Advanced Surface Engineering
Room 2007a - Session SE2-FrM

Wear Mechanisms, Tribochemistry and Nanotribology
Moderator: A.A. Voevodin, WPAFB

10:40am **SE2-FrM9 The Relation of Tribochemistry to Superlubricity in DLC Films***, **A. Erdemir**, O.L. Eryilmaz,* Argonne National Laboratory **INVITED**

Diamondlike carbon (DLC) films have attracted a great deal of interest in recent years, mainly because of their exceptional mechanical and tribological properties. Systematic studies of such films in our laboratory over the past 15 years have led to the development of a new class of carbon films that can provide friction coefficients of 0.001 to 0.005 and wear rates of 10-11 to 10-10 mm3/N.m when tested in inert-gas or high-vacuum environments.@footnote 1@ Comprehensive studies over broad test conditions and environments have shown that the unique friction and wear behavior of these films is very sensitive to the type and extent of tribochemical interactions that occur when certain gaseous species are present in the surrounding atmosphere. Among others, oxygen and water molecules were found to have the strongest adverse effects on their friction and wear. Using x-ray photoelectron spectroscopy and time-of-flight secondary ion mass spectrometry, we determined the chemical states of their sliding surfaces and correlated these findings with their super-low friction behavior in inert gases and high-friction behavior in oxidizing and moist environments.@FootnoteText@@footnote 1@Synthesis of diamondlike carbon films with superlow friction and wear properties, A. Erdemir, O. L. Eryilmaz, G. Fenske, Journal of Vacuum Science and Technology A, 18(2000)1987-1992.

11:20am **SE2-FrM11 Synthesis and Tribological Properties of Novel 'Chameleon' Coatings***, **C.C. Baker**,* North Carolina State University*; J.J. Hu, A.A. Voevodin,* Air Force Research Labs, MLBT

'Chameleon' coatings are nanocomposite coating systems adapt their tribological performance to changes in environmental conditions such as humidity and temperature. In this research we have investigated the tribological properties of two new nanocomposite 'chameleon' coating systems. One of the system includes the incorporation Al2O3 in an Au matrix with diamond like carbon (DLC) and MoS2 nanoparticle inclusions. The coating design approach included a formation of nanocrystalline hard oxide particles for wear resistance, their embedding onto an amorphous matrix for contact toughness enhancement, and inclusion of nanocrystalline and/or amorphous solid lubricants for friction adaptation to different environments. The other coating system that we have studied includes a composite of Rhenium and hexagonal Boron Nitride. Rhenium is a unique ultra hard material that shows low coefficient of friction at elevated temperatures to 700 @degree@C and in vacuum environments, while Boron Nitride is also excellent for high temperatures and for humid environments. All coatings were produced using a combination of laser ablation and magnetron sputtering. Chemical and structural analysis of the coatings included x-ray photoelectron spectroscopy, x-ray diffraction, transmission electron microscopy, and micro-Raman spectroscopy. Mechanical properties such as coating hardness and toughness were investigated using nanoindentation, scratch, and indentation adhesion tests. Friction measurements were studied by cycling between humid air and dry nitrogen conditions, as well as tests at temperatures of up to 700 @degree@C. Both of the new coating systems validate the universality of the 'chameleon' design approach.

11:40am **SE2-FrM12 Tribochemical Studies on Single Crystal Surfaces using Atomic Force Microscopy***, **J.T. Dickinson**, A. McEvoy, S.C. Langford,* Washington State University

We have examined two tribochemical processes on single crystal surfaces using the atomic force microscope that result in nanometer scale modification. Using solutions appropriate for crystal growth or crystal dissolution we show that application of tribological stimulation can lead to highly localized, in some cases atomic, deposition or material removal. The samples of current study include cleavage surfaces of calcite and gypsum (for growth) and Si(100) for tip-induced dissolution. The latter study relates directly to understanding the mechanisms of chemical mechanical planarization of silicon wafers where today's requirements for topography have reached the sub-nanometer scale.

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