Monday, May 11

1:30 p.m. T-1 Novel Design Approaches to the Development of Multifunctional

Nanocomposite Coatings for Demanding Engine Applications

A. Erdemir and O.L. Eryilmaz, Argonne National Laboratory, Argonne, IL; and M. Urgen, K. Kazmanli, and V. Ezirmik, Istanbul Technical University, Istanbul, Turkey

Invited 40 min. Talk

In this paper, we describe a crystal chemical model that can help identify the kinds of coating ingredients that are needed in nano-composite coatings for achieving ultra-low friction and wear under boundary lubricated sliding conditions. Using this model, we recently designed and synthesized a series of MoN-based nano-composite coatings and confirmed their superior tribological properties under severe sliding conditions. Employing advanced analytical tools (such as time-of-flight secondary ions mass spectrometry, x-ray photoelectron spectroscopy, and Raman spectroscopy) we ascertained the chemical nature of the tribofilms forming on sliding surfaces of these MoN-based nano-composite films that were responsible for their superior friction and wear properties. Overall, crystal chemical model used in this study seems to provide a new scientific means for the design and production of next generation nanocomposite coatings that can endure harsh tribological conditions of various engine applications.

Monday, May 11

2:10 p.m. T-5 Effect of Si Incorporation on the Mechanical and Electrochemical Properties of DLC Films

M. Azzi, École Polytechnique de Montréal, Montréal, Canada and McGill University, Montréal, Canada; M. Paquette, École Polytechnique de Montréal, Montréal, Canada; J.A. Szpunar, McGill University, Montréal, Canada; and J.E. Klemberg-Sapieha and L. Martinu, École Polytechnique de Montréal, Montréal, Canada

In the present work, the effect of silicon incorporation on the mechanical, tribological and electrochemical properties of diamond like carbon (DLC) coatings on metal substrates is investigated in the context of their biomedical applications, namely in implants or in surgical instrumentation. DLC films with different silicon contents (0, 16, 20, 26 at.%) were deposited using plasma enhanced chemical vapour deposition (PE-CVD). Elastic recoil detection (ERD) technique was used to measure the chemical composition, and nano-indentation tests were carried out to assess the mechanical properties of the DLC/Si films. The hardness slightly deceased with increasing the Si content from about 18 GPa at 0 at.% Si to 16 GPa at 26 at.% of Si. Electrochemical tests were performed in Ringer's solution to simulate the body fluid conditions. Potentiodynamic polarization curves were measured and corrosion current densities, passive current densities, and breakdown potentials were obtained. Electrochemical impedance spectroscopy (EIS) was applied to measure the resistance to general corrosion (RGC) of the coatings. EIS spectra were interpreted in terms of appropriate equivalent electrical circuits. It was found that RGC increased significantly with increasing Si content from 3.5 $G\Omega.cm^2$ at 0 at.% to almost 25 $G\Omega.cm^2$ at 26 at.%. This finding represents a clear indication of lower porosity of the DLC that can be related to enhanced oxidation of Si inside the film. Potentiodynamic polarization curves showed that the passive current and the breakdown potential increased with Si incorporation; in fact, the passive current decreased almost one order of magnitude over the studied range (0 at.% to 26 at.%). The Si-doped DLC coatings, in conjunction with appropriate interface engineering approaches on metals, and the use of highly resistant interfacial layers provide excellent protection against tribo-corrosion effects in liquid (particularly body fluid) environments.

Monday, May 11

2:30 p.m. T-3 Reactive Co-Evaporation of Carbon/Carbide Nanocomposites: Process, Structure and Tribological Properties

E. Bergmann, University of Applied Science of Western Switzerland, Geneva, Switzerland; G. Wahli, Roth & Rau AG, Neuchâtel, Switzerland; G. Pannatier, Platit AG, Grenchen, Switzerland; B. Pecz and L. Toth, Muszaki Fizikai és Anyagtudományi Kutatóintézet, Budapest, Hungary; and C. Mitterer, University of Leoben, Leoben, Austria

Reactive co-evaporation is a new method to synthesize carbide/carbon nanocomposite coatings. Coatings are produced by cathodic arc evaporation from solid metal and carbon sources. The method can be tuned to produce almost isotropic nanocomposites. They are hydrogen and metal free. The coatings are thermally stable to at least 900°K. Their hardness is in the range of 13-16 GPa, slightly lower than CrN. The structure of CrC/C and CrCN/C coatings will be presented. Depending on their composition, the coatings have low friction at room temperature, but maintain fair tribological properties up to higher temperature.

Monday, May 11

2:50 p.m. T-4 Erosion-Resistant Multilayer Coatings

A. Flores Renteria, O. Schroeter, R. Mykhaylonka, and C. Leyens, Technical University of Brandenburg at Cottbus, Cottbus, Germany

In this research work, the development of an alternative erosion-protective coating for compressor blades has been carried out. In those parts of the world were the sand particle concentration in the air is high, the lifetime of the compressor blades is principally limited by erosion. The sand particles are ingested into the aero-engine during low-altitude flights and upon take-off and landing. The use of coatings is one standard method to effectively protect bulk materials against erosion. Particular attention has been given to multilayer coatings containing hard and tough-ductile layers. In this study, the Cr_3C_2/Cr_2AlC multilayer system was investigated. The Cr_3C_2 layers are hard enough to avoid particle penetration, and the Cr_2AlC phase should be able to resist the deformation and cutting processes caused by the impacting particles. The coatings were deposited by DC-magnetron sputtering, and the erosion tests using solid particles were carried out in an erosion rig. The obtained results indicate the effective protection of metal alloys against erosion of solid particles impacting at different angles and velocities, which are representative of in-service conditions for compressor blades.