Thursday Afternoon, May 15, 2025

Plasma and Vapor Deposition Processes
Room Town & Country B - Session PP8-2-ThA

Commemorative Session for Papken Hovsepian II

Moderators: Arutiun P. Ehiasarian, Sheffield Hallam University, UK, **Philipp Immich**, IHI Hauzer Techno Coating B.V., Netherlands

1:20pm **PP8-2-ThA-1 PVD Based Solutions for Mankind Through Applied Research*, Ton Hurkmans [ton.hurkmans@ionbond.com],*** IHI Ionbond Group, Germany **INVITED**

During our Ph.D. studies as well as early work at Bodycote and then later at Ionbond, we had a lot of positive interaction with Prof. Dr. Papken Hovsepian. Our shared passion was a desire to use thin film vacuum coating technology to improve products that are being used by people on a daily basis.

Applied research requires insight on both the technology and the market opportunities. It's basically a reversed engineering from macro-scale back to atomic levels, i.e. to translate desired product properties into coating properties and finding a way to synthesize such coating properties. Sheffield Hallam University and Ionbond have worked on many such examples and during the presentation we will elaborate on some of them.

At Bodycote commercial products were introduced and sold, known under tradenames like Supercote 11 (TiAlCrYN), Supercote 30 (TiAlN/VN), and Supercote 55 (CrN/NbN). In parallel we collaborated on multiple EU funded development projects, with names like Newchrome (replacement of electroplating), HIDAM (cutting tools), NitraCote (duplex treatments), ALTICUT (high end machining operations), Colour PVD (PVD coating with post-anodizing), HIPIMS (first EU project on HIPIMS), INNOVATIAL (coatings for jet engines), CORRAL (atomic layers against corrosion), and Monaco (the use of OEM within industry 4.0). There were also joined developments where the manufacturer or end user participated as well.

All the hard work also resulted in joined scientific papers and patents.

2:00pm **PP8-2-ThA-3 Managing Relative Abundance of Ions and Neutrals: A New Plasma Performance Metric in Modern Surface Engineering*, Ganesh Kamath [ganesh.kamath@asml.com],*** ASML, USA **INVITED**

Modern engineering components made up of metals/alloys, plastics and glass have to meet very stringent multifunctional quality specifications and must survive under longer operating conditions. The advent of innovative industrial scale ionized plasma technologies have successfully demonstrated the ability to process those components and fullfill such demands. More specifically, these plasma technologies are being used to produce and control desired amount of ions ($Metal^+$/Gas^+) and neutrals to bombard onto engineering component surfaces to create new multifunctional homogeneous/inhomogeneous nanostructured surface. The metal ions havethe most important influence on coating properties and structure. The modification of the surface of the substrate-to-be-coated by metal ion etching is important for improvement of coating adhesion, while assistance of the coating deposition process by metal ion bombardment plays the leading role in formation of nanostructured coatings with unique properties, usually outside of the thermodynamic equilibrium. Thus relative abundance of ions and neutrals are considered as new plasma performance metric in today's advanced surface engineering application.

One of the first technologies which used metal ion bombardment as a tool for improvement of magnetron sputtering coatings was arc-bond sputtering (ABS) technology introduced by W.D. Munz in 1991 and later perfected in the collaborative works by W.D. Munz and P. Hovsepian and their coworkers. In this technology the initial coating sublayer was deposited by cathodic arc followed by magnetron sputtering deposition which dramatically improved adhesion of the magnetron sputtering coating to the substrate. The ABS technology was utilized in large industrial-scale coating machines by Hauzer company. The filtered cathodic arc technology developed in 1980s-1990s allows to get rid of macroparticles and produce 100% ionized metal vapor plasma flow. It was developed to industrial scale applications by Large Area Filtered Arc Deposition (LAFAD) systems. The LAFAD process is capable of deposition the thermodynamically non-equilibrium coatings such as hydrogen-free diamond-like carbon (DLC) coatings and DLC-based nanocomposite coatings, both as a single layer and as nano-multilayers with high adhesion and cohesion properties. The productivity of the LAFAD process allowed its application for deposition of multilayer erosion resistant coatings for turbomachinery with coating thickness >100 µm.

2:40pm **PP8-2-ThA-5 The Role of University–Industry Collaboration in the Development of Industrial Innovations: The HIPIMS Technological Journey*, Pawel Ozimek [pawel.ozimek@trumpf.com],*** Trumpf, USA **INVITED**

This work discusses the importance of university–industry collaboration in fostering the development of industrial innovations. Over the years, sustained cooperation between academic research institution and industrial partners has built a foundation of trust and strong relationships. These long-term partnership have not only accelerated technological advancements and streamlined innovation processes but also fostered a mutual belief that research will lead to significant business outcomes. This work highlights how collaborative efforts in the development of High Power Impulse Magnetron Sputtering (HIPIMS) have facilitated the effective translation of cutting-edge research into commercially viable technology, delivering a substantial impact on the industry. The findings underscore the importance of fostering robust university–industry partnerships to sustain competitive advantage and drive progress within high-tech sectors. The second part of this contribution will review highlights of current state of the art industrial applications of HIPIMS technology and explore potential technology adoption in cutting-edge areas, where the proven advantages of HIPIMS have shown great promise for processing improvements.

3:20pm **PP8-2-ThA-7 Carbon Based Surface Solutions – from a Glorious Legacy to Recent Advances*, Vishal Khetan [Vishal.Khetan@oerlikon.com],*** Oerlikon Surface Solution AG, Switzerland **INVITED**

Tribology and Surface Engineering, as enabling technologies, have been continuously advancing global manufacturing sectors in terms of fuel economy (reduced friction and wear), improved productivities and product reliability, functionalisation of machine components, providing alternative manufacturing processes due to environment legislations, and electrification of vehicles, etc. Along with the new generation manufacturing and climate change energy challenges surface engineering will phase in a new era of research and innovation. Carbon based surface solutions using technologies such as physical/chemical vapour deposition (PVD, CVD) deliver new and sustainable pathway in multiple manufacturing industries such as automotive, medical, packaging and aerospace can be addressed and introduced to a broader industry perspective.

While developing new carbon coatings and bringing them to industry as solutions, we always stand on the shoulders of giants like Prof. Papken Hovsepian. His work in the field of thin film technology was an inspiration for many and through this talk we illustrate how his work has channelled beautiful scientific ideas which turn into products serving various industrial application especially in the field of carbon-based surface coatings. Further, in co-relation to his work, we would be discussing scientific background, tribological and industrial relevance various carbon based surface solutions offered by Oerlikon Surface Solutions AG ranging from amorphous hydrogenated carbon to hydrogen free carbon coatings via PACVD,S3p (Scalable pulsed power plasma), Cathodic Arc evaporation and PICVD(Plasma induced chemical vapour deposition) with special focus on new upcoming carbon based solutions such as BALINIT® MAYURA, upcoming nanocrystalline diamond coating using PICVD technology.

4:00pm **PP8-2-ThA-9 Materials and Technology Design Guided by the Thirst for Knowledge and Thirst for Life -the Story of Prof. Papken Hovsepian*, Arutiun P. Ehiasarian [a.ehiasarian@shu.ac.uk],*** National HIPIMS Technology Centre, Sheffield Hallam University, UK **INVITED**

The amazing ability of functional coatings produced by Physical Vapour Deposition (PVD) to perform in a host of applications has been a source of fascination for many decades for many scientists.None more so than Professor Papken Ehiasar Hovsepian.His pioneering research led to the discovery and deployment of many fundamental concepts that are widely used in contemporary PVD research, including cathodic arc evaporation, high power impulse magnetron sputtering, metal ion etching to enhance adhesion, and nanoscale multilayer coatings. Papken's scientific path coincided with a period of rich development in PVD technologies.From humble beginnings in designing plasma cleaning and thermal evaporation technology and systems for reel-to-reel wire coating, it went on to the first planar and rectangular arc evaporators, the introduction of the metal ion implantation concept to enhance adhesion, the nanoscale multilayer coating systems, implementing HIPIMS for coating deposition and on industrial scale bringing real value to the technology.

A firm believer in the importance of utility in science (and in life), Papken used the final application as a guiding principle in the three steps at the heart of any coating development process, namely: material selection, structure selection and finally coating deposition method consideration.The nanoscale multilayer microstructure was used extensively as its multitude of interfaces increased the toughness of the coatings, whilst enabling flexibility in material selection.CrN/NbN was developed to combine wear and corrosion resistance in applications including biomedical implants to enhance lifetime and barrier to ion release, and power generation turbines to protect from superheated steam.The ability of CrAlYN / CrN to form dense oxides was exploited as oxidation and hot corrosion protection of gamma TiAl alloys in jet propulsion turbines and against water droplet erosion.The TiAlN / VN ± C system, which produced self-segregated low-shear interfaces and solid lubricant Magneli oxide phases, was developed for cutting and friction stir welding sticky alloys such as Ti and Al.Mo- and Cr- containing DLC achieved ultra-low friction and stable wear in lubricated conditions.All of these systems benefited from the pioneering use of HIPIMS technology to enhance density, tailor crystallographic texture and improve adhesion.Papken was instrumental in industrialising the HIPIMS technology through designing large-scale power generators and automated systems.

The application-informed innovative design approaches employed in Prof. Hovsepian’s research have made it one of the definitive bodies of work in PVD.

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