TechCon 2021 Nashville

Gaylord Opryland Resort & Convention Center

May 1 – 6, 2021

Deadlines for Abstracts: **October 2, 2020** (Guaranteed placement in requested session) | **January 31, 2021** (Guaranteed conference participation)

Keynote and Invited Speakers

Now Accepting Abstracts for the 2021 Technical Conference

Featuring a Symposium on:

Thin Film Solutions for a Sustainable Future

Technical Program: May 3 – 6

- Technical Sessions
- Interactive Networking Forums
  + Breakfast Discussion Groups

Education Program: May 1 – 6

- Problem-Solving Tutorial Courses

Together with:

- Additive Manufacturing *NEW*
- Atomic Layer Processing (ALP)
- Coatings for Energy Conversion and Related Applications
- Coatings and Processes for Biomedical Applications
- Communication 2030
- Emerging Technologies
- Heuréka!
- High-Powered Electron Beam Technology
- High-Power Impulse Magnetron Sputtering – HIPIMS
- Large Area Coatings
- Optical Coatings
- Plasma Processing
- Protective, Tribological and Decorative Coatings
- Technical Poster Session
- Thin Film Sensors *NEW*
- Thin Film Superconductors *NEW*
- Vendor Innovator Showcase
- WebTech Roll-to-Roll Coatings for High-End Applications

Technology Exhibit: May 4 – 5

Over 150 Exhibitors + Free Admission

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For more information, contact the SVC at 505-897-7743
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Announcing the 2021 SVC TechCon Symposium on:

Thin Film Solutions for a Sustainable Future

Simplistically speaking, sustainability is a highly complex concept that occupies an ever growing portion of the global "consciousness". "Sustainability" as a discrete concept is almost fifty years old and was first detailed in 1971 in *The Ecologist's A Blueprint for Survival*. The quest to make modern civilization 'sustainable' inspired the UN's Stockholm Conference in 1972 and formed the basis of "global trusteeship" that has served as the foundation of almost all subsequent international environmental treaties. The most quoted definition of sustainability comes from the UN World Commission on Environment and Development: "***sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.***"

It is difficult to imagine a sustainable future that does not rely on and in reality, is driven by, thin film technologies and surface engineering. Novel functional thin film structures, deposition modalities of new materials, structure property relationships at the atomic level, and large-scale manufacturing technologies ***will be*** the enablers for a sustainable future.

This Symposium seeks to bring together experts in the thin film and surface engineering communities to discuss applications, challenges and technology development that will be critical drivers for a sustainable future. Presentations that address the intersection of sustainability and thin film technology/surface engineering with developments in:

- Battery technology (e.g. post-lithium),
- Energy storage (hydrogen – from the cradle to the grave: generation, storage, fuel cells),
- Energy generation (Photovoltaics, Solar to hydrogen, wind power),
- Life cycle management,
- Replacing/substituting limited raw materials as well as materials whose refinement poses environmental challenges,
- Solutions for recycling costly materials,
- CO_2 footprint reduction in mobility and transportation,

are particularly welcome in the interest of encouraging discussions and development that will have global impact.

The SVC technical program is complemented by the industry's most extensive trade show exhibition, a comprehensive tutorial program, Young Members Group, and ample networking and business opportunities. The SVC TechCon creates a forum where researchers, industry practitioners, decision makers, and newcomers to the field can connect, exchange ideas, and get questions answered.

We are looking forward to seeing you in Nashville in 2021!

Back by Popular Demand:

FREE Technical Conference Admission on May 4th or 5th | Further Details at www.svc.org

2021 TechCon

2021 SVC TechCon Call for Papers

Message from the Program Committee

The 2021 SVC TechCon will be held in the heart of Nashville, Tennessee!

The Thin Film Solutions for a Sustainable Future Symposium will encompass a broad range of relevant issues covering the intersection of sustainability and thin film technology/surface engineering. The Symposium will address applications, challenges, and technology development from a contemporary focus. The TechCon offers an industry-leading technical exhibition, abundant networking opportunities, along with an extensive educational program and in-depth technological expertise. The 2021 TechCon is a great opportunity to present your latest research results, coating processes, and equipment applications in the field.

We invite you to share your latest R&D and application successes with the SVC community. The TechCon offers a broad range of presentation options – oral, posters, or vendor innovation formats – which can accommodate the full spectrum of academic research and industrial product innovations. This is complemented by our publication options – PowerPoint presentation or manuscript in the conference proceedings or peer-reviewed journal submission. The SVC Student Sponsorship Program provides financial support for a limited number of qualified applicants to encourage student participation.

We encourage you to contribute a paper, taking advantage of the opportunity for renewing or making new connections that only the SVC can offer! Our academic researchers, industrial innovators, technical practitioners, and application experts await your news and look forward to talking with you in Nashville. With the addition of our new Thin Film Superconductors, Additive Manufacturing, Thin Film Sensors, and Communication 2030 sessions, the SVC TechCon enhances its position as the worldwide forum for thin film technologies and surface engineering. Come and be a part of SVC 2.0!

SVC™ SOCIETY of VACUUM COATERS

Our Vision: *To be the global source for learning, applying and advancing vacuum coating, surface engineering, and related technologies.*

Our Mission: *To promote technical excellence by providing a global forum to inform, educate, and engage the members, the technical community, and the public on all aspects of vacuum coating, surface engineering and related technologies.*

Publication Options:

There are two publication options to publish manuscripts for work presented during the 2021 Technical Program

1 **WITHOUT PEER REVIEW**

Submission Deadline: July 3, 2021

Publication in PowerPoint OR Manuscript format in Society of Vacuum Coaters Annual Technical Conference Proceedings (ISSN 0737-5921)

2 **PEER REVIEWED**

Submission Window Open May 1 – July 15, 2021

Publication in a special edition of Elsevier's Surface and Coatings Technology Journal (ISSN: 0257-8972)

For more information, contact the SVC at 505-897-7743 or CLICK HERE to submit an abstract

SVC

Introducing the SVC's Keynote

Atomic Layer Deposition: An Enabling Thin Film Nanotechnology for a Growing Number of Applications

W.M.M. (Erwin) Kessels *Eindhoven University of Technology, Eindhoven, The Netherlands*

Processing at the atomic scale is becoming increasingly critical for many applications also well beyond electronic devices for computing and data storage. Yet, the semiconductor industry has been the main driving force behind the industrial implementation of the method of atomic layer deposition (ALD) in high-volume manufacturing in the last two decades. ALD allows for the preparation of high quality thin films on challenging surface topologies while precisely controlling nanometer dimensions. It has therefore been key for the materials- and 3D-enabled scaling which has been necessary to continue Moore's law over the last decade.

In this presentation, the developments in the field of ALD will be briefly reviewed including a description of its key features and its hallmarks. A particular focus will be given to the technological opportunities provided by the method in terms of materials, processes and applications. An overview will be given of recent and emerging applications of ALD, for example, in energy technologies including solar cells and batteries, in large-area electronics including displays, and in optical and mechanical coating applications. Also the developments in ALD equipment will be presented with respect to ALD configurations (thermal and plasma-enhanced ALD) and with respect to high volume manufacturing including batch and spatial ALD and roll-to-roll ALD for flexible substrates.

Erwin Kessels is a full professor at the Department of Applied Physics of the Eindhoven University of Technology TU/e (The Netherlands). He is also the scientific director of the NanoLab@TU/e facilities which provides full-service and open-access clean room infrastructure for R&D in nanotechnology. Erwin received his M.Sc. and Ph.D. degree (with highest honors) in Applied Physics from the TU/e in 1996 and 2000, respectively. His doctoral thesis work was partly carried out at the University of California Santa Barbara and as a postdoc he was affiliated to the Colorado State University and Philipps University in Marburg (Germany). In 2007 the American Vacuum Society awarded him the Peter Mark Memorial Award for "pioneering work in the application and development of in situ plasma and surface diagnostics to achieve a molecular understanding of thin film growth". In recognition of his research, he received a NWO Vici grant in 2010 to set up a large research program on "nanomanufacturing" in order to bridge the gap between nanoscience/nanotechnology and industrial application. In 2019 he was awarded the ALD Innovation Award at the International Conference on Atomic Layer Deposition and he became a visiting professor and Mercator fellow at the Ruhr Universität Bochum in Germany.

His research interests cover the field of synthesis of ultrathin films and nanostructures using methods such as (plasma-enhanced) atomic layer deposition (ALD) and atomic layer etching (ALE). Within the field of ALD, he has contributed most prominently by his work on plasma-assisted ALD, his research related to ALD for photovoltaics, and ALD for nanopatterning (including area-selective ALD). Currently Erwin is focusing his research on atomic scale processing, a field which is believed to grow in importance quickly in the next decade for a wide variety of application domains.

Erwin chaired the International Conference on Atomic Layer Deposition in 2008 (Bruges, Belgium) and he frequently (co-)organizes ALD-related workshops. He will serve as chair ALE workshop in 2020. Erwin is active within the American Vacuum Society and has been President of the Netherlands Vacuum Society. He is an associate editor of the Journal of Vacuum Science and Technology. He is also the driving force behind the AtomicLimits.com Blog and the founder of the ALD Academy.

Vacuum Deposition of Electro-Active Coatings for Thin-Film Neural Interfaces

Stuart F. Cogan *University of Texas at Dallas, Richardson, TX*

There is growing interest in multielectrode arrays that electrically record and stimulate neural activity with a spatial selectivity that is on the order of a single cell or nerve fiber. Emerging applications, particularly those employing neural recording for volitional control or neural stimulation for somatosensory feedback, also contemplate multielectrode arrays with hundreds and likely thousands of individually addressable electrodes. Because these electrodes have a small surface area (<2000 μm^2), they are typically coated with an electrode material that is capable of delivering charge to neural tissue via reversible reduction-oxidation reactions that are confined within the three-dimensional structure of the electrode coating. These electrode coatings, typified by sputtered iridium oxide (SIROF), are on the order of 100-1000 nm thick. To achieve a low impedance for recording and high levels of charge-injection at high current densities for stimulation, the coatings are hydrated, mixed electron-ion conductors with a density that is usually <70% of bulk crystalline values. Sputter deposition methods for achieving the desired electrochemical properties of these neural electrode coatings through control of film morphology, density and, when appropriate, hydration are described. Emphasis is placed on SIROF and a comparatively new electrode coating based on ruthenium oxide. The selection of reactive plasma constituents based on hydrogen/oxygen or water/oxygen gas mixtures during DC magnetron sputtering is discussed. The manner in which the plasma chemistry might control the properties of the SIROF and ruthenium oxide films is investigated through optical emission spectroscopy and mass spectroscopy (RGA), using x-ray diffraction, XPS, and Raman spectroscopy, as well as electrochemical measurements, to characterize the electrode coatings. In addition, the neural stimulation properties of the electro-active coatings are compared with those of high-surface-area sputtered titanium nitride (TiN) that is commonly used in cardiac pacing and operates through charging and discharging of the electrochemical double-layer to provide charge delivery for neural stimulation.

Dr. Cogan is Professor of Bioengineering at The University of Texas at Dallas, where he conducts research on neural stimulation and recording with an emphasis on thin-film electrodes, materials, and devices. His current research focuses on the development of multielectrode arrays based on amorphous silicon carbide and the application of ultra-microelectrodes as neural interfaces for the brain and peripheral nerve. Prior to joining the UT Dallas, Dr. Cogan was Vice President and Director of Advanced Materials Research at EIC Laboratories. Dr. Cogan received a B.Sc. degree in mechanical engineering and a M.S. degree in materials science from Duke University in 1975 and 1977, respectively. He obtained a Sc.D. from the Massachusetts Institute of Technology (MIT) in 1979. Dr. Cogan was a Visiting Assistant Professor in Mechanical Engineering and Materials Science at Duke University from 1979 to 1980, where he worked on amorphous semiconductor materials for solar cells. He returned to MIT as a Research Associate in 1981. His research at MIT focused on micro-filamentary, metal matrix composites for compound superconductors. In 1983 he joined EIC Laboratories. His research interests have included thin-film electrochromics for optical switching devices and coatings, materials for encapsulating implanted medical devices, and thin-film electrode materials for stimulation and recording in prosthetic and pacing applications.

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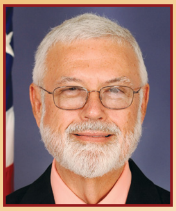
Speakers for the 2020 TechCon

Additive Manufacturing (AM): Towards Realizing AM's Full Potential

William E. Frazier *President, Pilgrim Consulting LLC , Lusby, MD*

Additive manufacturing (AM) is a rapidly emerging and continuously evolving technology. It has already significantly impacted the manufacturing community enabling low volume production of commodity parts, where and when they are needed. However, the high cost and time associated with AM process qualification and component certification have significantly impeded the widespread use of AM metallic parts used in critical applications. In this presentation, the need to shift from the conventional statistically substantiated means of qualification to a probabilistic means utilizing both machine learning and Integrated Computational Materials Engineering (ICME) will be explored. Further, attention will be given to the importance of surface condition and post AM fabrication processing on component fatigue life.



Dr. William E. Frazier, "Pilgrim," founded Pilgrim Consulting LLC following a 39-year long career with the Department of the Navy. He serves as the President and Principal Consultant of the company which specializes in Technology Transfer, providing "Expert Advice and Pathfinding Strategies." Discipline areas include Strategic Planning, Materials Science & Technology, and Additive Manufacturing.

Dr. William E. Frazier received his BS, MS, and Ph.D. degrees in Materials Engineering from Drexel University. He is a graduate of the Naval Aviation Executive Institute's Senior Executive Management Development Program, and the Defense Systems Management College's Advanced Program Management Curriculum.

Dr. Frazier has 39 years of naval aviation materials engineering and science experience. He was inducted into the Department of Navy's Executive Core in July 2005 where he served as The Navy Senior Scientist for Materials Engineering, and the Chief Scientist of the Air Vehicle Engineering Department at NAVAIR. Dr. Frazier provided technical direction and developed strategic plans for the research, development, and transition of naval aviation technologies. He served as the Command's primary scientific advisor and consultant in the discipline of materials science and was responsible for performing, stimulating, planning, coordinating and reviewing the scientific value of RDT&E of all materials and processes. Dr. Frazier served as NAVAIR's Additive Manufacturing (AM) Technology Lead focused on accelerating the deployment of AM technology and overcoming the challenges associated with achieving rapid, low cost AM process qualification and part certification. A significant milestone was achieved in July 2016: the Ti-6Al-4V AM V22 Osprey Nacelle Link became the Navy's first Safety Critical metallic AM component to be certified and flown.

Dr. Frazier served as head of NAVAIR's Metals, Ceramics, and Nondestructive Evaluation Competency from 1995 to 2005. In that capacity, he was the NAVAIR authority responsible for safety-of-flight issues involving metals, ceramics, and NDE. Dr. Frazier is a recognized expert in (i) additive manufacturing technology, (ii) materials selection, qualification and certification, (iii) materials processing, (iv) aircraft durability technologies, (v) strategic planning, and (vi) nanotechnology. He has authored more than 100 technical publications, edited 6 books, and holds two U.S. Patents. Dr. Frazier is an ASM Fellow, a NAVAIR Esteemed Fellow, and a Fellow of Alpha Sigma Mu. He served as the 2017 President of ASM International and as a Board Officer from 2016-2018. Prior to that, he served as a Trustee of ASM International (2003-2007). Dr. Frazier is an Associate Editor for the Journal of Materials Engineering and Performance, a Key Reader for Materials Transaction A, and a member of the Journal of International Materials Reviews' Committee.

Covid19 Pandemic and the Impact on the U.S. Economy

Debra Anne Haaland *U.S. Representative, 1st Congressional District, New Mexico*

The Covid19 pandemic and the resultant impact on the US economy represents the once in a lifetime "perfect storm" that touches all aspects of society, technology, and business. Debra Anne Haaland (born December 2, 1960) is an American politician serving as the U.S. Representative from New Mexico's 1st Congressional District. The district includes most of Albuquerque along with most of its suburbs. Deb Haaland is a former leader of the Democratic Party of New Mexico; she and Sharice Davids are the first two Native American women elected to the U.S. Congress and is also a member of the Laguna Pueblo people. Congresswoman Deborah will address the SVC on how the fundamental nature of government and our interaction with government has changed as a result of Covid19. As a pioneering climate change activist in the U.S. House of Representatives, Deb will also share her thoughts and ideas on the importance of embracing a robust program to address an issue that will define our society in the very near future. The SVC is honored to have secured Deb Haaland to share a unique perspective on such critical topics with all our stakeholders!

Debra Anne Haaland (D-NM)
U.S. House of Representatives
https://haaland.house.gov/

For more information, contact the SVC at 505-897-7743 or CLICK HERE to submit an abstract

Introducing the SVC's Don Mattox Tutorial

Superconductivity: From Discoveries to Thin Film Devices

Larry Scipioni *PVD Products, Wilmington, MA*

At a scientific meeting in 1911, Kamerlingh Onnes described the resistance behavior of mercury near liquid helium temperatures. He reported that "the resistance diminished very rapidly and disappeared at 4°,19K." The abrupt transition was not in accord with any of the existing theories of low-temperature electrical properties of metals, and ongoing efforts to explain this in the 10,000+ materials which exhibit it has led to much interesting 20th century physics.

At a scientific meeting in 1987, Mueller, Tanaka and others reported the observation of high temperature (high-Tc) superconductivity in Lanthanum Barium Copper Oxide at a temperature 13°C above the liquid nitrogen boiling point. One attendee reported to us the excitement in the air and the overflowing crowd pouring out into the hallway, staying until 3 AM to hear the results (you can experience this "Woodstock of Physics" yourself on YouTube!) These perovskites have sparked great imaginations ever since, with thoughts of applications ranging from lossless utility grids to levitating cars. Although Bednorz and Mueller used liquid phase methods to prepare polycrystalline films, high-Tc superconductivity was demonstrated that same year in Yttrium Barium Copper Oxide (YBCO) films deposited epitaxially by pulsed laser deposition, which actually produced higher quality material.

At this tutorial we will continue the story, discussing the physics, technology, and applications of thin film, high-Tc superconductor electrical carriers, grown entirely or partly by physical vapor deposition. Since YBCO is a ceramic, it cannot be worked or drawn into wires nor can it be flexed. However, in thin film form on a flexible metal tape, it can be bundled into cables or wrapped into magnet coils. And reel-to-reel coating processes can be utilized for scale-up, similar to web coating applications. Several buffer layers are required to obtain ordered YBCO films, making for multiple process steps. There are also a variety of techniques employed to deposit the actual superconducting layer, each method bringing its own advantages and issues. All these technical issues are interesting in their own right, and they also influence the suitability of each manufacturer's product for various applications. Large current capacity cables, high efficiency motors, and high strength magnets are all developed with this technology. And although flying cars are not on the high-Tc technology roadmap, applications such as compact fusion reactors are poised to drive this industry toward high volume scale-up.

Dr. Scipioni's career has been in research and development for the capital equipment space for 24 years. He has served as Chief Technology Officer at PVD Products since 2017, supporting instrument design, research, product development, customer applications and marketing strategy. PVD Products has provided about 15 tools for superconducting tape development and production. Prior to PVD he worked in the analytical equipment business, specifically in electron and ion microscopy. At the FEI Company (now Thermo-Fisher Scientific) he developed advanced charged particle source and optics technologies for next-generation ion and electron microscopes. His work on DARPA, NIST and SEMATECH programs for plasma and gas-field ion sources led to the development of new product categories including the Plasma-FIB and helium ion microscope. He later worked at Carl Zeiss Microscopy developing and promoting applications of that technology in semiconductors, material science, biology, and nanotechnology. Dr. Scipioni completed his Ph.D. in Physics at New York University in 1996, working on experimental surface science studies of magnetic oxide thin film growth and characterization. He also completed a Master of Business Administration in 2004.

2021 TechCon | May 1 – May 6, 2021

Invited Speakers

SVC TechCon 2021

In addition to the 2021 SVC TechCon Symposium on Thin Film Solutions for a Sustainable Future, the SVC is inviting contributions in the following areas. Each area is organized by a Technical Advisory Committee (TAC) or Session Organizing Committee.

Sustainability In A Rapidly Changing World

Simplistically speaking, sustainability is a highly complex concept that occupies an ever growing portion of the global "consciousness". "Sustainability" as a discrete concept is almost fifty years old and was first detailed in 1971 in *The Ecologist's A Blueprint for Survival*. The quest to make modern civilization 'sustainable' inspired the UN's Stockholm Conference in 1972 and formed the basis of "global trusteeship" that has served as the foundation of almost all subsequent international environmental treaties. The most quoted definition of sustainability comes from the UN World Commission on Environment and Development: "***sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.***"

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INVITED SPEAKER:

Sustainability in a Rapidly Changing World

Marc Landry
National Renewable Energy Laboratory,
Golden, CO

The world population is predicted to hit 10 billion people by 2050. That is less than 30 years, or one working generation away. How anyone can possibly think that this type of exponential growth, with the key word being "growth" can continue on into the future with no effect on future generations and quality of life for most humans is shear madness and magical thinking.

The reality of the situation is that the flawed concept of continued exponential growth of humanity, as well as runaway industrial growth feed the ever expanding masses and to fund exorbitant lifestyles for too few is nothing more than a Ponzi scheme to finance today's lifestyles with future resources and human capital, at the expense of future generations.

The inevitable transition toward policies and economic models for more sustainable goods and services, as well as continued innovative technological discoveries will enable us to wean the human race off of our current insatiable diet of limited and polluting natural resources, toward more resilient and sustainable populations and societies with new and innovative ways to use and reuse our existing resources.

Where an antiquated technology becomes obsolete, new sustainable technologies arise to fill that void, opening up many opportunities for industry and innovation, providing a means of viable employment and wealth for humanity as well as a meaningful quality of life for all.

As with any correction in an existing system, there may be a period of disruption, but the pain can be minimized by using our big human brains to capitalize on humankind's innate ability to work together to survive and thrive into the future as a species where all can enjoy the fruits our beautiful blue planet can give us.

Symposium Co-Chairs:
Kurt Lesker IV, *Kurt J. Lesker Company,* Kurtiv@lesker.com
Chris Stoessel, *Eastman Chemical Company,* stoessel@attglobal.net

Additive Manufacturing

Additive Manufacturing (AM) is a revolutionary set of near-net-shape manufacturing technologies. Many different manufacturing methods have been established, from powder sintering, plasma jet deposition, extrusion, screen/ink-jet/aerosol printing, to just name a few. However, recent, accelerated widespread industrial adoption

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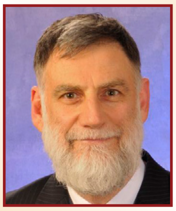
of AM represents a significant milestone. The research and development of AM has moved the industry from polymeric prototyping of complex parts to the application of structural metallic and composite components with complex geometries that cannot be produced by forging or casting. Two areas of increasing importance are the application of AM to produce unique bio-mechanical devices of complex structures and materials, and flexible electronics. Electronic circuits can be printed (rather than etched/reductively manufactured); enabling them to flex and stretch.

There are several intersections between AM and the surface and coatings industry that are of common interest to researchers and practitioners of these communities:

- AM components often require surface treatments to achieve their final functionality, and optimizing the overall design and manufacturing process that utilizes the appropriate choice of the wide range of coating and surface modification processes will ensure improved outcomes
- AM components frequently exhibit interfaces between similar or dissimilar materials, and proper interface and surface engineering are essential to successful component functionality
- Plasma-based processes are eminent in many AM manufacturing methods, and many process/structure/property interactions have been extensively studied in the plasma surface treatment and coating fields
- AM also presents challenges to AM equipment suppliers as they expand the requirements of reflective/transmissive/focusing optics for laser/electron beam generation, direction and control. As the AM platform expands into more complex alloys and metals the duty will fall on the optical coating, laser and electron beam manufacturers/suppliers to keep pace with industrial demand

This session/TAC seeks to bring together experts from the AM and thin film/surface engineering communities to discuss challenges and possible solutions in common areas of interest in an effort to further the successful adoption of AM in industrial applications by leveraging the deep knowledge that resides in the surface engineering and thin film coating community. Contributions that highlight particular challenges or constraints as well as talks that highlight key operating principles of AM and their relation to coating and surface engineering aspects are particularly welcome in the interest of encouraging lively discussions.

INVITED SPEAKERS:



Surfacing Matters: Manufacturing Thin Coatings by Thermal Spray Methods

Christopher C. Berndt, A.S.M. Ang
Swinburne University of Technology, Melbourne, Australia

Thermal spray processes fall under the umbrella of additive manufacturing. These coatings function under harsh environments; e.g., high temperature, aggressive wear, and corrosion within applications such as power generation, the transportation industries, petro-chemical plants and bioengineering. This presentation focuses on the microstructural nature of thermal spray coatings and how the materials engineering design of future applications is driving fundamental R&D.

Furthermore, recent advances to commercialise thin thermal spray coatings that are manufactured under ambient atmospheric conditions will be described. The goal is for thermal spray to enter new markets; e.g., sensors, hydrophobic/hydrophilic films, electronic circuits etc., and other endeavours that are on the near-term horizon.

High-Rate Printing of Nano and Micro Electronics and Sensors

Ahmed Busnaina
Northeastern University, Boston, MA; Chief Technology Officer and Founder, Nano OPS, Inc., Newton, MA

We introduce a new additive manufacturing technology for making nanoelectronics that is estimated to cost one to two orders of magnitude less than the current conventional semiconductor manufacturing. This is largely accomplished by reducing the initial cost of infrastructures but also by drastically cutting the operating cost by significantly reducing the power requirement and very little water or chemicals use. This new disruptive technology will enable the fabrication of nanoelectronics while reducing the cost by 10-100 times and allowing device designers the use of any organic or inorganic semiconducting, conductive or insulating material on flexible or rigid substrates. This will allow industry to leverage novel properties of nanomaterials such as two-dimensional (2D) materials, quantum dots, nanotubes, etc. The new technology is enabled by directed assembly-based nanoscale printing at ambient temperature and pressure and can print 1000 faster and 1000 smaller (down to 20nm) structures than ink-jet based printing. The nanoscale printing platform enables the heterogeneous integration of interconnected circuit layers (like CMOS) of printed electronics and sensors at ambient temperature and pressure. The directed assembly-based printing processes were specifically created to be scalable, sustainable and designed to enable precise and repeatable control of assembly of various nanomaterials at high-rate. The new technology has demonstrated the printing of several devices including transistors, inverters, diodes, chemical and biosensors, and interconnects using a variety of nanomaterials at the nano and microscale.

TAC Chairs:
William Frazier, *Pilgrim Consulting,* frazierwe@pilgrim-consulting.com
Dean Plaisted, *Junora Ltd.,* dean.plaisted@junoraltd.com
Frederick E. Schmidt, Retired, drfeschmidtpe@gmail.com
David Sanchez, *Materion Advanced Chemicals*, david.sanchez@materion.com
Ric Shimshock, *MLD Technologies, LLC,* ricshimshock4mld@aol.com

Atomic Layer Processing (ALP)

Over the last few years, atomic layer processes (ALPs), such as atomic layer deposition (ALD) atomic layer etching (ALEt), molecular layer deposition (MLD), and atomic layer epitaxy (ALEp) have increased in importance, enabling many new products and applications. With excellent uniformity, nanoscale precision and high versatility, ALPs are finding applications in sensing, optical coatings, energy storage, and microelectronics. Recent advances in low temperature processing makes ALP methods attractive to the processing of polymers, biomaterials, and other applications with low thermal budgets.
We are soliciting oral or poster contributions to the ALP session in areas including both established ALP technologies and creative new developments in ALP technologies. Advanced ALP technologies which successfully cross over from early-stage feasibility studies into commercially viable industrial solutions are also of interest.
Topics of this session will include:

- Fundamental aspects of atomic layer processing (ALP)
- Plasma-enhanced processes
- Challenges and applications of ALPs
- Novel concepts and technologies for ALP process control, monitoring and thin-film characterization
- Modelling of ALPs and ab-initio calculations enabling their design and understanding
- Innovations in methods and progress in up-scaling of ALPs towards high-volume industrial applications
- Creative new business concepts or market perspectives that accelerate transfer of ALP technologies from lab-scale to commercial viability

INVITED SPEAKER:

Elucidating the Mechanisms for Atomic Layer Growth through In Situ Studies

Jeffrey Elam
Argonne National Laboratories, Argonne, IL

Atomic Layer Deposition (ALD) provides exquisite control over film thickness and composition and yields excellent conformality over large areas and within nanostructures. These desirable attributes derive from self-limiting surface chemistry, and can disappear if the self-limitation is removed. Understanding the surface chemical reactions, i.e. the ALD mechanism, can provide insight into the limits of self-limitation allowing better control, successful scale up, and the invention of new processes. In situ measurements are very effective for elucidating ALD growth mechanisms.
In this presentation, I will describe investigations into the growth mechanisms of ALD nanocomposite films comprised of conducting (e.g. W, Mo and Re) and insulating (e.g. Al_2O_3, ZrO_2 and TiO_2) components using in situ measurements. These ALD nanocomposites have applications in particle detection, energy storage, and solar power. We have performed extensive in situ studies using quartz crystal microbalance (QCM), quadrupole mass spectrometry (QMS), Fourier transform infrared (FTIR) absorption spectroscopy, and current-voltage measurements. These measurements reveal unusual ALD chemistry occurring upon transitioning between the ALD processes for the two components. This results in unique reaction products that affect the properties of the films in beneficial ways. The knowledge gained from our in situ studies of the ALD nanocomposite films has helped us to overcome problems encountered when we scaled up the ALD processes to large area substrates. Beyond fundamental understanding, in situ measurements are extremely effective in ALD process development and process monitoring. I will end my talk by describing our recent work combining in situ measurements and machine learning to accelerate ALD process development.

TAC Chairs:
Lenka Zajíčková, *Central European Institute of Technology, Masaryk University, Czech Republic,* lenkaz@physics.muni.cz
Scott Walton, *US Naval Research Laboratory,* scott.walton@nrl.navy.mil
Craig Outten, *Universal Display Corporation,* coutten@verizon.net

Coatings and Processes for Biomedical Applications

As medical device manufacturers are pressed to design ever-smaller devices with increased longevity, optimizing the performance and profile of each component becomes more crucial. Consequently, electrode coatings and surface solutions have been the focus of many device and component manufacturers in the cardiac rhythm management, electrophysiology, neurostimulation, and cochlear sectors. With the overall objectives of improving biocompatibility, surface area, electrical conductivity, and electrochemical performance, thin films and coatings have gained significant attention in these markets. For example, electrodes with enhanced surface properties for cardiac pacing, sensing and recording applications or electrodes connecting brain and machine have demonstrated significant promise.

In all applications of implantable electrodes for these devices, improving the coupling of electrical charge and electric field between the biological system and the underlying electrode is extremely important so that electrodes are effective and can be miniaturized to eliminate problems associated with size, scar tissue, increased trauma, longer healing times, and system rejection. Many coating and thin film systems such as platinum group metal alloys and oxides, high surface area TiN coatings, etc. (primarily synthesized and deposited using physical vapor deposition methods), are aimed at the improvement of the charge coupling and therefore, enhancing information exchange between the biological fluid and the electrode.

Real-time medical data recording, real-time physician engagement and active feedback control of biomedical systems is exceedingly crucial nowadays since they would cover extended monitoring of disorders, pain management, neurostimulation, and other disorders. The use of novel coatings and surface solutions provides benefits in these device platforms through enhanced electrochemically active surface area that has become increasingly crucial in advanced devices benefiting from various platforms such as flexible electronics, wireless sensor platforms, intelligent data infrastructure, and embedded systems.

Topics of interest for this session include but are not limited to:

- Coatings on implants
- Coatings for biosensors
- Coatings for cardiac and neurostimulation sensors
- Coatings for cardiovascular intervention
- Bio-corrosion and osseointegration
- Antibacterial and antiinflammation coatings
- Treatment of biological surfaces/tissues
- Coatings for medical instrumentation and tools
- Atmospheric Pressure Plasma in biomedical applications
- Standardization and biocompatibility

INVITED SPEAKER:

Reactively Sputtered Coatings for Bactericidal and Other Implantable Biomedical Applications

Jeff Hettinger
Rowan University, Glassboro, NJ

Infections from bacteria are a major medical issue impacting 2.8M patients and resulting in 35,000 deaths annually. Implanted orthopedic device related infections are prevalent. Elective surgeries for joint replacements result in 0.7% to 4.2% infection rates but given the large number of approximately 1M implants annually, this results in more than 24,500 device related infections in the United States. The number of this type of procedure in the United States is expected to increase to 4M by 2030. Infections often require hospitalization, revision surgery, or amputation and can result in sepsis leading to death. Orthopedic trauma cases requiring the use of intramedullary nails result in higher infection rates from approximately 1% for closed fractures up to 30% for open fractures. The development of antibiotic resistant bacteria stemming from misuse of pharmaceutical antibiotics amplifies these issues. Non-pharmaceutical solutions to address the large numbers of infections are needed.

Bactericidal elements including copper, silver, zinc and others, have been considered as an alternative to antibiotics. Ions of these elements interact with individual bacteria cells to damage the cell wall changing the cell morphology introducing ruptures and cracks leading to their demise. A single ion-single bacterium interaction leads to the killing of bacteria. This simple notion suggests that the bactericidal ions must outnumber the bacteria cells to be fully effective.

In the past, silver has been demonstrated to be effective killing bacteria in the laboratory. However, when implanted, the complex nature of the human chemical system reduces the number of available silver ions, and therefore, the bactericidal effectiveness of the pure silver and silver nanoparticles. An active infection can be thought of as 104 or more colony forming units multiplying exponentially in the so-called "logarithmic" phase. Low solubility elements result in a shortage of bactericidal ions which results in the potential to develop resistant bacteria. We present detailed work on the development of silver oxide coatings using reactive sputtering.[4] These coatings have been demonstrated to be effective as a broad-spectrum bactericidal coating. The presentation will highlight important characteristics and measurements which verify the coating efficacy.

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Coatings for Energy Conversion and Related Processes

The Coatings for Energy Conversion and Related Processes Technical Advisory Committee (TAC) welcomes papers in the following areas:

Solar and Ambient Light Energy Conversion:

- Thin-film and thin wafer photovoltaics
- Organic flexible photovoltaics (OPV)
- Semi-transparent photovoltaics
- Coatings for improved performance

Energy Harvesting:

- RF Harvesting
- Piezoelectrics
- Kinetic harvesting through body movement

Energy Storage:

- Thin flexible batteries
- Conformal batteries
- Coatings for improved stability
- Graphene and carbon nanotubes
- Protective coatings

Efficient Functional Coatings:

- Radiative cooling
- Hydrophobic and hydrophilic
- Self-cleaning catalytic coatings

Business Topics:

- Market assessment
- Advanced manufacturing processes
- Integration of functional coatings into wearable products

Other traditional subjects of the Coatings for Energy Conversion and Related Processes TAC will be considered including:

- Smart windows
- Selective radiators
- Fuel cells
- Large-scale energy conversion and storage

INVITED SPEAKER:

The Intriguing Formation of the SEI on Negative Electrodes in Batteries

Kristina Edström
Department of Chemistry – Ångström Laboratory, Uppsala University, Uppsala, Sweden

Important and critical reactions take place on the electrode surfaces and at interfaces to the electrolyte in Li-ion and Na-ion batteries. The operation voltage of these electrodes is typically close to or even outside the thermodynamic stability window of the electrolyte, which leads to electrolyte decomposition even with the use of organic electrolyte solvents. For Li-ion batteries, this process is self-limiting on the negative electrode as reduction of the electrolyte solvents and salts forms a passivating layer. This is the layer is called the solid electrolyte interphase (SEI). This interphase is at a certain thickness passivating for electrons to tunnel through it but still ionically conducting for lithium or sodium ions. It is hence essential for the prevention of extensive and continuous electrolyte decomposition. On the positive electrode, oxidation of solvents, decomposition of the electrolyte salt, and dissolution of metal ions from the electrode material may decrease battery performance. Altogether, the properties of interfaces and interphase layers in Li-ion and Na-ion batteries influence to a large extent, parameters such as safety, capacity loss, rate capability, and cycle life.

Photoelectron spectroscopy (PES) is a widely used technique to study surfaces and interfaces in batteries because of its sensitivity to chemical environments/chemical shifts and as a technique to study the redox state. PES provides information on elemental compositions, relative amounts, and the depth distribution of the species analyzed.

In this presentation, the possibility to follow the formation of the SEI is discussed as new techniques such as ambient pressure XPS are developed. Model systems are investigated and as a background to understand the results a description of how to assess XPS peak positions which shift due to SEI formation. The impact on peak positions caused by changing electrode potentials were using a model system consisting of a mixture of $Li_4Ti_5O_{12}$, carbon coated Li_2FeSiO_4, carbon coated $LiFePO_4$, $LiMn_2O_4$, Carbon black, and PVdF-HFP binder. Also, standard $LiMn_2O_4$ and nano-Si electrodes were analyzed to demonstrate changes to the spectra caused by changing Li content (state of charge).

The results show that components in the SEI have a significantly different binding energy reference point relative to the bulk electrode material (i.e., up to 2 eV). It is also shown that electrode components with electronically insulating/semiconducting nature are shifted as a function of electrode potential relative to highly conducting materials. Further, spectral changes due to lithiation/sodiation are highly depending on the nature of the active material and its lithiation/sodiation mechanism.

Correct interpretations of peak shifts are necessary for correct data interpretation but even more important is the information the peak shifts can provide about double layers at buried interfaces within the electrode. Considering battery operation, it should be noted that the presence of a double-layer potential drop at an interface between different battery components will influence the (de)lithiation kinetics because it may act as a barrier for Li-ion or Na-ion insertion/extraction depending on the dipole orientation.

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Communication 2030

It's all about communication. Our desire to communicate more, with increased content and at faster speed drives the development of new infrastructure and device technologies. We are amid an explosion in data transfer: business-to-business, business-to-people, person-to-person, person-to-machine, and machine-to-machine. Trends in the type of data transferred will also drive device technology as consumers move more toward communication via mobile video. This trend is driving new technologies including 5G wireless communication, high-resolution miniature displays, smart manufacturing, driverless autonomous controls of machines and vehicles, real-time medical data recording, real-time physician engagement, active feedback control of biomedical systems, and the Internet of Things (IoT).

Many, if not all, of these advances are enabled by thin film technology. As a consequence, deposition, lithography, and characterization processes must evolve to make the vision of the future a reality. The requirement for additional miniaturization, to make devices more compact and energy efficient, will push the limits of traditional vacuum technologies and propel the adoption of advances such as high-power impulse magnetron sputtering (HIPIMS) and development of multi-frequency and voltage wave-form control in all the plasma processing methods. The sunset of Moore's Law will pull gas-based self-limited thin film technologies such as atomic layer deposition and etching further into the mainstream. Materials technologies which enable advanced heat transfer, energy storage, moisture resistance, electrochemically active/biocompatible surfaces, and optics will require continual development. The challenge of three-dimensional thin film device architectures will continue to drive the capabilities of thin film systems and device designers. These new challenges will also drive characterization technologies including interfaces, morphologies, crystal structure, thickness, resistivity, adhesion, and composition.

This session will spotlight advanced communication technologies that will support the explosion in data communication anticipated in the new decade. These alternative communication strategies include:

- 5G wireless networks and devices
- Holography
- Driverless "everything"
- Embedded systems
- Flexible electronics
- Internet of Things
- New semiconductor architectures
- Non-volatile memory
- Wireless sensor platforms
- Small high-resolution displays
- Intelligent data infrastructure
- Autonomous control of vehicles

These new communication technologies will drive advances in thin film materials, substrates, deposition processes, lithography, and additive manufacturing. These advances will trickle down into new requirements for vacuum systems, system design, and fabrication. With devices needing to be built on a molecular level, vacuum systems may have to be engineered to reach an extremely high vacuum with pressures at or below 10^{-11} Torr. It is an exciting and challenging time for vacuum enabled coatings. The advancement of many of these new technologies is dependent on robust, scalable processes which will push the boundaries of current capabilities. Presentations that focus on key new trends in communication technologies and the challenges and opportunities for the vacuum coating community in the next decade are eagerly solicited.

INVITED SPEAKER:

Miniaturization of Optical Sensors using Patterned Interference Filters

Georg Ockenfuss, Robert Sargent
Viavi Solutions, Santa Rosa, CA

The patterning of optical filters to enable sensors dates back more than 50 years. Today this technology serves numerous aerospace, industrial, automotive, medical and consumer electronics applications. One driver for patterned coatings is to reduce Packaging size. This can be achieved by either integrating multiple spectral filtering functions on one substrate or to coat directly onto the active photo sensing areas of CMOS wafers. Another reason is to reduce cost of the final product by reducing the number of components, and by simplifying the assembly. In some instances, better optical performance can be expected due to the reduction of the number of interfaces. We describe the historical development of patterned optical filters, provide an overview of the process flow, production processes and the related challenges. We will discuss the following applications: Ambient light and color sensors for consumer electronics, continues glucose monitoring and multispectral sensing.

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Emerging Technologies

Technology is the greatest agent of change in the world today. The Emerging Technologies session is the forum for boosting technological breakthroughs, technical innovations, new application trends, and visions in the thin-film coating industry. Such trends, which represent progressive developments within a field for competitive advantage, may be either the application of established coating technologies in innovative ways to expand into new applications, or creative new developments in coating technologies that overcome long-standing roadblocks in the industry. Technologies which successfully cross over from early-stage feasibility studies into commercially viable industry solutions are the primary focus of this session. Supporting business topics are also welcome.

Topics of strategic interest for the Emerging Technologies session are:

- Economically viable alternatives to classic transparent conducting oxides (TCOs), and resulting thin film device architectures, e.g. graphene, new metal oxides, other transparent conductive materials, wide band gap semiconductors, amorphous semiconductors
- High-performance electronics on flexible transparent substrates and roll-to-roll processing, including material science, e.g. on flexible glass, polymers, metal foils.
- New thin film concepts that allow the combination of previously incompatible material properties, such as meso- and metamaterials, or phase changing materials
- New concepts and technology development for thin film coating, refinement, treatment and modification of surfaces that enable revolutionary performance improvements in active or passive devices such as photovoltaics or electronics, e.g. annealing processes by e-beam, flash lamp annealing or by laser
- Progress in integrating previously incompatible processes at scale, for example, the advancement of incorporating thin films into printed flexible electronics
- Innovations in methods for the in-situ characterization of thin film properties
- Creative new business concepts or market perspectives that accelerate or de-risk transfer of new thin film technologies from lab-scale to commercial viability
- Advanced thin-film processing and applications for communication technology, biotechnology, nanotechnology, energy harvesting, energy storage, and energy conversion

We welcome contributed talks and posters for these and other areas, and always consider new and innovative topics that advance the use of thin film processing in advanced technology applications.

INVITED SPEAKER:

The Emerging World of Flexible Hybrid Electronics

Art Wall
NextFlex, San Jose, CA

Emerging technologies in today's electronics industry continue to evolve rapidly. A new class of electronics that is enabling new applications and form factors is Flexible Hybrid Electronics (FHE). Flexible circuits are common, but in our case conductive traces are printed on flexible plastic substrates with a wide variety of methods, including screen printing, ink jet, aerosol jet and gravure offset. While these print methods may be well known, the methods and materials used for electronics applications are new and highly dependent on the desired outcome. The "hybrid" of FHE is defined by leveraging the best of commercial integrated circuits at the wafer level after thinning them so the chip becomes flexible (<50um). Chips are attached directly to the printed circuits to make unique devices that can be prototyped rapidly and enable new applications. In nearly all cases, we are dealing with new materials or at least new interfaces between flexible plastic substrates, new or repurposed adhesives, and electronic components. The applications are far reaching and include aerospace, automotive, asset monitoring, medical devices and more. NextFlex leads more than 100 members of its consortium, working collaboratively to mature this new breed electronics fabrication into manufacturing jobs in the US.

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HEURÉKA! Recent Developments

The HEURÉKA! session is an excellent opportunity for introducing and presenting the latest knowledge and experience, inspiring ideas, development and stimulating achievements in coating technologies. It is an important forum for presentation of the "hot-off-the-press" achievements delayed due to patenting procedures, specific business strategy, etc.

Topics in the HEURÉKA! program are usually diverse, which always stimulates inspirations and interesting discussions. There are no invited papers, because all presentations are welcomed on equal basis. However, the total number of presentations is limited. **Abstracts to the HEURÉKA! session can be submitted through January 31, 2021,** after the general abstract submission deadline. We are looking forward to receiving your contributions. *Please understand that space is limited in this session and not all submissions will be guaranteed an oral presentation. For those presentations impacted by space/time in the main session, an opportunity to participate in the TechCon's poster session will be afforded.*

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High-Powered Electron Beam Technology

The High-Powered Electron Beam Technology Technical Advisory Committee (TAC) is a spin-off from the International Conference on High-Powered Electron Beam Technology, originally founded by Dr. Robert Bakish in 1983. Today, high-powered electron beam technology is well established for coating, melting and welding. The focus of the TAC is the development of new coatings and coating processes utilizing high-powered electron beam technology as well as new ebeam guns, power supplies and beam guidance systems for improved materials properties. Of particular interest are improvements to equipment that enable new applications such as additive manufacturing of turbine engine components and medical implants.

For more information, contact the SVC at 505-897-7743 or CLICK HERE to submit an abstract

The TAC supports the technical and technological exchange of knowledge to promote high-powered electron beam technology for industrial applications and is looking for papers on the topics listed below:

- Advances in high-rate PVD by electron beam evaporation for thermal barrier coatings
- Electron beam processes for the production of novel materials
- Additive manufacturing with electron beam
- New applications for PVD by electron beam evaporation for photovoltaics, concentrated solar, energy production (fuel cells), energy storage (batteries) and high efficiency lighting
- Modelling of electron beam sources, processes, and systems
- New components in electron beam technology (guns, power supplies, vacuum systems, plasma assist)
- Emerging technologies (electron generation, beam guidance, etc.)
- Related and new applications for high-power electron beams

INVITED SPEAKER:

Gas Discharge Electron Sources – Powerful Tools for Thin-Film Technologies

Burkhard Zimmermann, Goesta Mattausch, Fred Fietzke, Bert Scheffel, Jens-Peter Heinß, Michiel Top, Christoph Metzner
Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP, Dresden, Germany

Highly productive substrate pre-treatment, coating, and post-treatment methods are required to combine versatile and environmentally-friendly physical vapor deposition (PVD) processes in vacuum with economic demands. Electron beam (EB) technologies are very promising to address these requirements. This talk gives an overview of various types of electron sources which are in use at FEP for different steps along the process chains in thin-film technology, and which are based on the generation of free electrons by gas discharges.

Compact low-voltage electron beam (LVEB) sources based on hollow-cathode arc discharges have proven their value in diverse applications, mostly in plasma activation of high-rate PVD. The latest generation of these plasma sources with magnetic enhancement allows for creating high-power plasmas with high and smoothly distributed ion densities in large volumes. This, for example, enables high etching rates during sputter cleaning of substrates as highly efficient and fast inline pre-treatment prior to coating. Furthermore, new high-rate deposition methods as, e.g., the hollow-cathode arc PECVD of carbon or silica-based coatings, and also advanced process control techniques based on the optical emission of the hollow cathode discharge could be developed.

High-voltage glow-discharge EB sources with cold cathodes have previously been reported to provide an economically attractive alternative to conventional thermionic electron beam guns. In this paper, a new type of a discharge-based EB source with "hybrid cathode" will be discussed. It combines the simplicity of cold-cathode devices with beneficial performance parameters reached so far with traditional thermionic electron sources only. This regards, for instance, the higher power density in the focal spot and the higher acceleration voltage.

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High Power Impulse Magnetron Sputtering – HIPIMS

High Power Impulse Magnetron Sputtering (HIPIMS) has moved from lab scale to industry. Today, a significant number of industrial-scale HIPIMS processes exist as well as some commercial processes and products. Both fundamental understanding and application-oriented development are essential for exploiting the full potential of this technology.

The latest results from fundamental research, new and advanced approaches for simulation and modeling, and the combination of applied research from lab scale to industrial size cathodes and machines are the focus of this TAC. The session aims to provide a forum linking scientists, technologists, and industrialists to discuss all aspects of the HIPIMS technology.

Papers are solicited, but not limited to, from the following areas:

- Fundamental research on plasma, discharge, and coatings
- Simulation and modeling of HIPIMS
- New plasma sources and process modifications
- Recent development in pulse generation and process and plasma diagnostics
- Application oriented results: tribological, optical, medical, etc.
- New coatings and products

INVITED SPEAKER:

Thin Films for Green Hydrogen Production by PEMWE: An Outlook for HIPIMS Technology Benefits into Bipolar Plates Protection

Lucia Mendizabal
K4-Tekniker, Eibar, Spain

Green hydrogen production by polymer electrolyte membrane water electrolysis (PEMWE) from surplus intermittent renewable energy sources (RES) and water is currently one of the main suitable alternatives for large and long-term energy storage known as Power-to-H_2, that can later be re-converted back to electricity by a polymer electrolyte mebrane fuel cells (PEMFC) closing the loop of power-to-power (PtP).

Even if not the most efficient solution of PtP sector, the conversion of electricity into H_2 by water electrolysis is expected to emerge as a promising solution for energy storage beyond PtP, since H_2 can act as a cross energy vector for sector coupling, enabling large amounts of renewable energy to be transferred from power sector to end-use sectors (transport, industry, buildings…) further contributing to decarbonization.

PEM water electrolysers are today a technological reality at small scale, but to become a relevant technology for energy storage further developments are a must in terms of enhanced performance and durability and cost reduction. Bipolar plates (BPPs) are the most expensive PEMWE stack components, accounting for > 40% of the total costs, depending on the selected cell design. Titanium is currently considered the best BPP material for PEMWE, particularly on the anode side where high overpotential (1.6-2.0 V) are combined with low pH (2-5) in an oxidizing atmosphere. However, passivation (ICR increase and cell efficiency reduction) of titanium on the anode side and hydrogen embrittlement (mechanical degradation) on the cathode side severely reduced the durability and performance of the PEMWE stack. In order to avoid this, BPPs have commonly been coated with PGM or Au coatings, which further increases BPP costs.

This presentation will describe current different coating solutions for BPPs for PEM water electrolyser and discuss about the recent developments of non-precious metal coatings by magnetron sputtering and HIPIMS techniques as a cost-effective and sustainable alternative for bipolar plates.

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Large Area Coatings

Large Area Coatings, generally considered to be on substrates or aggregates of substrates larger than one square meter, are found all around us in applications for communication, recreation, architecture, eyewear, lighting, entertainment, electronics, airplanes, aerospace, automotive and so on. The Symposium theme for our 2021 TechCon, "Thin Film Solutions for a Sustainable Future" is vitally important to the large area community. For example, how will the large-area, low-E community respond to developing coatings based on alternative materials with reduced environmental refining challenges? How will deposition processes be developed and scaled at the order of magnitude required for global scale energy storage? What are the challenges for improving the recycling potential of thin film coated products bringing greater value at lower cost to the marketplace?

Large Area manufacturing typically provides the benefits of low cost, high volume, excellent quality and low capital cost per unit yielded capacity. In 2021 the Large Area Technical Advisory Committee invites presentations in the following and related areas:

- "Thin Film Solutions for a Sustainable Future", including:
  - Battery technology (e.g. post-lithium),
  - Energy storage (hydrogen – from the cradle to the grave: generation, storage, fuel cells),
  - Life cycle management,
  - Replacing/substituting limited raw materials as well as materials whose refinement poses environmental challenges,
  - Solutions for recycling costly materials,
  - CO_2 footprint reduction in mobility and transportation,
- Communications and Displays
  - Touch screen, cell phone and other active display applications
  - Semiconductor deposition and fabrication
- Architectural and Automotive thin film materials, processes, equipment and applications including:
  - Low-emissivity, absorbing and reflective architectural coatings
  - Electrochromic and other smart window coatings
  - Transparent conductor, anti-reflection and mirror coatings
  - Temperable and bendable coatings
  - Windshield coatings (heat reflecting, hydrophobic/hydrophilic)
  - Antennas, including fractal circuits
  - Surface modification coatings: friction-reducing, wear-resistance, chemical-resistance, thermal control, anti-reflection, mirror and barrier coatings
  - Decorative coatings for automotive reflectors, trim etc.
- Green/alternative energy applications including:
  - Thin film photovoltaic and semiconductor materials

INVITED SPEAKER:

Structural Colors and Flexible Transparent Conductors Enabled by Thin Film PVD Technology

Chengang Ji, Cheng Zhang, L. Jay Guo
The University of Michigan, Ann Arbor, MI

Structural colors have shown great promise as an alternative for the existing colorant-based pigments owing to their noticeable advantages, such as high brightness, durability and stability, and environmental safety. They may find potential applications in energy-efficient displays, high-resolution imaging, special effect coatings, and building-integrated photovoltaics. The structural colors can be produced by exploiting optical resonances in various resonators, which can be either 3D, 2D or 1D structures. To enable scalable manufacturing, layered structures can be designed, and can be easily made by additive deposition processes. A new type of flexible transparent conductor based on ultra-thin Ag film was demonstrated. It can be designed to have even greater transparency than the PET substrate itself. Such transparent conductors could find wide range of applications in flexible displays, touch screens and transparent EM shielding, and can be manufactured in large area format by industrial roll sputtering processes.

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Optical Coatings

Exciting developments in optical coatings are stimulated by the latest trends in optics, optoelectronics, photonics, optical data processing, mobile devices, displays, biomedical, sensors, energy and photovoltaics, architectural, aerospace, astronomical, and other technologies. The Optical Coatings sessions will bring together these different aspects for technical interchange in the field of optical interference coatings. To build a well-rounded Optical Coatings session, abstracts are solicited to cover topics including coating design, development of practical manufacturing techniques, characterization methods, and a wide range of applications. Specific areas may include:

- Application of Optical Coatings for mobile electronics (e.g. fingerprint sensors, cameras, displays, touch-screens, etc.).
- Performance enhancement through optical coatings (e.g. improved efficiency for solar cells)
- Coatings on sapphire, polymers or other special substrate materials
- Applications in non-traditional wavelengths, from EUV to IR (e.g. IR thermal imaging)
- Complex 3-D optical devices
- Coatings for LIDAR/Driverless vehicles
- Coatings for biomedical applications
- Optical coatings for energy control and solar power
- Optical coatings for laser applications, including femto-second laser
- Optical coatings for display, aerospace and integrated photonic device applications
- Novel optical coating materials, including metamaterials and metasurfaces
- New fabrication processes for optical coatings.
- Novel optical interference design software and design techniques.
- Production issues common to the industry - including lessons learned or serendipitous discoveries that came from problems or disasters
- Metrology of optical films (new instrumentation and software developments, in-line or in-situ approaches, etc.).
- Real-time process monitoring and control with optical coating processes
- Industrial scale-up

We will also have a special focus session featuring eye wear applications and solicit abstracts for the following related topics:

- Antireflection coatings on polymers
- New polymers for optical applications
- Optical coatings for multifunctional requirements (scratch resistance, anti-smudge, anti-fogging, anti-microbial…)
- Coatings and architecture for Smart Glasses, including layers for high-index glass used for augmented wearables
- Coatings for blocking and filtering in eyewear
- Optical characterization of coatings for ophthalmics
- Photochromics
- High-yield processes for mass production

INVITED SPEAKERS:

Quantitative Test Development for Optimizing Ophthalmic Coating Quality

Markus Grau
Rodenstock GmbH, Munich, Gemany

The ophthalmic market has seen substantial changes in recent years, regarding market share of substrate indices, diversity of consumer requirements and faster fulfillment of these requirements. These changes also placed higher demands on ophthalmic coatings in terms of individualization and robustness.

Introduction of new coatings especially on new substrates requires high testing standards to insure superior product quality throughout product lifetime. One of the challenges for coatings on plastic lenses are visible structural changes of the lenses often associated with humidity and temperature, called climate structures. Detailed experiments show that these obvious environmental influences humidity and temperature are not the most important root causes. Instead the interplay of UV light and oxygen proved to be crucial for climate structure emergence. Based on this, a model and a corresponding test were introduced, which illustrate the influence of UV light and oxygen on the formation of climate structures. Using this model and test, lacquer and AR Systems have been optimized for best climate stability. In order to ensure a reproducible production of these optimized layers, the special operating conditions of the plasma source were examined more closely. A correlation between plasma parameters and coating properties will be given.

Challenges for Optical Coatings in Global Markets: Consumer Electronics, Automotive and E-mobility

Steffen Runkel
Bühler Alzenau GmbH, Alzenau, Germany

Optical technologies continuously penetrate into our everyday life and enable new functionalities in consumer electronic devices, medical, industrial and automotive applications. Specifically optical sensors are a key enabling technology for new applications like self-driving cars, extended reality, mobile optical sensing and analytics.

The talk will focus on current and future challenges for optical thin film interference filters to match the technical and cost requirements while producing high volume. The combination of applying high precise and uniform thin film coatings on optical glass substrates or structured CMOS wafers at highest yields and lowest costs are mandatory.

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Plasma Processing

Plasma has the unique capability of providing a diverse and complex environment that has proven to be well-suited for a wide variety of industrial applications including anisotropic dry etching, surface chemical modification, magnetron sputter-deposition and plasma enhanced chemical vapor deposition (PECVD) of thin films and coatings. Nevertheless, the potential of plasma processing on an industrial scale can only be realized when basic material processing studies are accompanied by the understanding of plasma physics, plasma chemistry and the underlying mechanisms at the plasma-surface interface, developed through both modeling and experimental efforts. More recently, the plasma processing community is exploring exciting new opportunities involving atmospheric pressure discharges, micro-plasmas and pulsed discharges, plasma interactions with liquids, plasma-enhanced catalysis at surfaces and plasma processing of nanomaterials. These new developments along with the never-ending quest for improvement in long standing applications are the basis for an active plasma processing community engaged in the research of reactive plasma environments and exploration of new possibilities and applications.

Accordingly, the plasma processing chairs welcome papers of a fundamental and applied nature in the following topics:

- Plasma-enhanced physical or chemical vapor deposition and plasma-surface modification techniques
- Novel and emerging plasma processing methods such as the processing of nanoparticles and nanomaterials, plasma catalysis and the treatment of non-traditional materials including liquids.
- Development of plasma sources and related technologies (ex. power electronics) to enable both conventional and novel plasma processing techniques including those operating at or near atmospheric pressure
- Diagnostics (optical, electrical, particle, or systemic) applied to understand the plasma environment and plasma interactions with materials, along with techniques to improve diagnostics capabilities
- Modeling of gas-phase phenomena in plasmas, plasma-surface interactions, and plasma processing systems

INVITED SPEAKER:

Plasma Diagnostic: A Mandatory Step Towards a Better Understanding of the Plasma Polymerization Process

Damien Thiry
University of Mons, Belgium

Since the eighties, functionalized plasma polymer films have attracted considerable attention owing to their potential in a wide range of applications. For such materials, controlling the chemistry of the coatings by a clever choice of the process parameters represents the main challenge. Through the years, it became quickly obvious that, in view of the complexity of the growth mechanism, a fine control of the layers properties can only be reached by understanding, at a fundamental level, the mechanistic formation of the layers. In this context, a detailed comprehensive study of the plasma chemistry is therefore of crucial importance as the numerous interlinked chemical reactions occurring in the discharge govern the film properties. In this presentation, we review our recent efforts to contribute towards a better understanding of the plasma polymerization chemistry by using state-of-the-art diagnostic tools such as Mass Spectrometry and in-situ Fourier Transform Infrared Spectroscopy. In addition, we describe how theoretical calculations based on Density Functional Theory (DFT) can help for a better understanding of the acquired data.

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For more information, contact the SVC at 505-897-7743 or CLICK HERE to submit an abstract

Protective, Tribological and Decorative Coatings

The Protective, Tribological and Decorative Coatings Technical Advisory Committee (TAC) encourages speakers to submit presentations dealing with design, research, development, applications, and production in the field of vacuum coatings and surface engineering processes, materials characterization and equipment for applications to protect components, tools, as well as decorative parts.

The use of such coatings is typically driven by performance requirements, reduction of life-cycle cost, environmental consideration, and durable cosmetic and aesthetic designs. These end-user motivations lead to dedicated coating and technology developments, vacuum coating equipment concepts, new testing procedures and methods, and production quality standards. Therefore, successful coating solutions in the marketplace require strong co-operation between market specialists, universities, suppliers, manufactures, and end-users.

The TAC invites speakers to present on the subjects of new emerging technologies. Developing and scaling up from laboratory to high volume production at high production yields are also of high interest to the participants in this session.

Today's global landscape is changing rapidly and will drive developments that include new coatings on new applications. Environmental pressure on CO_2 emissions and electroplating as well as fast moving communication technologies are well known examples of such change. Electrification of transportation and moving away from the combustion engine are daily news.

Topics of interest for this session include, but are not limited to:

- Applications:
  - Fuel cell and energy storage technology
  - Coatings for high-performance engines
  - Coatings for cutting, forming and molding tools
  - Coatings for the reduction of friction and exhaust gas emissions
  - Low- and High-temperature coatings for aerospace applications
  - Decorative components and large area pre-fab plates
  - Corrosion protective coatings (e.g. Zn:Al) on large-area surfaces
  - Electroplating Replacements by vacuum deposited coatings and engineered surfaces
- Development:
  - Super-lubricity Coatings
  - Corrosion protection
  - New colors
  - Testing and evaluation of coating performance
  - Scale-up of vacuum coating processes for industrial demands
  - Failure analysis of coatings
  - Assessment, control and management of residual mechanical stress
  - Duplex coatings and thin-on-thick systems
  - Modelling approaches to performance analysis and prediction
- Production Related:
  - Reliability and life of coated parts and systems
  - Upscaling from laboratory to production
  - Scrap rates from percentages to ppm levels

INVITED SPEAKERS:

Thin Film Tribological Coatings to Enhance Machine Component Durability

Ryan D. Evans
The Timken Company, North Canton, OH

The application of engineered thin film coatings on machine components to enhance tribological performance and durability is not new. However, with the benefit of 20 years of R&D and industrial field experience, a journey from early stage development of a-C:H:W coatings on rolling element bearings to initial product launch to mature field experience is reviewed. As the use of these layers continues to increase on one hand, competitive surface treatment technologies such as black oxide are emerging in wear-critical applications in parallel. Referring to the 2020 Society of Tribologists and Lubrication Engineers (STLE) Emerging Trends report, some future machine technology and tribology trends are identified and perspectives on the potential application of wear-resistant thin film coatings in those areas are shared.

Quantitative Evaluation of Performance Attributes and Financial Incentives

Frederick Schmidt
Advanced Applied Services, Saint Charles, IL

Since early 1970 the innovative use of various layers on substrates has enabled progress across the periodic table. Implementation has progressed: from Macro '80's, Micro '90's, Micron layers '20's, and Nano surfaces in the 2020's on catalysis and medical products. What is the difference between decorative/cosmetic verses engineered coatings? In a word, the difference is "reliability". In this presentation the need to specify and quantitatively evaluate coating performance will be reviewed and explored. The context will be performance based using/advocating ASTM procedures, tests, and parametric design criteria. Further, economic examples will be given to illustrate the "Art-of-the-possible".

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Thin Film Sensors

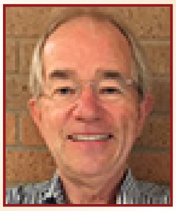
The evolution of sensors in today's world has been driven by numerous technological advances and an explosion of new demand/applications. It is evident that as we continue to grow as a society, there are limitless ways to advance our capabilities as it pertains to health, labor, safety, transportation and economic prosperity. Sensors are becoming extremely common in our everyday lives and can be found in such items as clothing, machinery, photovoltaics, analysis of light, pressure, gas, temperature, speed, and a wide variety of health monitoring equipment. Sensor technology is frequently based on thin film technologies; principally physical vapor deposition (e.g., magnetron sputtering and thermal evaporation), and even when they incorporate additive manufacturing (such as printing and device attach) or micro-electromechanical systems (MEMS), the interfaces and multi-layer material sets of the resulting sensor structures require expert knowledge of surface and thin films engineering. The competencies found in the thin film and surface engineering community can provide solutions to advance the overall capability and efficiency of these devices. This advancement will not only accelerate the adoption of existing applications, but also enables new sensor applications and modalities.

Topics of interest to this session will include:

- Advanced photonic sensing materials design and fabrications,
- Nano plasmonic materials for environmental sensing applications,
- Sensing modalities enabled by microfluidics and selective surface functionalities, and
- Flexible sensing materials and devices for wearable health monitoring applications.

This session /TAC seeks to connect thin film and surface engineering technologies to the myriad applications driven by the connectivity opportunities of the Internet of Things (IoT). Contributions that focus on novel solutions, techniques, and manufacturing challenges are of particular interest.

INVITED SPEAKER:



Periodic Thin-Film Optical Sensors: Technology and Applications

Robert Magnusson
University of Texas at Arlington,
Arlington, TX

Optical sensors are needed in many high-value fields including medical diagnostics, biomarker discovery, drug development, food safety, industrial process control, and environmental monitoring. Here, we summarize the physical basis, fabrication process, and functional characteristics of an efficient sensor modality grounded in optical resonance effects. The sensor operates with quasi-guided waveguide modes induced in periodic layers by a beam of light. The resonance is enabled by one- or two-dimensional nanopatterns that can be fabricated in large formats in a reliable, repeatable, and cost-effective manner making this method commercially viable. Optical thin films play a major role in this technology as a main practical fabrication method is to deposit dielectric films on nanoimprinted plate modules. We invented and experimentally demonstrated the guided-mode resonance biosensor more than two decades ago. Since then, there have been steady developments in technology and implementation. Label-free photonic sensors are immune to electromagnetic interference and permit effective light input and output which is key to achieving compact architectures. These sensors are economic due to material sparsity and simple interrogation with unpolarized light. We summarize resonance sensor fundamentals, unveil the various technological expressions of this sensor class, and give examples of viable applications.

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Thin Film Superconductors

High temperature superconductors (HTS) based on Rare Earth Barium Copper Oxide (REBCO) are an emerging technology for a range of high-volume applications. This "coated conductor" technology is unique in the superconductor field because it is based upon a stack of multiple layers grown on a supporting tape substrate. Thus, it fundamentally enabled by a variety of vacuum-based thin film deposition techniques. This TAC aims to drive the introduction and integration of mature, high speed, high production volume technologies into the HTS coated conductor industry.

For more information, contact the SVC at 505-897-7743 or CLICK HERE to submit an abstract

Superconductors have a key role to play in securing our energy future in an environment-friendly manner. Several new concepts for scalable power generation by nuclear fusion will rely on HTS. High power-to-weight ratio machinery is being enabled by HTS as well: from wind turbines to aircraft propulsion. Electrical power transmission offers opportunities on a global scale for superconductors, and the applications are ideally suited for HTS in particular. In addition to these there exist needs in health care (MRI) and large-scale research (particle accelerators and materials science), which HTS could serve in the future.

To give an idea of the production scales involved:

- A currently funded fusion energy reactor concept will require 10,000 km of HTS conducting tape to make each energy-producing reactor
- The market for the next twenty years in small jetliners, which could be equipped eventually by electric motors, is over 28,000 planes with a value of $3,000B
- The MRI markets consumes up to 4000 tons of (low temperature) superconductors per year, for magnet construction

Markets not fully open to HTS solutions rely on low temperature superconductors which were discovered an entire generation earlier. Only in the last 2-5 years have large applications started opening for HTS.

However, critical manufacturing needs exist to take advantage of these emerging applications and markets. This session/TAC seeks to bring a diverse group of subject matter experts together to review challenges, opportunities, and developments in the following areas:

- Transformation of the REBCO production process from a materials science focus to a scalable manufacturing focus
- Reduction of manufacturing costs. Estimates in multiple markets call for a factor of ten improvement
- Increase in manufacturing speed, also by a factor of ten, to meet required volumes
- Improvement of yield and tight process control
- Innovations in streamlining and automating the production process

INVITED SPEAKER:

Roll-to-Roll Manufacturing of Thin Film Superconductor Tapes: Status, Challenges, and Opportunities

Venkat Selvamanickam
University of Houston, Houston, TX

Tremendous progress has been made in the past two decades in the development and roll-to-roll (R2R) manufacturing of thin film RE-Ba-Cu-O (REBCO, RE=rare-earth) superconductor tapes world-wide. Based on a unique biaxially-textured substrate/buffer architecture and epitaxial film growth, REBCO tapes have been demonstrated with high critical current densities over a wide range of temperatures – 4.2K to 77K. Using CVD, PVD and solution coating techniques, many companies worldwide are producing thin film REBCO tapes in lengths of several hundred meters with uniformly good critical currents. Additionally, through the introduction of Artificial Pinning Centers (APC) in form of nanoscale defects, the critical current densities of these tapes have been increased over 10-fold, resulting in pinning force levels 100 times that of the most-commonly used superconductor, Nb-Ti. The major challenges in large-scale commercialization of thin film superconductor tapes are in their high cost and limited manufacturing throughput. Status, challenges and opportunities in R2R manufacturing of thin film superconductor tapes will be discussed in this presentation.

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Vendor Innovator Showcase

This unique session allows our exhibitors and other vendors to introduce their company's newest products and services to the SVC community. This is an ideal way to share your company's message, new products and encourage booth traffic at the TechCon.

Submit an abstract for a 10-minute oral presentation during this session before January 31, 2021.

Session Organizer:
Jason Hrebik, *Kurt J. Lesker Company*, jasonh@lesker.com

WebTech Roll-to-Roll Coatings for High-End Applications

WebTech is the forum for flexible web and roll-to-roll (R2R) processing at the SVC. It is the podium to present new achievements in processing of flexible substrates such as polymer or textile webs and thin glass, and encompasses manufacturing techniques, products, market developments and economical aspects of this versatile high-volume manufacturing method.

Presentations on materials, deposition processes, manufacturing techniques, market analysis and economical perspectives in the following application areas related to R2R processing are welcome:

- Bio- and health-related topics such as medical sensing and imaging, antimicrobial films and surface treatments, sterile packaging materials, wound care, and many others
- Films and coatings for energy-efficient glazing in buildings, vehicles and spacecraft thermal control
- R2R manufacturing integration combining vacuum and atmospheric processes
  - Spatial Atomic Layer Deposition
  - organic/inorganic hybrid materials deposition
  - printing and patterning
- High performance polymer- and glass-based substrates, diffusion barriers and sealing techniques for roll-to-roll processing
- Roll to roll processing of novel materials for sustainable plastic products including biopolymers, bio-degradable plastics and paper substrates
- Flexible electronics applications for displays, radiation management, driving electronics, security and anti-counterfeiting devices
- Large-area films that enable flexible lighting, LEDs and OLEDs.
- Thin film/flexible batteries, solar cells, and energy storage
- Films for energy smart building envelops including building-integrated photovoltaics, electro- or thermochromic films and smart windows as well as energy storage solutions in facades
- High-volume productivity improvements for metallization, decorative applications, window films, smart and sustainable food and non-food packaging

INVITED SPEAKER:

Spatial Atomic Layer Deposition for Large-Area and Flexible Electronics

Fieke van den Bruele, Frank Grob, Yves Creyghton, Robin Koldeweij, Paul Poodt
Holst Centre/TNO, Eindhoven, the Netherlands

Atomic Layer Deposition is a deposition technique capable of producing ultrathin conformal films with control of the thickness and composition of the films at the atomic level. For these reasons, ALD has become a key enabling technology for further miniaturization in the micro-electronics industry. The major drawback of ALD, however, is its low deposition rate that makes implementation of ALD in high-volume and low-cost markets a challenge. The last few years have seen major progress in the development of spatial atomic layer deposition. The main advantages of spatial ALD are the high deposition rates that can be achieved (nm/s as compared to ~nm/min for conventional ALD) and the possibility to conduct atmospheric pressure deposition. The first industrial applications exploited today for spatial ALD in surface passivation of crystalline silicon solar cells and new applications, such as encapsulation, diffusion barriers and roll-to-roll processing, are emerging. We will present our roll-to-roll spatial ALD technology and some examples of applications, such as the manufacturing of barriers foils and buffer layers for flexible thin-film photovoltaics. We will also touch upon the use of atmospheric pressure plasma technology to be able to do plasma enhanced Spatial ALD, to enable high speed Spatial ALD at low temperatures.

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Technical Poster Session

Poster Presentations serve as an important component of the Technical Porgram by providing a format for extended discussions of the results in a casual environment.

The Program Committee encourages poster presentations on all topics covered in the Call for Papers, including those with topics related to the Symposium theme. A $200 cash award for the Best Poster will be offered. **Submit an abstract for your presentation in the Poster Session before January 31, 2021.**

Technical Advisory Committees (TAC)

Additive Manufacturing

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Atomic Layer Processing (ALP)

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Coatings and Processes for Biomedical Applications

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Coatings for Energy Conversion and Related Processes

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Emerging Technologies

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HEURÉKA! Recent Developments

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High-Powered Electron Beam Technology

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High Power Impulse Magnetron Sputtering - HIPIMS

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Large Area Coatings

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Thin Film Sensors

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Thin Film Superconductors

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WebTech Roll-to-Roll Coatings for High-End Applications

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Vendor Innovator Showcase

Session Organizer:
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