## Surface Engineering - Applied Research and Industrial Applications

### Room Town & Country C - Session G1-TuM

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

**Moderators: Satish Dixit**, Plasma Technology Inc., USA, **Martin Engels**, IonBond Inc., USA

9:40am **G1-TuM-6 Photons meet Plasma – Adding Value to your Al, Mg and Ti Components*, Anna Buling (buling@ceranod.de),*** ELB Eloxalwerk Ludwigsburg GmbH, Germany*; J. Zerrer,* ELB Eloxalwerk Ludwigsburg, Germany

PEO, plasma-electrolytical oxidation, remains as an unknown or at least niche surface technology, giving lightweight metals a hard and robust protection shell. Expiring an increasing interest in the research society in the last decade, it is supposed to be promising for increasing lightweight potential but being not ready for wide industrial applications, due to high costs or being applicable only on small series. In this talk we will refute these reservations by unveil high demand applications of our clients, who use our surfaces on their components under harsh conditions. The CERANOD® surfaces can withstand high vibration loadings providing a high corrosion and wear protection for alloys of Al or Mg. One of our automotive clients is using our technology on highly loaded components in the power train, whereas the second generation of a lager-volume production ist starting now, providing to the world's biggest OEMs. This illustrates that PEO is neither too expensive when hitting the demands nor a niche technology for very particular fields. In a further application case a Mg component modified by our ceramic atomic bonded surface found its way in large production series last year after being tested world-wide for several years in an innovative ICE application.

We will show application possibilities and different fields of our surface modification used industrial in tribological, corrosive and high temperature applications, whereas, e.g., maintenance-free power units can be realized.

Being convinced that facing the incessantly growing demands on sustainability, efficiently and endurance in automotive, aerospace and machinery applications, is only possible by lightweight, including multi-material mix, accompanied by the right solutions for the surfaces, we enhance our technologies. Most recently, we found that especially in the case of Aluminum casting alloys an adopted PEO process leads to positive tribological behavior in combination with novel low-viscosity oils. The utilization of Direct Interference Laser structuring and hybridizing with a solid lubricating polymer manifold the positive effect. A 1000-h wear test just being finished prior this submission proves a very promising solution with low friction and almost no wear.

We will report on wear and corrosion test results accompanied by SEM and EDS findings for different CERANOD® solutions. These findings will be compared and correlated with different application cases of our clients, who utilize our solutions on their end products to enable the usage of lightweight metals under harsh tribological, vibrating and /or corrosive environments, and, thus, saving a lot of energy and resources.

10:00am **G1-TuM-7 The Effect of Coating Conditions on the Life of PVD Coated Steel Rods Immersed in a Molten Aluminum Die Casting Alloy*, Stephen Midson (smidson@mines.edu),*** *N. Delfino de Campos Neto, W. May, A. Korenyi-Both, M. Kaufman,* Colorado School of Mines, USA

Die casting is a high-volume casting processes, where liquid metals (primarily alloys of aluminum, zinc or magnesium) are injected at extremely high speeds and pressures into re-usable, hardened steel dies. In commercial die casting operations, PVD coatings are applied to aluminum die casting dies to reduce the erosion of the steel die by the liquid metal, and to minimize soldering (sticking) of the solidifying aluminum to the die.While these types of PVD coatings are becoming relatively widely used, there is little rigorous data to identify the best coating conditions to maximize life of the coatings.This presentation will report on a laboratory study that examined the effect of coating conditions on coating life.Three conditions have been studied, coating thickness, substrate roughness, and the impact of nitriding the steel surface prior to the PVD coating.Using an accelerated test, 11 mm diameter rods of H13 steel PVD coated with CrN were rotated at 540 rpm in a crucible of molten aluminum A380 alloy held at 700ºC.The rods were periodically removed from the melt (typically every 1-2 hours) to observe their condition, and it was found that the coatings would fail either close to the melt line or at the end of the rod, and once the coated failed the underlying steel was rapidly dissolved.The results of the testing will be reported in this presentation, along with metallography characterizing the conditions and failures of the coatings.

10:20am **G1-TuM-8 Carbon-Based Surface Solutions for High Performance Forming Tools - A Journey from Material Research to Industrial Solutions*, Vishal Khetan (vishal.khetan@oerlikon.com),*** Oerlikon Balzers, Oerlikon Surface Solutions AG, Liechtenstein, Switzerland **INVITED**

With rapid increase in use of non-ferrous materials especially aluminium in automotive industry, manufacturing challenges occurring from galling have become significant. Along with increase the service life of forming tools used for processing these materials, decreasing maintenance downtime and end product quality are key for good production reliability. Multiple strategies have been investigated both in academia and industry to mitigate these challenges. Some of them are reduction of surface roughness (Polishing of tools), Nitriding or Nitro carbonizing of tools (diffusion treatment) and more recently use of Carbon based coatings. Different carbon based coatings deposited by physical vapor deposition (PVD) or chemical vapor deposition (CVD) have been used for these applications. With appropriate pre and post treatment - They have helped significantly reducing galling in industry. The preferred choice of technique to deposit these coatings depends on the requirement of the application namely type and dimension of material being processed, surface roughness requirements and challenges involved in the technique to coat the tools to avoid adhesion challenges of the coatings owing to the geometry of the tools.

Owing to multiple factors involved in mitigating galling in non-ferrous materials forming - decision making to select an appropriate surface solution (a combination of coating and pre/post treatment before and after coating) needs significant trial in the form of Design of experiments or trial and error method which is time consuming and often makes decision making difficult for the OEM to select an appropriate solution in a cost effective way.

This presentation will focus on usage of a laboratory based tribological test which results in effectively evaluating adhesive wear in the system and provides appropriate insights into effectiveness of a total surface solution in an industrial application in short duration and being cost effective. The test rig presented is known as the load scanner rig which can effectively simulate the tendency of Aluminum sticking on to different substrate and suggest the effectiveness of the tooling system to provide an indication towards its effectiveness to a given application in Aluminium forming. They save time and resources needed for expensive production tests. Furthermore the tests also help the OEM or tool maker take correct decision on the type of carbon coating he needs to use for their specific alloy and tooling system. Hence, providing a pathway to maximize the cost benefit for their investment on a surface solution in a scientific way.

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