WEDNESDAY, AUGUST 24, 2005, A.M.

SESSION 37: INTERNATIONAL SYMPOSIUM ON MATERIALS DEGRADATION: INNOVATION, INSPECTION, CONTROL AND REHABILITATION

RESEARCH IN WEAR AND OTHERS
Sponsor(s): Material Performance and Integrity Section, The Metallurgical Society of CIM
Room: Bannerman
Chair(s): A. ALFANTAZI, University of British Columbia, Canada

PAPER 37.1 — 8:30
WEAR BEHAVIOR OF NANOSTRUCTURED AND CONVENTIONAL Y-PSZ COATINGS.
M.A. GOLOZAR, Isfahan University of Technology, Iran
J. MOSTAGHIMI, T. COYLE and R. SOLOTANI, University of Toronto, Canada

Partially Stabilized Zirconia (PSZ) have been proved to be an excellent candidate as Thermal Barrier Coatings (TBC) for hot sections in, for instance, heat or internal engines and gas turbine parts. The main function of these coatings arereduction of heat losses, reduction of fuel consumption, increasing the efficiency, and extending durability and life. Regarding the development of such coatings for these applications, one of the main problems involved is the wear behavior. Using Air Plasma Spraying (APS) technique, conventional and nanostructured 8wt%Yutria Partially Stabilized Zirconia (Y-PSZ) coatings were deposited on austenitic stainless steel (AISI 304) disc shape substrates. The coated substrates were subjected to pin on disc wear tests using 10 mm silicon nitride and ziconia balls, as the pin. The coefficient of friction was recorded in real time. The weight loss of coated substrates was measured. Coatings were characterized before and after subject to wear testing by various techniques including optical microscopy, scanning electron microscopy (SEM), energy dispersive X-ray spectrometry (EDX) and X-ray diffraction. Effects of various experimental parameters were also investigated. Results obtained revealed that regardless of experimental conditions applied, the nanostructured zirconia coating shows better wear and tribological properties compared with that of the conventional one.

PAPER 37.2 — 8:55
WEAR OF HIGH SPEED STEELS AS POTENTIAL MATERIALS FOR BEARINGS IN AERO-GAS TURBINES.
R. GHOMASHCHI, Université de Québec à Chicoutimi, Canada

Wear, fatigue and corrosion are the most widely encountered failure modes of materials used in engineering applications, including aero-gas turbines. Although wear is distinctly classified as adhesive, abrasive, erosive, fretting and so on, there are usually more than one wear mechanisms which contribute towards the failure of components in service. This is due to the fact that there are large numbers of system and materials variables active during the course of materials wear which make the study of materials wear more difficult. This is further complicated by the discrepancies between the laboratory tests and field data. The present investigation was set up to examine wear characteristics of M50 and T1 high speed steels at both room and elevated temperatures to draw a thorough understanding of wear behavior of this class of high speed steels. This article is concentrated on the mechanical and microstructural characterization of wear for T1 and M50 high speed steels using pin-on-disk wear machine.

PAPER 37.3 — 9:20
CORROSION-WEAR MONITORING OF TiN COATINGS BY ELECTROCHEMICAL NOISE MEASUREMENTS.
P-Q. WU, University of Western Ontario, Canada
Z. QUAN, Qingdao University of Science and Technology, China
B. TANG, Taiyuan University of Technology, China and
J.-P. CELIS, Universiteit Leuven, Belgium

A modified electrochemical noise (EN) technique has been applied to monitor corrosion-wear of TiN coated ASP23 steel and TiN coated AISI 316 stainless steel sliding against corundum in 0.5 M H2SO4. Experimental results show that the EN technique can sensitively detect potential and current variations during a corrosion-wear process. Corrosion-wear mechanisms of TiN coatings depend on their substrate properties. If the substrate is passive, such as AISI 316 stainless steel, the potential and current variations reflect the properties of coating. Depassivation and repassivation alternately take place on the tribo-activated wear area during the steady-state phase. If the substrate is active, such as ASP23 tool steel, the electrochemical noise is dominated by dissolution of the substrate at the pinholes and the hydrogen evolution all over the exposed surface.

PAPER 37.4 — 9:45

EFFECTS OF CHEMICAL COMPOSITION AND MICROSTRUCTURE ON CORROSION- AND WEAR-RESISTANCE OF CHROME WHITE IRON.

B.T. LU, J.L. LUO, University of Alberta, Canada and
S. CHIOVELLI, Syncrude Canada Ltd., Canada

The corrosion and wear properties of a series of cast chromium white iron (CWI) materials were study using electrochemical and low stress sliding abrasion tests. The results confirm that corrosion resistance of these materials is largely dependant on the quantity of chromium in the matrix while wear resistance is mainly controlled by the volume fraction of chromium carbides. A pseudo-wear/corrosion map is developed to identify alloy compositions that may be suited for erosion/corrosion conditions.

COFFEE BREAK — 10:10-10:25

PAPER 37.5 — 10:25

RECOVERY OF WC POWDER PARTICLES FROM CEMENTED CARBIDE SCRAPS BY SELECTIVE ELECTROLYSIS PROCESS.

P. ABACHI, A.M. ARAGHI and K. PURAZRANG, Sharif University of Technology, Iran

Cemented carbides or hard metals which generally consist of hard tungsten carbide and tough metal binder such as cobalt are important in many segments of the world economy, ranging from automobile related components to machining, cutting, drilling tools. For metal cutting operations, such as turning and milling, replaceable cemented carbide inserts are frequently used. The exposure of inserts to very severe conditions, e.g. temperatures as high as 1000 C in combination with very high loads, limits the lifetime of them. When the tools and components are scrapped, they are collected with a view to recovering the tungsten carbide and cobalt due to environmental aspects and in light of the strategic importance of these materials. In this work, selective electrolysis process was used for recovery of WC powder particles from cemented carbide scraps. The WC-10Co and WC-10Co-VC up to 3 wt.% VC was produced using powder metallurgy route. The mean particle size of WC, Co and VC were selected as 2.5, 1.5 and 2.2 μm, respectively. Referring to electrochemical curves of WC-10Co cemented carbides in hydrochloric acid solutions with different concentrations, the recovering rate was enhanced in 1N acid. Therefore, this solution was selected for recycling of all samples. The surfaces of as produced and corroded specimens were investigated using SEM. Detection of corrosion products was provided by EDX. According to results, the selective electrolysis process could be useful in the recycling of scrap carbide materials. Although, more studies should be provided on economical aspects of the process and the quality of samples produced by using recovered powders.

Paper 37.6 — 10:50

ASSESSMENT OF TUNGSTEN CARBIDE HARDFACING DEPOSITS UNDER DIFFERENT WEAR CONDITIONS.

R. LLEWELLYN and D. KUMAR, NRC Institute for Fuel Cell Innovation, Canada

Tungsten carbide-based weld deposited hardfacings have been used increasingly in the severe environments faced in oil sands operations over the last ten years, particularly in situations where their low stress and slurry abrasion resistance properties are principal requirements. The main assessment and qualification testing method employed has been the ASTM G65 dry sand rubber wheel, a low stress sliding abrasion technique. However, knowledge of the influences on their wear performance under other types of mechanisms, is of very considerable importance for wider industrial application and also to help optimise the various formulations and deposition methods for different service conditions. A range of tungsten carbide-based hardfacing deposits produced by several techniques, has been subjected to a variety of wear tests that simulate some of the main wear mechanisms encountered in mining and mineral processing. An assessment will be made of the influences of welding consumable composition, application technique, hardness and microstructural characteristics on their resistance to wear attack under high stress and low stress abrasion, slurry erosion and gouging abrasion.

PAPER 37.7 — 11:15

DETERMINATION OF REFRACTORY AND CASTABLE QUALITY IN OPERATING INDUSTRIAL FURNACES, USING A STRESS WAVE REFLECTION TECHNIQUE.

A. SADRI and G. WATERS, Hatch, Canada

The quality of the refractory bricks and castables could be determined by direct measurements of their material properties such as elastic properties, porosity, density, etc. using conventional static or non-destructive testing (NDT) dynamic techniques. Quality monitoring of refractory linings is a lot more challenging and complicated. The static methods require undesirable drilling and sample extractions from the furnace structure. A more desirable alternative is the use of NDT techniques for material quality estimation. The Acousto Ultrasonic-Echo (AU-E) technique is a new stress wave propagation approach for quality monitoring of refractory lining in operating furnaces. In this paper, the conceptual methodology for the AU-E technique is described, the capabilities and limitations are expanded, and the result from two (2) case studies is discussed.

PAPER 37.8 — 11:40

NON-DESTRUCTIVE DETERMINATION OF REFRACTORY AND BUILD-UP THICKNESS IN OPERATING FURNACES USING AN ACOUSTO ULTRASONIC REFLECTION TECHNIQUE.

A. SADRI, Hatch, Canada

For the last few years a new and innovative technique has been successful used to determine refractory and castable thickness in various vessels. The acousto ultrasonic-echo (AU-E) technique uses stress waves to detect metal penetrations and delaminations within refractory linings. In addition, it is capable of measuring thickness of refractory layers and build-ups. The inspection and measurements can be carried out while the furnace is in full operation. Present paper discusses the principals of AU-E technique, its advantages and limitations. In addition a number of case studies are presented to demonstrate various capabilities of this new Non-Destructive Testing (NDT) technique.