PRELIMINARY PROGRAM

---Tuesday October 5, 2010---

08:30
Room number: Oxford (Conv-3rd Flr)
Stream: MATERIALS DEGRADATION & CONTROL
Session: Materials Degradation & Control I (TUESAM1)

Paper Start Time: 08:30
Paper No.: 4969
Paper Title: **Identification of the Hydrogen Damage in Industrial High Strength Steels after Electrochemical Charging**
Diana Maria Perez Escobar; University of Ghent; Lode Duprez, ArcelorMittal Research Industry (OCAS); Kim Verbeken, University of Ghent; Marc Verhaege, University of Ghent;
Multiphase steels are quite sensitive to hydrogen embrittlement. Laboratory tests often use electrochemical charging to introduce hydrogen into the sample, but damage caused by charging has to be avoided. A ferrite-bainite steel was charged using various conditions to identify when surface damage occurred. Samples were also checked for internal damage by electron microscopy. This study was repeated for three other multiphase steels and pure iron. HSLA steel was more resistant and pure iron was quite susceptible to hydrogen damage. For all industrial steels, cracks concentrated in the middle of the sample were attributed to inclusions and segregations, inherent to production.

Paper Start Time: 08:55
Paper No.: 5075
Paper Title: **The Effect of Heat Treatments on Carbon Dioxide Corrosion Performance of API-X100 HSLA Steel**
Faysal Eliyan; University of British Columbia; Akram Alfantazi, University of British Columbia;
API-X100 High Strength Low Alloy Steel (HSLA) is considered to be one of the promising pipeline materials that exhibit very good strength performance in high pressure applications in petroleum industry. The corrosion behavior of X-100 steel subjected to various heat treatments is studied using electrochemical methods including potentiodynamic polarization at a temperature range of 30 □ 70 C and a PH range of 5-7 under CO2 purging. The results reveal that the type of heat treatment applied to the X-100 substrates has a noticeable impact on the corrosion performance in terms of the corrosion rate and the nature of corrosion product. The experimental investigation of the formed corrosion product using X-ray Electron Diffraction and Scanning Electron Microscopy indicates various differences in the morphology and the chemical composition of the corrosion product. Those characteristics of the corrosion product in addition to the measured corrosion rate provide a very good source of information about the basic mechanisms of the corrosion process of X-100 and corrosion product formation as a function of the type of heat treatment.

Paper Start Time: 09:20
Paper No.: 5132
Paper Title: **Strain-induced Defects Associated with Hydrogen Embrittlement of Cold-drawn Pearlitic Steel**
Tomoki Doshida; Sophia university; Hiroshi Suzuki, Sophia University; Kenichi Takai, Sophia University; Yukito Hagihara, Sophia University;
The relationship between hydrogen embrittlement susceptibility and strain-induced defects associated with hydrogen was evaluated for cold-drawn pearlitic steel under different trapping states of hydrogen and temperatures. The experimental conditions causing ductility loss increased the amount of strain-induced defects evaluated by means of thermal desorption analysis using hydrogen as a probe. Since the strain-induced defects were annihilated at a temperature of 200?C, the defects were not dislocations but rather vacancies or vacancy clusters. These results indicate that enhancement of the formation of strain-induced defects is directly associated with hydrogen embrittlement.

Paper Start Time: 09:45
Paper No.: 5165
Paper Title: **The Effect of Bovine Serum Albumin on the Polarization Behavior of Stainless Steel, Cobalt-Chromium, and Titanium Bio-implants Alloys**
Shima Karimi; University of British Columbia ; Rizhi Z. Wang , University of British Columbia; Akram Alfantazi, University of British Columbia;
316L stainless steel, Co-28Cr-6Mo, and Ti-6Al-4V alloys are biocompatible materials due to the spontaneous formation of a passive oxide film. However, implants are at the risk of slow diffusion of metal ions through the passive film, transpassive dissolution under high oxidizing conditions, and the local break-down of passivity as a consequence of pitting or crevice corrosion. It is believed that the presence of proteins such as albumin could influence the corrosion behavior of alloys. Implants are in contact with blood which containing various organic compounds. In human body, the total concentration of organics is more than 80 g/l including mainly proteins along with other substances such as fatty acids, glucose, cholesterol, lactate, and urea. Implant□s corrosion processes can be affected

by adsorption of organics onto the surfaces. In this study, the corrosion behavior of 316L stainless steel, wrought Co-28Cr-6Mo, and Ti-4V-6Al is studied in aerated solutions of Ringer□s, Hank□s, Simulated Body Fluid and phosphate buffered saline at pH of 7.4 and 5.5 at 37°C by potentiodynamic polarization tests. The effect of Bovine Serum Albumin (BSA) is also investigated at various concentrations (0.2, 0.4, 0.8, 1.2, 2, and 4 mg/L). Furthermore, the chemical compositions of solutions after testing are measured to understand the ion release from the alloys. The surface chemistry and structure are analyzed by energy dispersive X-ray spectroscopy and scanning electron microscope. Finally, the corrosion resistance of these alloys in each solution is compared at various BSA concentrations.

10:30
Room number: Oxford (Conv-3rd Flr)
Stream: MATERIALS DEGRADATION & CONTROL
Session: Materials Degradation & Control I (TUESAM2)

Paper Start Time: 10:30
Paper No.: 5187
Paper Title: **Identification of Hydrogen Trapping Sites in Pure Iron Using Thermal Desorption Spectrometry Detected from Low Temperature**
Yuta Sato; Sophia University; Kei Fujita, Sophia University; Hiroshi Suzuki, Sophia University; Kenichi Takai, Sophia University; Yukito Hagihara, Sophia University;
In order to determine the hydrogen trapping sites in metals, a new method, that is able to elevate temperature linearly from -200 C and is called low-temperature thermal desorption spectrometry (L-TDS), has been developed. Diffusible hydrogen trapped at various lattice defects directly causing hydrogen embrittlement in pure iron was separated using L-TDS. Experimental data show that the hydrogen peak temperatures desorbed from solid solution hydrogen, dislocations, grain boundaries, vacancy clusters, and blisters correspond to -70 C, 10 C, 90 C, 100 C and 100 C, respectively. These results indicate that L-TDS enables us to determine the hydrogen trapping sites in metals.

Paper Start Time: 10:55
Paper No.: 5193
Paper Title: **Corrosion of Lead Anodes**
Matthew Tunnicliffe; University of British Columbia;
Understanding the mechanisms of lead in a sulfate media will allow result in the increasing lifespan of lead anodes in a zinc electrowinning process. Anodes are susceptible to corrosion and currently have a lifespan between three and five years depending on a electrolyte's acid, zinc, and manganese concentrations in addition to physical and chemical preconditioning, the operating temperatures and the applied current density. Minimizing the corrosion of lead will reduce capital costs at the plant and improve grade of material produced.

Paper Start Time: 11:20
Paper No.: 5195
Paper Title: **A Simple Equation for the Prediction of the Corrosion Rate in the Presence of Corrosion Inhibitors (Inorganic Oxidizing agent) of the type MeOx z- (Chromate, Vanadate, Molybdate, and Pertechentates)**
Mahmoud/R. Reda; CanadElecrochim;
Inorganic oxidizing agent of the type MeOx-z such as Chromate, Vanadate, Tungstate, and Molybdate... etc. are widely used as corrosion inhibitor. In non acidic solution these oxidizing agent (OX) are reduced on the surface of the metal according to following cathodic reaction OX + m e + p H2O ------ Red + n OH- In which ? = (n-m)/m. The purpose of this publication is to show that for many metals the value of ? (greater or less than 1.0) for any oxidizing agent determines the possibility of that oxidizing agent being an inhibitor or activator for the corrosion process.

14:00
Room number: Oxford (Conv-3rd Flr)
Stream: MATERIALS DEGRADATION & CONTROL
Session: Materials Degradation & Control II (TUESPM1)

Paper Start Time: 14:00
Paper No.: 5197
Paper Title: **New Environmentally Friendly Corrosion Inhibitor as Replacement for Chromate**
Mahmoud/R. Reda; CanadElecrochim;
Because of the adverse environmental effect of Chromate, Molybdate ions had been investigated as replacement for Chromate and the results had shown not to be encouraging. Film deposited from peroxopolymolybdate (form from reaction of Molybdenum metal with excess Hydrogen Peroxide),are more robust than that deposited from molybdate solutions. This was shown to be due to higher fraction

of Mo(IV) and Mo(V) that form from Mo(VI) in the peroxopolymolybdate deposited film than the film deposited from Molybdate solutions. The protective properties of peroxopolymolybdate was shown to be due to the effectiveness of the un-hydrated Molybdic acid.

Paper Start Time: 14:25
Paper No.: 5237
Paper Title: **Application of Electrochemical Impedance Spectroscopy for Fouling Monitoring of Inconel 625 at High Temperature and Pressure**
Hamid Reza Zebardast; University of British Columbia; Edouard Asselin, University of British Columbia; Steve N. Rogak, University of British Columbia;
The high operating temperature and pressure in the heat transport system of Supercritical Water Reactors (SCWRs) can induce fouling in coolant tubes due to the changes in water properties which occur at the sub- to supercritical conditions. As a result of the thermally insulating layer usually consisting of corrosion product deposits, heat transport tubes often experience overheating. In the present paper results on an electrochemical approach for fouling monitoring at elevated temperatures and pressures using electrochemical impedance spectroscopy (EIS) are discussed. The emphasis is placed on the development of a sufficiently accurate, reliable and in-situ monitoring method. The effect of experimental parameters such as water chemistry, temperature, pressure, and concentration of simulated corrosion products such as hematite and magnetite are investigated.

Paper Start Time: 14:50
Paper No.: 5613
Paper Title: **Load and Temperature Effects on the Superelastic Characteristics of TiNi under Localized Compressive Load**
Meisam Shahirnia, Dalhousie University; Zoheir Farhat, Dalhousie University; George Jarjoura, Dakhousie University;
TiNi shape memory alloy has been widely used in various applications due to its unique properties such as shape memory effect and superelasticity, as well as its superior wear and corrosion resistance. Shape memory and superelastic effects are due to a reversible martensitic transformation that can be thermo-mechanically induced. Although the behaviour of TiNi shape memory alloys is well established under tensile conditions, its behaviour under compressive conditions is not well understood. In this study, indentation tests at different temperatures and loads have been performed on shape memory and superelastic TiNi alloys in order to establish an understanding of their stress-temperature characteristics under localized compressive loading.

15:35
Room number: Oxford (Conv-3rd Flr)
Stream: MATERIALS DEGRADATION & CONTROL
Session: Materials Degradation & Control II (TUESPM2)

Paper Start Time: 15:35
Paper No.: 5272
Paper Title: **Electrochemical Impedance Characteristics of Coated Buried Pipeline under Different Field Conditions**
Hamid Reza Zebardast; University of British Columbia; Mohsen Saremi, University of Tehran; Nima Parsi Benehkohal, McGill University;
Monitoring and maintaining of buried pipelines is one of the most important concern in gas, oil and petroleum industry with due attention to the fact that, Steel pipelines can be damaged by electrochemical interaction with the soil environment. The aim of the present article is to investigates the influence of different field conditions such as soil resistivity and cathodic protection on AC electrochemical impedance spectroscopy (EIS) signals, along with pipeline coating defect`s size and position. In this respect, a buried pipeline system under laboratory conditions was simulated and then results obtained under different conditions were fitted by Zview for data interpretation. Experimental EIS findings demonstrated a promising procedure for buried pipelines monitoring.

Paper Start Time: 16:00
Paper No.: 5276
Paper Title: **Erosion-corrosion Behaviour of Cold Spray Ni-20Cr Coating on SA 516 Steel in Actual Boiler Environment**
Harpreet Singh Saheet; Indian Institute of Technology Ropar; Niraj Bala, BBSB Engineering College; Satya Prakash, Indian Institute of Technology Roorkee;
High temperature corrosion accompanied by erosion is a severe problem, which may result in premature failure of the boiler tubes. Several countermeasures have been proposed to counteract this type of erosion-corrosion in the literature. One such measure is the use of thermal spray protective coatings on the boiler tubes. Cold spray coating process is a relatively newer emerging technique in this field. Ni-20Cr powder was successfully deposited on SA 516 (Grade 70) boiler steel with the cold spraying technique. In this work the bare as well as the coated steels were subjected to an actual boiler environment to ascertain their erosion-corrosion behaviour. Cyclic experimental studies, which consisted of 100 hours heating, followed by 1 hour cooling, for 15 cycles were performed in the superheater zone of a coal fired boiler. The weight change data was used to establish kinetics of the erosion-corrosion. XRD and SEM/EDS techniques were used to analyse the as-sprayed and corroded specimens. The uncoated steel showed a significant overall

weight gain during exposure in the actual boiler environment for 1500 hours. The high corrosion rate may be due to the formation of unprotective Fe2O3 oxide scale on the bare SA 516 steel. However, after the deposition of the Ni-20Cr coating the weight change became negligible after only a few cycles. The EDS analysis of the exposed coating indicated the formation of Cr2O3 in its oxide scale, which might have acted as a barrier to the erosion-corrosion of the steel. It has been concluded that Ni-20Cr coating could be successful to reduce the erosion-corrosion of the said steel.

Paper Start Time: 16:25
Paper No.: 5313
Paper Title: **Comments on the Prediction of the Top of Line Corrosion: A Simple Equation for Corrosion Engineers to Predict the Occurrence of the Top of the Line Corrosion**
Mahmoud/R. Reda; CanadElecrochim;
Top of the Line Corrosion has become a growing concern in the oil and gas industry and a better understanding of the corrosion mechanisms involved are needed. Corrosion engineers need a simple equation to estimate the possibility of whether TLC Corrosion will occur. The equation depends on partial pressure of CO2 and H2S and total organic acid in oil flowing inside the pipe. If the coefficient ß exceeded certain critical value, and then there is a good possibility of TLC corrosion ß = Function [(PCO2 + PH2S)/ (organic acid)] Once the gases CO2 and H2S are dissolved in a condensed droplet at the surface of the pipe then corrosivity will be determined by the pH of the droplet. Scale can be soluble and destructive (ferrous or ferric bicarbonate). Scale can be insoluble and protective (ferrous and ferric carbonate).

---Wednesday October 6, 2010---

08:30
Room number: Oxford (Conv-3rd Flr)
Stream: MATERIALS DEGRADATION & CONTROL
Session: Materials Degradation & Control III (WEDAM1)

Paper Start Time: 08:30
Paper No.: 5376
Paper Title: **Low-temperature Hydrothermal Deposition of Alpha-alumina Coatings on Metals**
Wojciech Suchanek; Sawyer Technical Materials, LLC;
Hydrothermal synthesis was used to prepare corrosion-resistant a-Al2O3 –based coatings on 316 stainless steel, 1018 carbon steel, Inconel 718, and Grade 5 Titanium, at low temperature around 400ºC without any template layers. The coatings were either 100% phase alpha-alumina (corundum, a-Al2O3) or consisted of mixtures of the a-Al2O3 and substrate metal-derived oxides. Their microstructures, i.e. grain size, coating thickness, or surface coverage, could be controlled in wide ranges by changing the synthesis conditions. Growth mechanisms of the coatings are discussed. The hydrothermal deposition minimizes thermal stresses in the coatings (<1.8 GPa) and provides uniform coverage of complex shapes.

Paper Start Time: 08:55
Paper No.: 5411
Paper Title: **ZERON 100 for Downstream Processing in Acid Leach Mining**
Roger Francis; Rolled Alloys; Devin Wachowiak, Rolled Alloys;
There is increasing use of acid leach extraction methods at elevated temperatures and pressures by the mining industry. In many locations there are limited supplies of fresh water and waters with higher chloride contents must be used, making conditions more corrosive. The fluids after the main autoclave are hot, acidic, oxidizing and contain chlorides and present a challenge to the mining community to ensure reliable operation. Zeron 100 is a high strength superduplex stainless steel that offers high corrosion resistance at a cost effective price. The paper presents a combination of laboratory data and service experience, particularly in the aggressive fluids found in downstream processing.

Paper Start Time: 09:20
Paper No.: 5449
Paper Title: **Effect of Temperature on the Flow Properties of Lead-free Solder Pastes used in Electronics Manufacturing**
Sabuj Mallik; University of Greenwich;
Solder paste is the widely used bonding material in electronics assembly process. It experiences changes in temperature at different stages of its manufacturing and application phases. Also depending on the geographical location, the handling and operating temperature of solder paste could be different. In this study, two different solder pastes were used to carry out a series of rheological tests (namely viscometry, oscillatory and creep tests) at three different temperatures (150 C, 250 C and 350 C). Results show that the paste flow behaviours are highly dependent on temperature. Increasing temperature caused the viscosity to decrease and hence

weakened the structure and also enhanced the occurrence of creep.

Paper Start Time: 09:45
Paper No.: 5462
Paper Title: **Development of a Risk Based Inspection System for the Mining and Metals Industry**
Sophie Boisvert; BPR-Bechtel; Joël Fortin, BPR-Bechtel; Daniel Savard, BPR-Bechtel;
Risk Based Inspection (RBI) addresses the challenges associated with ageing plants by focusing the inspection effort on the process equipments with the highest risk, thereby improving plant safety and reducing inspection costs. The RBI methodology is commonly used in the oil industry through the API 581 standard. Since no such standard exists in the mining and metals industry, BPR-Bechtel has developed one using inspection data from process equipments in CEZinc. Models were developed for various consequences and damage mechanisms such as uniform corrosion and stress corrosion cracking. The equations were organized into a user friendly software that facilitates the implementation process.

10:30
Room number: Oxford (Conv-3rd Flr)
Stream: MATERIALS DEGRADATION & CONTROL
Session: Materials Degradation & Control III (WEDAM2)

Paper Start Time: 10:30
Paper No.: 5463
Paper Title: **Corrosion of Stainless Steels in Hot, Concentrated Sulphuric Acid, Comparison of Lab and Field Data**
Joey Kish; McMaster University; John R. Rodda, McMaster University; M. Brian Ives, McMaster University;
Stainless steels are widely used to handle concentrated sulphuric acid (H2SO4) solutions produced in the manufacturing process.The corrosion resistance of these alloys relies on the formation of a protective passive film, which tends to tends to breakdown on a periodic basis. This cyclic behaviour presents challenges in determining meaningful corrosion rates. An attempt was made to correlate corrosion rate data extracted from lab exposure extracted from field exposure to identify a corrosion rate technique that best predicts the long term corrosion resistance.

Paper Start Time: 10:55
Paper No.: 5630
Paper Title: **Effect of Cold Work on Erosion Corrosion Properties of Passive Materials as a Function of Friction Force**
Farzad Mohammadi; University of Alberta; Jing Li Luo, University of Alberta;
Erosion corrosion of passive materials has had catastrophic consequences for industries involved with fossil fuel related processes. Both erosion and corrosion have an enhancing effect on each other. An earlier study by us showed that for passive materials exposed to the flow of slurries, friction forces played a major role in causing damage on the surface oxide scale (depassivation). Sample sheets of 304 stainless steel were cold rolled to investigate the effect of work hardening on erosion corrosion as a function of friction forces between impacting particles and the surface. Single particles were impinged on the surface while high speed camera was capturing photos from the event simultaneously. Friction force was calculated by comparing the impact and rebound characteristics of particle impacts derived from analysis of the photos. Friction force between the impacting particles and the surface decreased as the percentage of cold work was increased up to 20%. It was observed that a raise in the friction force raised both erosion rate and erosion enhanced corrosion rate.

Paper Start Time: 11:20
Paper No.: 5196
Paper Title: **Flow Induced Corrosion and Erosion Corrosion are Two Different Corrosion Phenomena**
Mahmoud/R. Reda; CanadElecrochim;
The first kind is due to the simultaneous effect of mechanical removal and electrochemical corrosion which is termed erosion corrosion. The second kind is flow induced corrosion which is due to the doping (substitution of impurities) of various kind of impurities such as hydroxide ions, Fe(II), Ca(II), oxygen and others which can occurs at critical velocity (due to the wall shear stress). The impurities can substitute in the position of for example Mo in the grain boundary of any kind of stainless steel. This doping will lead to change in the crystal structure (for example, from BCC to FCC).This can lead to protection or degradations.