

WEDNESDAY, AUGUST 24, 2004, P.M.

SESSION 51B: SECOND INTERNATIONAL SYMPOSIUM ON AEROSPACE MATERIALS AND MANUFACTURING: DEVELOPMENT TESTING AND LIFE CYCLE ISSUES - HONORING WILLIAM WALLACE

CORROSION AND REPAIR TECHNOLOGIES FOR AEROSPACE MATERIALS

Sponsor: Materials Performance and Integrity Section, The Metallurgical Society of CIM

Room: 206

Chairmen: P.C. PATNAIK, M. JHAZI, National Research Council – Institute for Aerospace Research, Ottawa, Ontario, Canada,

M. ELBOUJDAÏNI, CANMET, Ottawa, Ontario, Canada, and

J. LUO, University of Alberta, Edmonton, Alberta, Canada

PAPER 51B.1 — 14:00

EFFECTS OF APPLIED STRESS ON THE OXIDATION KINETICS OF γ -TiAl

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In addition to the harsh environment, materials for high-temperature applications are often subjected to a significant mechanical loading. Several researchers have noted that the rate of oxidation can be affected by stress in a range of materials. We have recently studied this effect in γ -TiAl, based on the preliminary work of Magnan and Weatherly which showed that nitridation rates on the tensile side of a flexural creep specimen could be 10 times higher than on the compressive side. We have since developed a four-point bending creep setup capable of controlled atmosphere testing. We present quantitative data on the effect of creep on scale growth under a range of atmospheric conditions. Finite element analysis will also be used to show how modest applied stresses can have a large effect on scale growth rates through the generation of large stresses due to the mismatch of creep rate between the metallic substrate and the scale.

PAPER 51B.2 — 14:25

INTERACTION OF MECHANICAL AND CHEMICAL FACTORS IN EROSION-CORROSION PROCESS OCCURRING IN OIL SAND WASTEWATER TRANSPORTATION

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B.T. LU and J.L. LUO, Chemical & Materials Engineering, University of Alberta, Edmonton, Alberta, Canada

In this paper, the synergism in erosion-corrosion process occurring in oil sand wastewater transportation caused by the interaction of mechanical and electrochemical factors was experimentally investigated. The erosion-corrosion tests were conducted with A1045 steel in synthetic slurries comprising tap water and silica sand. The material loss due to corrosion-enhanced erosion was assessed with the chemo-mechanical model developed by the authors recently. The results indicate that the material loss produced by corrosion-enhanced erosion at the open circuit potential can be formulated as a linear function of logarithm of corrosion current density. The wastage caused by the erosion-enhanced corrosion was analyzed based on the concept of non-equilibrium thermodynamics. The material loss induced by the erosion-enhanced corrosion is approximately a linear function of overall erosion rate measured in synthetic slurries, indicating that erosion-enhanced corrosion could be reduced by adopting surface strengthening techniques to improve the resistance to the plastic deformation in surface layer.

PAPER 51B.3 — 14:50

PRACTICAL EROSION AND CORROSION RESISTANT COATINGS FOR TURBINE COMPRESSOR AEROFOILS: SCALING UP FROM LAB SCALE TO COMMERCIAL PRACTICAL CAPACITY

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Controlling erosion in flight engine turbine compressors reduces fuel burn and prolongs time on-wing. Although differing styles of sand filters and separators have been proposed, basic hardening of the compressor airfoils is cheaper and more effective. Through years of development and testing, Liburdi has emerged with a practical ceramic coating technology, RIC, which has been in commercial use for 5 years. This paper reviews the engineering constraints of erosion coatings and briefly details the process. It focuses on the reality that small scale materials processes do not directly scale into larger production capabilities. Finally, it recaps some of the operational experience to date.

COFFEE BREAK — 15:15 – 15:45

PAPER 51B.4 — 15:45

ADVANCED CHARACTERIZATION OF A STRESS CORROSION CRACK FROM AN IN-FIELD SERVICED X-52 STEEL LINE PIPE

J. LI, M. ELBOUJDAINI, V. Y. GUERTSMAN, Materials Technology Laboratory, Natural Resources Canada, Ottawa, Ontario, Canada

M. GAO, PII North America, Inc., GE Power Systems

D.C. KATZ, Williams Gas Pipeline West

Analysis of stress corrosion cracking (SCC) usually involves high-end analytical tools including scanning electron microscope (SEM) and analytical transmission electron microscope (TEM). In recent years, focused ion beam microscope (FIB) has found many applications in materials science fields. In this study, high-resolution FIB images have shown details of crack morphology and a plan-view TEM specimen containing the selected crack-tip was successfully prepared. The preparation of cross-sectioned samples containing crack tips was of paramount importance for subsequent TEM analyses.

PAPER 51B.5 — 16:10

SYNERGISTIC EFFECT OF EROSION-CORROSION OF A1045 CARBON STEEL IN Na_2SO_4 SOLUTION

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This paper investigated the synergistic effect in the slurry-erosion process of carbon steel. In line with the mechanisms of material loss, the synergism due to interaction of erosion and corrosion was divided into the corrosion enhanced by erosion and erosion enhanced by corrosion. The erosion-corrosion tests were conducted with A1045 steel in slurries containing silica sand. Experimental results showed that the rotating of the sample in corrosive media raised both OCP and corrosion rate, but the impingement of solid particles did not affect the corrosion current significantly. In the quiescent solutions, the Faraday's law gave a good prediction for the weight loss caused by corrosion but for rotating samples, the weight loss experimentally measured was virtually greater than that predicted by the Faraday's law, indicating that the corrosion-enhanced erosion could occur in corrosive fluids in absence of solid particles. A half-logarithm relationship was observed between the weight loss due to corrosion-enhanced erosion and the anodic current density.