Hard Coatings and Vapor Deposition Technologies
Room Town & Country D - Session B6-2-WeA

Coating Design and Architectures II

Moderator: Paul Heinz Mayrhofer, Institute of Materials Science and Technology, TU Wien, Austria

2:00pm **B6-2-WeA-1 Industrial Antibacterial Decorative Coatings*, Ivan Kolev (ikolev@hauzer.nl)*,** *P. Immich, A. Fuchs, H. Vercoulen, D. Doerwald,* IHI Hauzer Techno Coating B.V., Netherlands

Anywhere large numbers of people gather, touch-based contamination contributes to the spread of bacterial infections. Coatings with antibacterial effect could have an important public health benefit. This includes door handles, bathroom taps and other high-touch elements in public and private buildings. Already for decades these elements have commonly had a PVD decorative finish, which provides them with an attractive look and increased wear and corrosion resistance. The next generation decorative coating should also include antibacterial properties.

In this work, decorative antibacterial coatings on industrial scale are presented. The antimicrobial properties are realised by doping of the standard decorative coatings with Cu and Ag. To verify the efficacy, the coatings are tested for their kill rate against two of the most common bacteria *Escherichia coli* and *Staphylococcus aureus*. The testing shows excellent results – kill rate of up to 100% within one hour. The effect on the doping upon standard properties, such as colour, wear and corrosion resistance are also discussed

2:20pm **B6-2-WeA-2 Few Thoughts about Hard Coatings and Machining Industry*, Aharon Inspektor (ainspekt@andrew.cmu.edu)*,** Carnegie Mellon University, USA

The development of cutting tools is a traditional proving ground for the design and testing of new materials, new coatings and new concepts in materials science. Recently we witnessed rapid development of innovative hard coatings with superior mechanical properties, thermal stability and chemical resistance. The new coatings are well suited for machining materials at significantly higher speeds and feed rates and play important role in machining industry. Nevertheless, "older" coatings such as TiN, TiCN and TiAlN are also still in use at many small and large machining centers. Why it is so? What is the reason for this wide range of hard coatings in the cutting tools industry? And how this affect development and introduction of novel coatings? In this paper we will discuss these questions, present selection criteria of hard coatings in the industry and examine how the Fourth Industrial Revolution will affect future hard coatings and machining landscape. We will start with "machining wear maps" that display the relationships between machining parameters and tool's wear: the starting point for tools' selection, and for the resultant wide range of hard coatings in the industry. Then we will examine how the Fourth Industrial Revolution, Industrial Internet of Things (IIOT) with multi-level connectivity of sensors, machines and systems, will likely changes this manufacturing landscape. We will conclude the talk by discussing the germane trends and ensuing future development of hard coatings for metal cutting industry.

2:40pm **B6-2-WeA-3 Effect of Coating Architecture on Stress Relief Mechanism of TiZrN Coatings on Si Substrate (Virtual Presentation)*, Jia-Hong Huang (jhhuang@ess.nthu.edu.tw)*,** *M. Liu, Y. Chiu,* National Tsing Hua University, Taiwan **INVITED**

Hard coatings deposited by physical vapor deposition are usually subjected to high residual stress. To relieve the residual stress, it is commonly introducing a metal interlayer between coating and substrate or by further coating architecture design. However, the underlying stress relief mechanism of coatings with architecture has not been fully understood. The purpose of this study was to investigate the extent of stress relief achieved by employing different types of interlayers or coating architecture, and explain the stress relief mechanism in each coating architecture using a simple energy-balance model. Themodel was based on the concept that the relief of stored energies from both coating (ΔG_f) and Si substrate (ΔG_{Si}) was converted to the plastic work by the metal interlayer. TiZrN/TiN/Ti tri-layer coatings and TiZrN bi-layer coatings with Ti, TiZr and TiZr/Ti interlayers on Si substrate were chosen as the model systems, which were deposited using unbalanced magnetron sputtering. Laser curvature method and the average X-ray strain method combined with nanoindentation were used to measure the residual stress of the entire specimen and individual layers, respectively. For the TiZrN specimens with different interlayers, the results showed that increasing the metal interlayer thickness may not be an effective way on increasing stress relief efficiency in the coating. Since plastic deformation of the interlayer could only occur in part of the interlayer near the TiZrN/interlayer interface, increasing the interlayer thickness did not substantially increase the effective deformation thickness. Furthermore, plastic deformation became difficult for the metal interlayer with higher strength coefficient (k). Therefore, ΔG_f may decrease by using high-k interlayer with the same thickness. However, the high-k interlayer could act as a channel to transfer the stress to the Si substrate, if proper interlayer thickness was used. For the specimens with coating architecture, the results revealed that the extent of stress relief in TiZrN coating with TiN/Ti architected interlayer was larger than that with only a single Ti interlayer. The TiN transitional layer served as an energy channel that effectively transferred the stored energy in TiZrN to the Ti interlayer and alleviated the large stress difference at the original TiZrN/Ti interface, thereby increasing the plastic deformation capacity of the underlying interlayer; therefore, a larger fraction of residual stress in TiZrN was relieved.

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