Chairs:

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Fan-Bean Wu, National United

University, Taiwan, fbwu@nuu.edu.tw

**TS3: Processes of Materials for Printed  
and Flexible Film Technologies**

Symposium Chairs:

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Panos Patsalas, Aristotle University of

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## Coatings for Use at High Temperatures (A)

Symposium A addresses coatings and surface modifications whose primary purpose is to sustain system performance under high-temperature and harsh thermochemical environments. Topics of interest include high-temperature aging, stress, corrosion (e.g., oxidation, sulfidation, carburization, and water-accelerated degradation), catalytic and physical fouling (e.g., coking, ash fouling, and slagging) and wear (e.g., abrasion, erosion, and impact), characterization and mechanistic understanding of high-temperature degradation and mitigation technologies. Typical applications span gas/steam turbines, chemical/petrochemical processes as well as emerging renewable energy technologies, such as geothermal, biomass and concentrated solar power, including the corresponding thermal storage materials.

### **A1. Coatings to Resist High-temperature Oxidation, Corrosion, and Fouling**

This session spans all aspects of design, processing, and performance of coatings to resist high-temperature oxidation, corrosion, and fouling. Topics include composition and process optimization, characterization of coatings and reaction products, development of advanced processing methods such as additive manufacturing, modeling of fabrication processes and degradation mechanisms, lifetime prediction and performance assessment in realistic conditions (atmosphere, stress, cycling, erosion, etc.). Environments of interest include, steam, SCO<sub>2</sub>, molten salts, liquid metal, hydrogen, ammonia, biofuels, etc. for applications such as turbomachinery, fuel cell and electrolyzers for green hydrogen production, concentrating solar power plants, advanced nuclear reactors, petrochemical and gasification plants, waste incinerators and metal-forming and recycling industries. Contributions addressing research as well as solutions are encouraged, with focus on coatings and surface modification.

#### **A1 Invited Speakers:**

*Martin Dienwiebel*, Fraunhofer IWM / Karlsruhe Institute of Technology, Germany

*Paul Mayrhofer*, TU Wien, Austria

### **A2. Thermal and Environmental Barrier Coatings**

This session focuses on the design, development, synthesis, and applications of thermal and environmental barrier coatings for gas and high volume H<sub>2</sub> turbines and other high and ultra- high temperature applications. Topics include process understanding and novel processing methods, characterization of coating microstructure, properties (thermal, optical, mechanical, and chemical), testing methods (destructive and nondestructive), structure-property relationships, residual stresses, aging phenomena, substrate/coating system effects, and failure mechanisms, including CMAS attack, erosion, abrasion, and impact. These topics can be addressed for experimental research and/or modeling development.

#### **A2 Invited Speakers:**

*Mohan Prabhakar*, Solar Turbines, USA

*Eli Ross*, Pratt & Whitney, USA

*Kitaoa Satoshi*, JFCC, USA

## **AP: Coatings for Use at High Temperatures (Symposium A) Poster Session**

## Hard Coatings and Vapor Deposition Technologies (B)

Symposium B focuses on surface engineering and materials science of hard and protective coatings. We are interested in the fundamentals of deposition processes, properties of new single, multilayer, nanocomposite and nanostructured hard coatings, process-structure-property relationships, substrate effects, modeling, and industrial practices.

### **B1. PVD Coatings and Technologies**

This session solicits contributions (except those covered by the topical sessions) related to sputter-deposition, cathodic and anodic arc discharges, laser ablation, electron beam (with and without additional ionization) and combinations of PVD coating methods. We welcome contributions on in-situ measurements, process modeling, plasma transport in electromagnetic fields, and multi-phase, gradient and nanostructured coatings, as well as hard and superhard coatings. Applications include but are not limited to wear-protective coatings for components and tools, low-friction thin films, high-temperature wear-, erosion-, and corrosion-resistant coatings, optical layers, biomaterials, decorative coatings, and materials for energy applications.

#### **B1 Invited Speakers:**

*Aharon Insektor*, Carnegie Mellon University, USA, "New Challenges and Opportunities for PVD Coatings in Metal Cutting Applications"

### **B2. CVD Coatings and Technologies**

This Session solicits experts in thin films deposition techniques, involving chemical vapor deposition, for the growth of protective coatings and multifunctional, smart, or hard materials. This session will address (1) various techniques including Atmospheric Pressure CVD, LPCVD, MOCVD, ALD, HVPE, Pulsed CVD, and their plasma assisted

counterparts, PECVD and PEALD; (2) novel molecular CVD precursors or original delivery systems for low vapor pressure/difficult precursors (DLI, pressure pulse, direct halogenation); (3) properties of materials and structures grown by these deposition techniques; and (4) CVD modeling techniques from molecular to equipment scale.

### **B2 Invited Speakers**

*Georges Chollon*, Laboratoire des Composites Thermostructurés, CNRS, France, "Si and SiC-based CVD Coatings for High Temperature Structural Applications"

### **B3. Deposition Technologies and Applications for Carbon-based Coatings**

This session solicits contributions that address the application of carbon-based coatings industry. We want to span the whole range from applications for DLC or ta-C on engineering components as well as coatings employed in devices and displays or electrochemical applications like fuel cells and electrolytic applications. Deposition technologies include plasma-based methods CVD, PVD, and their combination, arc, ion-beam, and laser-assisted deposition and HIPIMS as well as dip coating, sol-gel, and other transfer techniques. This session includes fundamentals and development of interfaces between substrate and DLC to improve adhesion, supporting layers, and hybrids with hard coatings, industrial practices, scalability, and cost estimates.

#### **B3 Invited Speakers:**

*Kwang-Ryeol Lee*, Korea Institute of Science and Technology, Republic of Korea, "Molecular Dynamics Study on the Interfacial Phenomena of Diamond-like Carbon Thin Film"

### **B4. Properties and Characterization of Hard Coatings and Surfaces**

This session solicits contributions (except those covered by the topical sessions) on the relationships among composition, microstructure, and properties of hard coatings and surfaces, the effect of deposition parameters on these properties, as well as the development and use of novel characterization techniques.

#### **B4 Invited Speakers:**

*Kao-Shuo Chang*, National Cheng Kung University, Taiwan, "Combinatorial Exploration of High-entropy High-dielectric-constant BaTiO<sub>3</sub>-based Films and Their Advanced Application in Metal-oxide-semiconductor-based Devices"

*Thomas Gradt*, Federal Institute for Materials Research and Testing (BAM), Germany, "Amorphous Carbon Coatings for Tribological Applications in Hydrogen and Natural Gas Environments"

### **B5. Hard and Multifunctional Nanostructured Coatings**

This session solicits contributions related to nanostructured and nanocomposite coatings as well as multi-component and layered films with morphological designs adapting the microstructure down to the nanoscale level. The desired functionalities range from structural properties such as high hardness, toughness, or thermal stability to chemical inertness up to adaptive mechanisms like controlled friction as well as sensing properties. The session not only emphasizes the design and synthesis of novel coating concepts but also their characterization, modeling, and applications. In addition, combined functionalities such as in-situ sensing of structural coatings – just to mention one possibility – are highly appreciated to explore the next level of multifunctional and smart coatings.

#### **B5 Invited Speakers:**

*Asunción Fernández*, Instituto de Ciencia de Materiales de Sevilla CSIC - Univ. Sevilla, Spain, "Nanoporous/Nanocomposite Thin Films by Magnetron Sputtering Deposition in Helium: New Materials and Applications"

*Yuxiang Xu*, Guangdong University of Technology, China, "High-Temperature Properties of Multicomponent Nitride Coatings Deposited by PVD"

### **B6. Computationally-aided Materials Design**

With increasing complexity in materials and their ever growing range of applications, there is a great need to understand the material characteristics at the atomic and electronic levels. To this end, quantum mechanical and classical methods are incredibly powerful tools capable of guiding the entire design process. Tremendous improvements in computational resources, coupled with the method developments and related software implementations development in recent years, make it possible to calculate real materials properties and thus provide a roadmap for experimental materials synthesis. This session focuses on computationally-guided experimental studies and purely computational investigations. It welcomes contributions from atomistic investigations employed in materials design, including first-principles approaches, molecular dynamics, and Monte Carlo simulations. Papers are solicited on both experimental and modeling studies for, e.g.: (i) synthesis/characterization/measurements supported by predictions of material properties; (ii) atomic/electronic-scale understanding of experimental observations; (iii) identification of correlations and/or causation between atomic scale-and-macroscale properties or phenomena. Machine learning and big data approaches are also welcome in combination or substitution of more traditional atomistic methods.

## **B6 Invited Speakers:**

*Philippe Djemia*, Université Paris, France, "Computational Supports to Identify Structural and Elastic Relationship of Crystalline and Amorphous Thin Films Alloys"

*Susan B. Sinnott*, The Pennsylvania State University, USA, "Investigation of Structure-Property Relationships in High-Entropy Oxides"

*Yen-Hsun Su*, National Cheng Kung University, Taiwan, "Selection of Photosensitive Materials on Metal Oxide Surface by Using Machine Learning"

## **B7. Plasma Surface Interactions, Diagnostics and Growth Processes**

Plasma processes are at the heart of inventive deposition strategies for innovative coating materials and nanostructures with enhanced properties and/or multiple functionalities. Diagnostics based on plasma composition and in surface characterization are essential to understand the physical proprieties of the coatings and mechanisms of the plasma growth processes and plasma-surface interaction. The objective of this session is to show how such correlations could establish processing-structure-property relationships and improve the design of materials. Talks featuring new plasma diagnostic techniques, characterization of plasmas in novel processes, correlation of intrinsic plasma properties to the structure and composition of materials and deployment of artificial intelligence/machine learning/big data methods to reveal the mechanisms of plasma generation, film growth and process quality assurance are welcome.

### **B7 Invited Speaker:**

*Holger Kersten*, Christian-Albrechts-University Kiel, Germany

## **B8. HiPIMS, Pulsed Plasmas and Energetic Deposition**

The energy carried to the thin film during deposition is crucial in reducing the growth temperature and improving the properties of thin film materials. Higher plasma density leads to enhanced ionization of the film precursors and offers better deposition process control. This results in improved coating characteristics, valuable e.g. optical, wear resistant, or photovoltaic applications. This session solicits contributions from academia as well as the industry which cover both the basic physics and the applications of energetic deposition. Topics of interest include but are not limited to: plasma generation and discharge physics, simulation and modelling, reactive processes and process control, mechanisms of film growth, surface and interface engineering, industrial applications and production, upscaling and associated equipment.

### **B8 Invited Speakers:**

*Julian Held*, University of Minnesota, USA, "Spokes in HiPIMS: Help or Hindrance"

*Tetsuhide Shimizu*, Tokyo Metropolitan University, Japan, "Impact of Selective Acceleration of High-mass ions - Low Temperature Growth of Stress-free Single Phase  $\alpha$ -W Films"

## **BP: Hard Coatings and Vapor Deposition Technologies (Symposium B) Poster Session**

### **Functional Thin Films and Surfaces (C)**

This Symposium focusses on surfaces, coatings and free-standing architectures with specific surface functionalities. The content encompasses materials growth and structure; fundamentals of operation; design of novel materials; production, processing and integration into products and devices; and characterization of advanced functionality and sustainable development for a range of applications divided into the following sessions.

### **C1. Optical Materials and Thin Films**

Current applications of optical materials, thin films, and advanced structured materials, impose extreme demands on their synthesis and performance. The optimization of these devices, from design to applications, can be facilitated by optical characterization methods such as spectrophotometry, ellipsometry, scatterometry, interferometry, vibrational spectroscopies, near-field microscopies and other light-matter interactions. We welcome contributions in the design, synthesis, characterization, and applications of thin films and nanostructures for optical applications.

#### **C1 Invited Speaker:**

*L Jay Guo*, University of Michigan, USA

*Des Gibson*, University of West Scotland, UK

### **C2. Thin Films for Electronic Devices**

This session is dedicated to functional thin films targeted for applications in active or passive thin film-based devices utilizing electronic, optical, magnetic, piezoelectric, and similar properties, and also addresses functional improvements using thin film coatings for electronic or semiconductor fabrication components. Material characteristics like electrical and thermal conductivity, optical and magnetic properties as well as thermal stability, oxidation, corrosion and wear resistance are considered. Application-related contributions are solicited addressing both experimental and theoretical studies on the design of film properties and processes to control growth, microstructure, phase changes, diffusion processes and oxidation protection, and corrosion and wear resistance aimed at a specific device or component performance.

## **C2 Invited Speakers:**

*S Z Chang*, Powerchip Semiconductor, Taiwan , "3D Device Integration Technology for AI Computing"

*Christophe Vallée*, SUNY Poly, Albany, USA

## **C3. Thin Films and Novel Surfaces for Energy**

This session focuses on the materials science, physics, chemistry, and device engineering of thin films, nanostructures and, in general, surfaces, for energy applications. These include batteries, fuel cells, thermoelectrics, photovoltaics, photo- and electrochemically active surfaces, supercapacitors as well as thermal energy and hydrogen storage solutions. The session will cover both theoretical and experimental work on the design, processing, characterization, and performance of novel material systems, which may include alloys, inorganic and organic semiconductors, oxides, nitrides, and novel compounds of earth-abundant elements. We welcome contributions on recent developments in physical and chemical phenomena, processing of new materials, and novel device concepts in renewable energy technologies.

### **C3 Invited Speaker:**

*Mitsuru Ito*, National Institute of Advanced Industrial Science and Technology/Tokyo institute of Technology, Japan

## **CP: Functional Thin Films and Surfaces (Symposium C) Poster Session**

### **Coatings for Biomedical and Healthcare Applications (D)**

This Symposium focuses on the synthesis, characterization, and performance (both in vitro and in vivo) of coatings and modified surfaces designed for biomedical applications (biomaterials, bioimplants, biosensors, general health care, etc.). The symposium will be devoted to creating a platform, a friendly hub, to promote research discussions between material scientists, coating experts, and clinicians. Papers are solicited in areas related to bioactive and biocompatible coatings for implants (orthopedic, dental, spinal, etc.), cardio-vascular stents, drug delivery, biosensing. Examples of research topics sought are hydroxyapatite coatings, biomimetic and bio-inspired coatings, antimicrobial, anti-biofouling, drug-eluting coatings, blood-compatible coatings, electrospun coatings, biofunctionalization of materials surfaces such as tissue engineering scaffolds by wet chemical and plasma methods, cell-surface interactions, bio-lubrication and bio-tribology, and processing and characterization of biomaterial surfaces. Studies of the interactions between coatings and the biological environment, including tribocorrosion and other degradation mechanisms are also welcome. Moreover, research on the effect of biomaterial coatings on biological behavior, such as cell growth, adhesion, and gene expression are sought. Contributions in the fields of retrieval implant analysis, the release of metal ions/particles, smart/intelligent surfaces and potential clinical concerns will be also considered. A new key interest is applications of coatings in additive manufacturing, as many novel 3D-printed implants benefit from surface coatings to promote osseointegration and more generally biocompatibility.

### **D1. Surface Coatings and Surface Modifications in Biological Environments**

This session is dedicated to coatings as well as surface modifications for use in biomedical applications in order to improve performance characteristics or to add functionality to an implant or surgical instrument. The functions of these coatings/surface modifications may focus on the improvement of one or more attributes such as biocompatibility, cell proliferation and viability, suppression of restenosis, preventing thrombus formation, antimicrobial properties, controlling metallic ion release, resisting corrosion and wear, etc. under in vitro and in vivo conditions.

#### **D1 Invited Speakers:**

*Jayaraman Balamurugan*, Korea Advanced Institute of Science & Technology (KAIST), Republic of Korea, "Current status and New directions of Using Electrochemistry for Health care Innovation"

*Nandini Duraiswamy*, U.S. Food and Drug Administration , USA, "Updates on the Coatings on the Guidewires in Cardio-Interventional Procedures"

*Peter Apata Olubambi*, University of Johannesburg, South Africa, "Nano-Mechanical Titanium Coating"

### **D2. Medical Devices: Bio-Tribo-Corrosion, Diagnostics, 3D Printing**

Metallurgical materials are essential components of medical devices used to restore biological function, detect or respond to physiological or external stimuli, or modulate the response of cells at interfaces. This session seeks to explore clinical applications and physiological responses to material systems used for tissue regeneration, implantable sensors, and smart drug delivery, among others. Fabrication and testing of these materials using additive manufacturing technologies are of particular interest. Research is solicited that evaluates biological reactions to implant surface coatings as well as methods of depositing coating particles of varying size and composition. Release of molecules or particles from surfaces, either intentionally or due to wear and corrosion processes is also an area of interest.



## D2 Invited Speaker: TBD

### D3. Biointerfaces: Coatings to Promote Cell Adhesion while Inhibiting Microbial Growth

Interaction between cells and biomaterials occurs via the surface characteristics of the material, which include their topography, chemistry, mechanical properties or surface energy. These interactions trigger desired or undesired processes. For example, they can induce signaling pathways to regulate cell adhesion, migration, proliferation and differentiation into specific phenotypes desirable for the application. However, they might also promote excessive adhesion of microorganisms forming biofilms that can lead to significant health risks. Such interactions are greatly determined by the initial protein adsorption that occurs in a shorter time scale. Understanding all these interaction processes and their correlation with the surface properties is key knowledge that will allow us to design novel surfaces or coatings to promote specific biological responses, i.e. design bioactive surfaces.

#### D3 Invited Speaker:

*Holger Hoche*, Technische Universität Darmstadt, Germany, "PVD Coatings to Control Corrosion Resistance of Mg Alloys"

## DP: Coatings for Biomedical and Healthcare Applications (Symposium D) Poster Session

### Tribology and Mechanical Behavior of Coatings and Engineered Surfaces (E)

This symposium covers all aspects of tribology, mechanical properties, and adhesion of coatings and engineered surfaces. The scope includes both experimental investigations and modeling of static (e.g., indentation and adhesion) and dynamic (e.g., oscillating, scratching, sliding, and rolling) contacts, and contact/fracture mechanics from atomistic to macroscopic length scales. We welcome contributions that improve scientific and mechanistic understanding of tribo-mechanical responses, characterization and performance of engineered surfaces and coatings, processing-structure-property-performance relationships, design of coatings for specific applications, and size effects. Additional emphasis is given to multifunctional (hard and lubricious) and nanocomposite coatings for extreme environments, nanostructured coatings, diamond and diamond-like carbon, and coatings for advanced aerospace, automotive, and machining applications, along with advances in instrumentation and measurement techniques.

#### E1. Friction, Wear, Lubrication Effects, & Modeling

This session covers all phenomena related to friction, wear, lubrication, and modeling. We solicit contributions on the development, characterization and modeling of materials, coatings or innovative structures to control friction and wear, including liquid and solid lubrication. We are interested in studies providing new understanding of tribological mechanisms of coatings and thin films. Emphasis will be given to contributions on understanding the role of coating composition and structure in friction and wear reduction. Incorporation of additional coating functionalities (thermal cycling resistance, fracture toughness, oxidation resistance, etc.) is also an important issue. Contributions on theoretical and computational modeling of tribological interactions at the atomic or molecular level are also welcome.

#### E1 Invited Speakers:

*Albano Cavaleiro*, University of Coimbra, Portugal

*Sophie Loehlé*, TotalEnergies, France, "Aromatic Compounds as Sustainable Lubricants for Iron"

*Vadym Mochalin*, University of Missouri S&T, USA, "Chemistry of MXenes: Fundamentals and Applications"

#### E2. Mechanical Properties and Adhesion

This session is devoted to the measurement and modeling of mechanical properties of surface and near-surface regions of thin films, coatings, and surface-engineered bulk materials. We are interested in measurement methods and models for the quantitative determination of mechanical properties, residual stresses, interface adhesion, fatigue, and fracture toughness. Emphasis will be given to contributions on novel test methods, such as in situ testing in SEM or TEM, multi-axial contact mechanics, MEMS test beds, and new approaches for the extraction of mechanical and constitutive properties by modeling of indentation load-displacement curves. Finally, special consideration will be given to contributions that address processing-structure- mechanical property relationships across multiple length scales.

#### E2 Invited Speakers:

*Chelsea Appleget*, The Aerospace Corporation, USA

*Jia-Yang Juang*, National Taiwan University, Taiwan, "Material Properties and Mechanics of Eggshells—Nature's Survival Capsules"

*Anna Kareer*, University of Oxford, UK

#### E3. Tribology of Coatings and Surfaces for Industrial Applications

Surface engineering and advanced coatings contribute to improved tribological properties and performance in many industrial applications. This session welcomes contributions on the development, characterization, and mechanical

as well as tribological evaluation of coating solutions and surface functionalization in industrial applications, e.g. transportation, production technology. Thin film coatings, diffusion treatments as well other types of coatings and surface treatments are welcome. Special consideration will be given to contributions that address overarching investigations to link fundamental insights with application results.

### **E3 Invited Speakers:**

*Sonia Bruehl*, Universidad Tecnológica Nacional (UTN), Concepción del Uruguay, Argentina

*Denis Romagnoli*, STS, Italy

### **EP: Tribology and Mechanical Behavior of Coatings and Engineered Surfaces (Symposium E) Poster Session**

#### **New Horizons in Coatings and Thin Films (F)**

This cross-cutting symposium aims at expanding the scope of the conference by encouraging hot topics that are new to ICMCTF. The five sessions of the symposium will provide a forum for new pioneering topics including the latest advances in computational material science, the synthesis of nanomaterials and nanofabrication, and coatings based on multi-principal-element and 2D materials.

#### **F1. Nanomaterial-based Coatings and Structures**

This session focuses on harnessing nanoscale phenomena and innovative deposition strategies for new types of nanostructures and nanomaterial coatings with a wide spectrum of functionalities. Advances in formation and applications of thin films based on nanocrystals, nanoparticles, nanowires, nanotubes, and other types of nanostructures, as well as the development of novel synthesis technologies and in-situ diagnostic methods enabling monitoring of nanomaterial growth processes will be addressed. The areas of interest include experimental, theoretical and computational research in nanomaterials with controlled properties, processing-structure-property relationships, novel application concepts or prototypes using nanoengineered structures. Thus, the session will provide a unique platform for the discussion of fundamental issues and recent developments in synthesis of novel functional nanostructured materials as well as the ways to apply them in the next-generation of research and manufacturing processes.

#### **F1 Invited Speaker:**

*Simon Brown*, University of Canterbury, New Zealand, "Brain-Like Behaviour in Percolating Films of Nanoparticles"

#### **F2. High Entropy and Other Multi-principal-element Materials**

High entropy alloys (HEAs) and other multi-principal-element materials are multicomponent systems in which high entropy of mixing, or kinetic effects, stabilize a solid solution. They exhibit unique chemical and physical properties and have therefore recently attracted a growing interest in the materials science community. This session will be a platform for thin film-related research on high entropy and multi-principal-element materials including metal alloys, carbides, nitrides, and oxides as well as other multicomponent systems in which high entropy affects phase stability. Topics of interest include, but are not limited to, modelling, thin film processing, and characterizations of HEAs and other multi-principal-element materials.

#### **F2 Invited Speakers:**

*Matthew Witman*, Sandia National Laboratories, USA, "Data Driven Methods Enable Rational Design of High Entropy Materials for Hydrogen Storage"

#### **F3. 2D Materials: Synthesis, Characterization, and Applications**

This session focuses on exciting developments in the field of 2D materials, including but not limited to graphene, transition metal dichalcogenides (MoS<sub>2</sub>, WS<sub>2</sub>, etc.), BN, oxides, as well as emerging 2D carbides and nitrides. 2D materials have been extensively researched in the last decade as atomically-thin metal, semiconductor, and insulator materials with novel and extraordinary properties. Recent advances in their synthesis have provided new possibilities to tune their structure, properties, and enhance their electrical, mechanical, lubrication, and anticorrosion performances. Researchers working in the field of 2D material synthesis and processing, characterization, and applications are encouraged to submit abstracts. We seek to advance the research and development of 2D material-based coatings by connecting researchers from diverse academic and industrial backgrounds, including tribology, materials science, physics, and chemistry. Topics include: controlled scalable synthesis of 2D materials, composite materials and heterostructures, mixed 2D phases and alloys, formation and control of defects, grain boundaries, edges, interfaces, nanopores, characterization, theoretical modeling, device fabrication, post-synthesis engineering of 2D materials using chemical treatments and ion/electron beams, and applications of 2D materials in electronics, sensing, coating, friction/wear reduction, anti-corrosion, and anti-fouling.

#### **F3 Invited Speakers:**

*Yu-Lun Chueh*, National Tsing-Hua University, Taiwan.: "Two-Dimensional Layered Materials Toward Phase/Structure-Engineered Hybrid Films for Innovative Nanoelectronics"

*Wenzhou Wu*, Purdue University, "Tellurene Electronics and Sensors"

#### **F4. Boron-containing Coatings**

Borides and boron-containing thin film materials are emerging as the next generation of hard, wear-, oxidation-, and corrosion-resistant coatings. Furthermore, various boron-based materials exhibit unique properties obtaining high potential for functional and architectural designs. The aim of this session is to provide a platform for first-principles design, synthesis, characterization of properties and defect structure as well as applications of different types of boron-containing protective and functional thin films.

##### **F4 Invited Speakers:**

*José Luis Endrino*, Universidad Loyola Andalucia, Spain, "Wear Resistant Boron-containing Coatings: Arc vs. HiPIMS"

*Christina Kainz*, Montanuniversität Leoben, Austria, "Quaternary CrTaBN: Experimental and Theoretical Insights Into a Novel Coating Material with Promising Mechanical Properties and Exceptional Thermal Stability"

*Tomasz Mościcki*, Polish Academy of Sciences, Poland, "Ternary Tungsten Boride Coatings with Improved Mechanical Properties Deposited by High-Power Pulsed Magnetron Sputtering from One Spark Plasma Sintered Target"

*Takayama Shin*, Mitsubishi Materials Corporation, Japan, "Characterization of AlTiLaBN Hard Coating and its Cutting Tool Application"

#### **F5. Machine Learning and Process Modeling for Coating Design and Production**

An exponential growth of computational power and storage density, combined with progress in data science, have brought the information revolution. Data-driven methods are now in ubiquitous use in multiple fields, including life sciences and medicine, economics, social networks, etc. A visionary suggestion of integrating materials development with data-driven methods, materials informatics, is bringing a disruptive paradigm shift in materials science. The framework has the potential to reduce dramatically cost, risks and time for materials discoveries, by an order of magnitude or more. It is capable to produce qualitatively new insights, beyond the reach of conventional research techniques. This topical session will focus on presenting machine learning, artificial intelligence, visualization algorithms and high-throughput methods, as well as best practices of their applications for the knowledge-based materials design. Challenges related to the generation, curation, and exploration of big materials data from a wide range of sources, theoretical, as well as experimental will be discussed. Additionally, predictive process modeling and simulation will be discussed as a tool which provides irreplaceable insight into process conditions and quantities which cannot be measured. Thanks to the advancements in computational power and process fundamentals, it has also become feasible to simulate entire industrial coaters and coated parts. As such, process modeling helps to de-risk and speed up coater design, process upscaling as well as retrofitting new processes into existing coaters. Process modeling also provides an additional layer of physics-based process metadata that can be leveraged by the machine learning and AI methods. The topical session will bring together the broad community of researchers in metallurgical coatings and thin films with leading experts and young researchers developing and applying data-driven methods in materials science.

##### **F5 Invited Speakers:**

*Andreas Pflug*, Fraunhofer Institute for Surface Engineering and Thin Films IST, Germany

#### **FP: New Horizons in Coatings and Thin Films (Symposium F) Poster Session**

#### **Surface Engineering - Applied Research and Industrial Applications (G)**

This symposium is jointly organized by ICMCTF (AVS/ASED) and the Society of Vacuum Coaters (SVC) and will focus on applied research related to industrial manufacturing and application aspects of various surface engineering and coating technologies. Topics include recent advancements in surface engineering equipment and the application of PVD/CVD deposition technologies for coatings and thin films in automotive, aerospace, component and tooling/cutting applications. Also of particular interest are surface treatments before and after the coating processes to enhance the performance of engineered surfaces, hybrid/duplex coating techniques, innovations in manufacturing practices, and cooperation between industry, research organizations, and academia to advance surface engineering applications.

#### **G1. Advances in Application Driven Research: New Methods, Materials, and Equipment for PVD, CVD, and PECVD Processes**

The scope of this session is on the research results produced in cooperation between industry, research laboratories, and academia. One focus should be on companies that can present current status and achievements, as well as to address future development trends. Academic institutions are highly encouraged to present results of background research or contributions aimed at the development of the tailored solutions to meet the industrial demands of thin film and hard coatings applications.

##### **G1 Invited Speaker:**

*Yaron Shenhav*, SolCold, Israel, "New Sun Light Cooling Mechanisms In Film Formed Systems"

## **G2. Surface Modification of Components in Automotive, Aerospace and Manufacturing Applications**

This session will cover application-oriented research and development on surface engineered products and technologies. Topics include surface modified or coated products/components in tribology, corrosion, high temperature, optical, magnetic, and allied technologies. The focus is also on novel substrate preparation and pre-treatment methods: nitriding, carburizing, boriding, or oxidation pre-treatments; intermediate etching treatment and interlayer design during the coating processes. The innovative technologies such as coating post-treatments, including laser, electron beam, annealing, ion implantation or mechanical/chemical/optical techniques, and integrated and/or novel treatments and process combinations are also of interest. The main criteria are that the surface engineering/coatings should be applied to semi/end products to enable/improve desired physical/chemical properties. The components used in automotive, aerospace, manufacturing, land-based and aero turbines, mining, oil drilling and fracking, construction machinery, sporting goods and farming equipment are of primary interest in this session. Papers dealing with aspects relating to properties, processes, performance, equipment, and industrial applications for such treatments are all welcome.

### **G2 Invited Speakers:**

*Miha Cekada, Jozef Stefan Institute, Slovenia*

## **G3. Innovative Surface Engineering for Advanced Cutting and Forming Tool Applications**

The requirements of manufacturing industries and recent innovative developments in coatings and surface engineering processes for advanced tooling applications are the focus of this session. Such applications include but are not limited to high-demanding sheet or bulk metal forming, plastics processing, die-casting as well as cutting operations of steel, cast iron and difficult-to-cut materials like high-temperature alloys or CFRP. Novelty related to the use of coating technologies like PVD arc, sputtering, HIPIMS, hybrid, electron beam as well as PECVD and CVD for application-oriented design of different coating materials, architectures and properties are welcome. Insights into the combined effect of tool geometry and adapted coatings are also in the focus of the present session. Furthermore, contributions highlighting the interaction of the coatings designed for cutting and forming applications with the ambient atmosphere and/or the counterpart materials including metallic alloys and polymers are within the focus of this session.

### **G3 Invited Speakers:**

*Christoph Czettl, CERATIZIT Austria Gesellschaft m.b.H., Austria, "Cutting Tool Coatings"*

*Martin Heß, FRITZ STEPPER GMBH & CO.KG, Germany, "Wear Protection of Stamping Tools"*

## **G4. Hybrid Systems, Processes and Coatings**

This session focuses on novel methods that employ combinations of several processes and systems during film deposition. Hybrid systems can combine different ionization sources, like lasers, hot filaments, hollow cathodes, electron- or ion-guns, etc. with conventional magnetrons or arc evaporators, in order to provide increased ionization, additional heating of the substrate, or to change the distribution of plasma density in the reactor. Hybrid systems can also combine different gas pressures, including atmospheric plasma activation, can use pulsed gas inflows synchronized with pulsed power, pulsed biasing, etc. Hybrid processes can integrate different mechanisms of production of species for film deposition, for example PVD with PE CVD. Contributions on organic-inorganic hybrid coatings and hybrid processes both at reduced and atmospheric pressures are also solicited.

### **G4 Invited Speakers:**

*Harm Knoops, Oxford Instruments Plasma Technology, Netherlands, "Plasma-enhanced ALD"*

## **GP: Surface Engineering - Applied Research and Industrial Applications (Symposium G) Poster Session**

### **Advanced Characterization Techniques for Coatings, Thin Films, and Small Volumes (H)**

This Symposium focuses on recent advances in the structural, microstructural, and mechanical characterization of coatings and thin films, which enhance our understanding of the growth and surface modification processes as well as the fundamental structure-property-processing relationships. Of interest are contributions that either highlight the application of, or draw attention to, recent advances in analytical methods, characterization techniques, and novel nano-mechanical testing methods for coating evaluation. Analytical methods may include numerical evaluation and quantification procedures (e.g., factor analysis, depth profiling, 3D mapping, etc.) to reveal the micro- and nano-structure, chemical composition, residual stress, chemical states, and phases of coatings, thin films, interfaces, and surfaces during or after surface modification. Micro- and nanomechanical methods may include compression, bending, or toughness testing to determine coating behavior, particularly at elevated/service temperatures and in harsh and cyclic environments, and the relationship to coating performance and lifetime. Residual stress analysis, phase characterization, surface topography probes, compositional analysis, high-resolution

spatial imaging and analysis, and hardness measurements continue to be subjects of interest in the sessions. In-situ characterization methods and other novel techniques presenting the combination between microstructural nano-mechanical probes are highly encouraged.

### **H1: Spatially-resolved and In-Situ Characterization of Thin Films and Engineered Surfaces**

This session deals with all aspects concerning novel spatially-resolved structural, microstructural and chemical characterization techniques, especially those that advance the in-depth understanding of the relationship between the processing, the structure and the properties of thin films and engineered surfaces. Particular attention will be given to papers using cutting-edge experiments to provide information on the microstructural evolution of thin films, including in-situ measurements during film growth, spatially resolved analysis of residual stress and three-dimensional chemical mapping. Emphasis will be given to novel high-resolution techniques, such as Atom Probe Tomography, X-ray nano-diffraction, advanced TEM characterization, micro-Raman spectroscopy, etc. Papers are furthermore also solicited in the emerging area of three-dimensional microstructural characterization in small volumes, such as FIB/SEM tomography, in-situ EBSD and/or ToF-SIMS 3D mapping.

#### **H1 Invited Speakers:**

*Wendy Gu*, Stanford University, USA

*Joshua Kacher*, Georgia Tech University, USA

### **H2: Advanced Mechanical Testing of Surfaces, Thin Films, Coatings and Small Volumes**

This session covers advanced mechanical characterization techniques for surfaces, thin films and coatings with a focus on the development of novel methods. This includes novel methods for performing nanoindentation and advanced micro-scale testing on coatings, thin films and nanostructures produced by FIB or other lithography techniques. Emphasis will be given to multi-techniques nanomechanical testing, performed in situ in the SEM, TEM, Raman, X-ray beamline, etc.

#### **H2 Invited Speakers:**

*Dan Gianola*, UC Santa Barbara, USA

*Andrea Maria Hodge*, University of Southern California, USA

### **H3: Advanced Characterization of Coatings and Small Volumes in Extreme and Cyclic Conditions**

This session covers the advanced characterization and mechanical behavior of coatings and small volumes under harsh, cyclic and/or unusual conditions, such as high or cryogenic temperatures, radiation, hydrogen embrittlement and high strain rates. Particular attention will be given to papers providing characterization in-situ, rather than after mechanical exposure: e.g. nanoindentation testing performed at high temperatures rather than after an annealing treatment in a separate furnace. Emphasis will be given to works which show progress pushing the testing envelope further into more extreme environments or combining multiple characterization techniques to gain better information on the coatings behavior.

#### **H3 Invited Speakers:**

*Verena Maier-Kiener*, Montanuniversität Leoben, Austria

*Benoit Merle*, University of Kassel, Germany, "Nanoindentation Measurements at Combined High Sustained Strain Rates and Elevated Temperatures"

*Han Xiaodong*, Beijing University of Technology, China

### **HP: Advanced Characterization Techniques for Coatings, Thin Films, and Small Volumes (Symposium H) Poster Session**

**TOPICAL SYMPOSIA (TS):** Three topical symposia will address emerging areas in surface engineering:

#### **TS1. Coatings for Energy Storage and Conversion - Batteries and Hydrogen Applications**

The future of energy is driven by the overall goal to provide green and sustainable energy for all industrial sectors. All mobile and stationary applications will be affected by these changes. The achievement of these goals relies on green and sustainable energy generation but also on the ability to store this energy. Once electricity is generated with regenerative technologies it can be stored in batteries or transported using Hydrogen as a carrier to its final destination and transferred to electricity again when needed. Electrochemical cells are key elements in Hydrogen production and storage of generated electricity in batteries. Surface coatings and surface functionalization in these cells are providing key properties to enable and drive necessary reactions. Electrode surfaces must provide high electric conductivities and withstand harsh electrochemically corrosive environments. On the other hand, membrane assemblies must be functionalized and act as carriers for catalysts. In solid-state batteries coatings are needed for interface design between electrodes and electrolytes. Moreover, coating processes are needed for the application of active materials. Future technical and economic success in Hydrogen generation and electricity storage is mainly driven by the developments related to these electrochemical cells. This topical symposium focuses

on coatings and surface functionalization in electrochemical cells used in Hydrogen applications, e.g. electrolysis, fuel cells, and in electricity storage, e.g. Li-batteries, solid state batteries, flow batteries.

#### **TS1 Invited Speakers:**

*Claus Rebholz*, Cyprus University, Cyprus, "Coatings for Hydrogen Applications"

*Chen-Hao Wang*, National Taiwan University of Science and Technology, Taiwan, "High Efficiency of Metal Oxide Catalysts for Vanadium Redox Flow Battery"

#### **TS1P: Coatings for Energy Storage and Conversion - Batteries and Hydrogen Applications- TS1 Poster Session**

#### **TS2. Sustainable Surface Solutions, Materials, Processes and Applications**

The symposium on sustainable surface solutions is intended for engineers and scientists working in all fields between fundamental research and product development by surface modification processes. The full scope of surface modifications like chemical or physical processing, material deposition or removal in dimensions of nanometers to some hundred microns shall be considered to generate functional surfaces. The focus is on the complete range from process and materials to applications with the goal to minimize or even to eliminate negative environmental impact, and perhaps also to improve environmental conditions. Surface solutions have the potential to enable sustainable solutions for functionalized and even smart surfaces, but surface solutions should also be sustainable. Innovative ideas for new pathways to generate sustainable surface functions are welcome.

The surface modification process in general or, as an example, a coating deposition process must be designed for sustainability including the adequately targeted durability, the effort and waste for production and the recyclability at the end of life. This includes an assessment of the total GHG (greenhouse gas) impact and the release of harmful substances. Impact measure for the total carbon footprint for any resource to adjust surface properties are increasingly of importance due to national and international regulations. This includes aspects of material selection, utilization, and energy efficiency. Life cycle assessment (cradle to grave) aspects are of interest beginning with the material selection ending with the "recycling" (circular economy, cradle to cradle). Selected keys are as follows: Tailored components of the deposition (treatment) equipment's (PVD, CVD; Spraying, Nitriding, and others) and the processes themselves are steps to achieve a progress in sustainability, e.g., to reduce energy consumption and pollutions; Low-impact materials (non-toxic, recycled materials) both for the surface and for intermediate steps are of special interest. Sustainable Surface Solutions should not be reduced to wear and/or friction reduction. Pathways of sustainable solutions based on various deposition (treatment) processes for energy conversion and storage (e.g., wind power, batteries, supercaps, hydrogen storage, thermal insulation), self-cleaning surfaces (e.g., photocatalytic effect, lotus effect), coatings on plastics, optical coatings, medical coatings, decorative coatings, antifouling coatings, corrosion protection coatings, sensoric and electronic coatings shall be highlighted.

#### **TS2 Invited Speakers:**

*Yashar Musayev*, Siemens Energy Global GmbH & Co. KG, Germany, "Surface Technology as a Key Technology for New Energy Systems"

*Jyh-Ming Wu*, National Tsing Hua University, Taiwan, "Progress Overview of Piezocatalysis : Water Treatment and Hydrogen Evolution"

#### **TS2P: Sustainable Surface Solutions, Materials, Processes and Applications - TS2 Poster Session**

#### **TS3. Processes of Materials for Printed and Flexible Film Technologies**

The emerging energy efficient and smart technologies, like those enabling the Internet of Things (IoT), are demanding facile, large area, low cost, scalable and environmentally friendly processes. A fundamental platform for their realization is undisputedly flexible thin film technology. This Topical Symposium will focus on developments in thin film processes compatible with flexible substrates that will include, but are not limited to: vacuum technology on flexible substrates (e.g. polymer, paper, thin glass etc.), large area manufacturing (e.g. r-2-r, c-2-c, batch reactors etc.), ink technology (for slot die, inkjet, gravure, flexo etc.), photonic processes (photonic assisted deposition and/or post-deposition photonic processing) and others. Additionally, advances in testing and characterization specific to flexible thin films will be considered (e.g. in-line optical characterization, off-line mechanical testing etc.). Potential applications are envisioned in the sectors of packaging, electronics, sensors, energy storage and/or generation, solid state lighting, displays, functional coatings, protective coatings and beyond.

#### **TS3 Invited Speakers:**

*Thomas D Anthopoulos*, King Abdulah University of Science and Technology (KAUST), KSA, Saudi Arabia, "Upscalable Nanomanufacturing of Thin-Film Electronics"

*Ravi P Silva*, University of Surrey, UK, "Solar Cells, Energy Materials, Carbon Nanotubes, Renewables, Nanotechnology"

#### **TS3P: Processes of Materials for Printed and Flexible Film Technologies - TS3 Poster Session**

### **SPECIAL SESSIONS & EVENTS**

**Plenary Lecture (PL)**  
***“Recent Trends in Artificial Photosynthesis: Atomistic/Surface Design and Probing of Nano-Photocatalysts”***

***Dr. Li-Chyong Chen, National Taiwan University, Taiwan***  
***Monday, May 22, 2023, 8:00 a.m.***

Photocatalytic CO<sub>2</sub> conversion to hydrocarbon fuels, which makes possible simultaneous solar energy harvesting and CO<sub>2</sub> reduction reaction (CO<sub>2</sub>RR), is considered a killing-two-birds-with-one-stone approach to solving the energy and environmental problems. However, the development of solar fuels, or the so-called artificial photosynthesis, has been hampered by the low photon-to-fuel conversion efficiency of the photocatalysts and lack of the product selectivity. Recent advances in development of integrated nanostructured materials have offered unprecedented opportunity for photocatalytic CO<sub>2</sub>RR, as depicted in my recent invited review article [1]. Here, selective cases in nanomaterials, especially, atomistic design and synthesis of highly functioning nano-photocatalysts, will be illustrated [2-4]. Ascertaining the function of in-plane intrinsic defects and edge atoms is necessary for developing efficient photocatalysts. A perfect planar layer is usually inactive to catalysis. Vacancy clusters, as well as the reconstructed and imperfect edge configurations enable CO<sub>2</sub> binding to form linear and bent molecules. To make the energy conversion techniques towards practical solutions, some key questions need to be addressed. For instance: What are the determining steps for CO<sub>2</sub>RR? Advancements in the *in situ* and *operando* synchrotron radiation-based spectroscopies, including X-ray absorption [5] and X-ray photoelectron spectroscopy (XPS), *etc.*, along with various vibrational spectroscopies, such as Raman and Fourier transform infrared spectroscopy (FTIR), and scanning electrochemical microscopy [6], have enabled scientists to probe the geometric, bonding and electronic information of the catalyst and obtain atomistic insights into the catalytic surfaces and reaction mechanisms. Selective cases utilizing these probing techniques will be illustrated.

**Exhibitors Keynote Lecture (EX)**

***“Future Requirements for Advanced Surface Modification and Coatings Technologies for Turbine Engine Applications”***

***Dr. David Furrer, Pratt and Whitney, USA***  
***Tuesday, May 23, 2022, 11:00 a.m.***

Evolution of engineered product designs and associated system requirements have given rise to increased challenges for materials and components. These challenges are in part being overcome through the development and application of surface related technologies. Surfaces are critical features that drive the ultimate behavior, capabilities and value of highly engineered components and systems. Surfaces provide for a means of protection for structural materials from extreme environmental conditions, such as elevated temperatures, corrosive and reactive materials, interfacial contact and loading, and erosion and wear. Turbine engine designs are continuing to evolve to meet the need for ever increasing energy efficiency and reduced environmental impact. Traditional efforts of increasing turbine engine efficiency are aimed at increased core temperatures and increased thermodynamic efficiency. Architecture changes for future turbine engines are bringing new challenges from the introduction of new thermodynamic cycles, hybrid energy systems and alternate fuels. These system-level design changes are increasing the need to advance surfaces to mitigate these new challenges and to support required component durability. A review of potential future system design changes and their potential impact on various materials and components will be reviewed. The requirements for advanced surface modification and coating technologies will be discussed in terms of future product-level requirements. In addition to the requirements for the surface modification or coating of components, the requirements for the manufacturing processes also need to be considered as we embrace and implement Industry-4.0 technologies.

**Special Interest Talks (SIT)**

A new feature of highlighted presentations offers added value to the technical program. Lectures are dedicated to topics of fundamental interest for scientists and engineers in surface engineering. Presentations are individual and not “classic” day-to-day R&D business. Discussion of new developments and trends of relevance to ICMCTF, both in materials science and in methodology, in a pioneering state, with long-term impact. Selected critical reviews in a field of relevance to ICMCTF. Recognition of colleagues with pioneering and lasting impact on ICMCTF.

**SIT1: Special Interest Session I**

*Jia-Hong Huang, National Tsing Hua University, Taiwan, “Residual Stress Measurement on Hard Coatings and the Evaluation of Energy Relief Efficiency of Architected Coatings”*

**SIT2: Special Interest Session II**

*Joerg Patscheider, Evatec AG, Switzerland, “Nitride and Oxide Functional Thin Films – The Key to our Digital World”*

**SIT3: Special Interest Session III**

*Shimpei Yamaguchi, Tokyo Electron, Ltd., “Advanced Patterning Technologies for Future Device Scaling”*

### **'FIRST TIMERS' SPECIAL**

We want to welcome new participants in 2023 with a special 'First Timers' offer of **free student registration** for one student accompanying their adviser/supervisor registering for ICMCTF 2023 for the first time. Both the mentor and student must be first time attendees, and both are required to stay in the conference hotel to be eligible for the offer. Please contact the ICMCTF 2023 General Chair, Samir Aouadi (Samir.Aouadi@unt.edu) if you have any questions regarding this opportunity.

### **ICMCTF VENDOR EXHIBIT**

Visit the exhibit hall on Tuesday, May 23, from 12:00-7:00 p.m. and Wednesday, May 24, from 10:00 am – 2:00 p.m. to learn about new products, services and application techniques that will help improve all facets of R&D, Engineering, Manufacturing, Quality Control and general laboratory operations. This is a great opportunity for attendees to interface with vendors who are eager to introduce their products that will satisfy your laboratory requirements and your specific research criteria. The exhibit hall is also a great place for networking. Join us each day for lunch and the exhibit hall reception on Tuesday at 5:30 pm. For questions regarding the exhibits, please contact Jeannette DeGennaro at [jeannette@avs.org](mailto:jeannette@avs.org)

### **Call for ICMCTF Awards**

1. **Graduate Student Awards:** The ICMCTF Graduate Student Awards are intended to honor and encourage outstanding graduate students in fields of interest to the Advanced Surface Engineering Division (ASED) of the AVS. ASED seeks to recognize students of exceptional ability who show promise for significant future achievement in ASED-related fields. The nominee must be a graduate student in science or engineering who is in good standing at a university with a recognized graduate degree program and the presenting author of an oral presentation at the annual ICMCTF conference. Nominees who receive their final research degree after the ICMCTF Abstract Submission deadline are still eligible for that year. However, previous Graduate Student Award winners are ineligible. Submission Deadline: November 15, 2022. Click here for **Nomination Procedures.**
2. **Bunshah Award:** R.F. Bunshah Award and Honorary ICMCTF lectureship is intended to recognize outstanding research or technological innovation in the areas of interest to the Advanced Surface Engineering Division (ASED) of the AVS, with an emphasis in the fields of surface engineering, thin films, and related topics. The nominee shall have made pioneering contributions to the science or technology of surface engineering, thin films, or related fields of interest to ASED. Submission Deadline: November 15, 2022. Click here for **Nomination Procedures.**
3. **Bill Sproul Award:** The Bill Sproul Award and Honorary ICMCTF lectureship is intended to recognize the achievements of a mid-career researcher who has made outstanding scientific and/or technological contributions in areas of interest to the Advanced Surface Engineering Division (ASED) of the AVS, with an emphasis in the fields of surface engineering, thin films, and related topics. Submission Deadline: November 15, 2022. Click here for **Nomination Procedures.**

**ONLINE ABSTRACT SUBMISSION ONLY: <https://icmctf2023.avs.org/>**

**Deadline: 11:00 p.m. ET, TUESDAY, November 15, 2022**

**Supplemental data (1-2 pages, 1MB) will also be accepted via the submission site.**

**Instructions may be found at the website above.**

**\*\*\*Please Note: A presenter may present one (1) ORAL AND one (1) POSTER presentation at ICMCTF\*\*\***

**ORAL Sessions:** Rooms will be set up with projectors, screens, microphones, and laptops (PCs).

**POSTER Sessions:** Each poster presenter will be allotted space that is 4 feet wide by 4 feet high. Please make your poster no larger than 46 inches wide by 46 inches high to ensure it fits nicely into the allotted space.

Any Questions? Please email [icmctf@icmctf.org](mailto:icmctf@icmctf.org)