Friday Morning, April 30, 2021

Live Session

Room Live - Session LI-FrM

Awards Session Live

Moderators: Dr. Ivan G. Petrov, University of Illinois at Urbana-Champaign, USA, Dr. Andrey Voevodin, University of North Texas, USA

10:15am **LI-FrM-2 Special Interest Talk: Design, Metallurgy and Manufacturing Technologies of Targets for Hard Coating and Tribological Applications***, Peter Polcik (peter.polcik@plansee.com)*, Plansee Composite Materials GmbH, Germany **INVITED**

Today, major share of tools and components is coated with hard coatings utilizing physical vapor deposition methods. The continuous improvement of coatings takes place by introducing new architectures and by implementation of new compositions in thin films designed for special applications. Furthermore, the coating suppliers work on cost and quality optimization for mass product implementation. The results of these efforts are for instance larger coating chambers and shorter process times leading to new target dimensions and shapes as well as the increase in power density applied to the targets.

The targets used for hard coating applications are produced either by powder or by melting metallurgy processes. Targets manufactured by powder metallurgy are characterized by several advantageous properties such as uniform microstructure, high density, as well as homogeneity concerning distribution of chemical elements. The quality of such targets depends on the manufacturing process and for the most part on the quality of the powder ingredients used.

Different ongoing developments of hard coatings are focused on beneficial effects by alloying with selected elements to control the composition of the coating. The big challenge is to apply a suitable technology for production of targets containing all these elements on the one side and to consider the impact of the purity of the targets on the whole production chain and the performance of the final product on the other side. In order to support the efforts of equipment manufacturers and coating designers, new technologies must be applied to produce targets in appropriate shape and dimensions.

The application driven demand on no reactive driven PVD processes requires ceramic based targets consisting of carbides, nitrides, borides or even mixtures of such phases. The challenge is to provide such targets not only suitable for lab scale coating equipment but also for large scale industrial PVD coaters. Further examples of target materials developed recently, utilizing sophisticated manufacturing technologies, are metal doped graphite as well as composite materials doped with elements increasing coating deposition rates.

To deliver cost-optimized targets for mass applications the whole process chain, including powder quality and standardization of raw materials, must be considered. The mentioned efforts, comprising the increase of target utilization, are also strongly related to the increase in power density applied to the targets. Therefore, the development of materials with high heat conductivity and thermal shock resistance are included in the challenges for target suppliers.

11:15am **LI-FrM-6 Bill Sproul Award and Honorary ICMCTF Lecture: Transition Metal Nitride Layers: New Phases and New Properties***, Daniel Gall (galld@rpi.edu)*[1], Rensselaer Polytechnic Institute, USA **INVITED**

We explore new transition metal nitride compounds using a combination of epitaxial layer growth, first-principles calculations, and measurements of electronic, optical, and mechanical properties as a function of composition and structure. Rock-salt structure nitrides are both mechanically and thermodynamically stable for group 3 transition metals. However, increasing the valence electron concentration by moving towards the right in the periodic table increases the strength of metal-metal bonds leading to a brittle-to-ductile transition and enhanced toughness, but also decreases the vacancy formation energy on both cation and anion sublattices, resulting in vacancy-stabilized compounds like cubic WN with a dramatically reduced elastic modulus, and new thermodynamically stable phases like a 5-fold coordinated base-centered monoclinic stoichiometric MoN. Conversely, reducing the valence electron concentration to reach a vanishing density of states at the Fermi level results in transition metal nitride semiconductors with promising properties for high-temperature electronic, thermoelectric, opto-electric, piezo-electric, plasmonic and magnetoresistive devices. Examples include ScN, $Ti_{0.5}Mg_{0.5}N$ and CrN with 0.92, 0.7-1.7 and 0.2+/-0.4 eV bandgaps, respectively. The carrier concentrations are controlled by F and O doping, the bandgap is engineered by alloying with Al to form $Cr_{1-x}Al_xN$, $(Ti_{0.5}Mg_{0.5})_{1-x}Al_xN$, and $Sc_{1-x}Al_xN$, the piezoelectric response is enhanced by the intentional introduction of local bonding instabilities in the wurtzite phase, and a two-dimensional electron gas is formed at the oxygen-exposed CrN(001) surface.

12:00pm **LI-FrM-9 R.F. Bunshah Award and ICMCTF Honorary Lecture: From a Sparkling Brass Chain and Twitching Frog Legs: The Astonishing Path to Plasma-Based Advanced Coatings***, André Anders (andre.anders@iom-leipzig.de)*[2], Leibniz Institute of Surface Engineering (IOM), Felix Bloch Institute, Leipzig University, Germany **INVITED**

As many accomplishments of modern life, plasma-based advanced coatings are ubiquitous today.It is educational to see how observation of strange effects and careful experimentation lead to discoveries that effectually enabled what we take for granted today. When taking the time for dwelling a bit deeper we find that assuming broad priority claims (like “for the first time” and “novel approach”) should be replaced by more humble statements.Among the truly astonishing early milestones is, for example, an 18th century report on pulsed atmospheric pressure plasmas, well-adherent metal and transparent coatings and nanoparticle generation from a time well before Volta and Faraday (I admit: the terminology was different).In this lecture, I will highlight a few of such milestones to advanced, plasma-based coatings showing that each accomplishment is built on observation and experimentation, and more recently on modeling, but enabled by discoveries made before.As a community of surface engineers, we can be proud having made the steps from observation to deeper understanding, knowledge-based discovery, optimization towards desirable properties, upscaling considering the economics of processes, and broad-scale applications now penetrating all aspects of society.

12:45pm **LI-FrM-12 Closing Remarks and Thank You's***, Andrey Voevodin (Andrey.Voevodin@unt.edu)*, University of North Texas, USA

Thank you for attending the ICMCTF 2021 Virtual Conference! We hope you enjoyed the event! We hope you will join us for the Post-session Discussion and some additional Q&A opportunities! Mark your calendars for ICMCTF 2022, May 22-27, 2022, in San Diego, CA!

[1] **2021 Bill Sproul Awardee**

[2] **R.F. Bunshah Awardee**

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