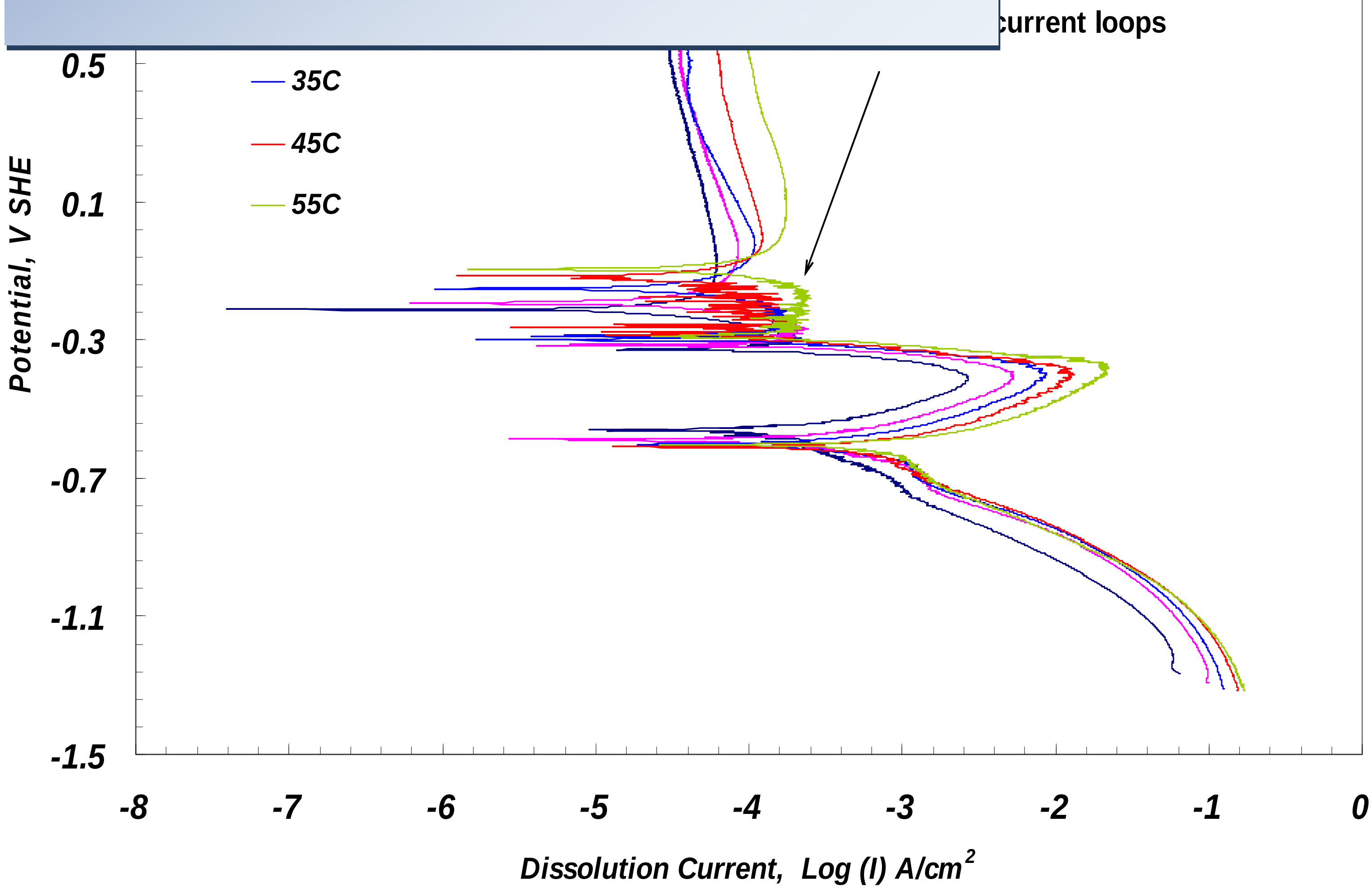
MERC 2009

December 4th 2009

10:30 - 14:00

Frank Forward Building

Room 217



Department of Materials Engineering

The University of British Columbia

Vancouver BC

Materials Engineering Research Colloquium Schedule

Friday December 4th, 2009

Presenter	Time	Title
C. Ubah	10:30	High Temperature and Pressure Electrochemical Sensors for Use in Supercritical Water
M. Bayat	11:00	Electrical and Magnetic Properties of Carbon/Fe_3O_4 Nanofibre Composites
P. Li	11:30	Electrospinning of Nanocrystalline Cellulose Reinforced Nanocomposite Fibres
LUNCH	**12:00**	
S. Roy	13:00	Electrochemical Dissolution and Passivation Behavior of Pure Iron in Ammoniacal Solution
S. Zacharski	13:30	Constitutive Model to Describe the Nonlinear Behavior of Coated Airbag Fabrics Under Deployment

High Temperature and Pressure Electrochemical Sensors for Use in Supercritical Water

Chinedu Ubah
Edouard Asselin
Department of Materials Engineering,
University of British Columbia

Research Summary:
As aqueous processing moves to higher temperatures and pressures to take advantage of increased kinetics there is a need to develop and test appropriate reactor materials to ensure that corrosion is minimized. Corrosion testing often requires an electrochemical approach to fully understand the range of behaviours which should be expected from a corroding metal or alloy.

Prior art of designs for electrodes, associated pressure vessels and sealing technology is presented. The development of an apparatus and methods for high temperature and high pressure electrochemical corrosion testing are discussed. The final flow-through electrochemical cell design, the Flow-Through External Pressure-Balance Reference Electrode (FTEPBRE) design, Working/Counter electrode and other components which were developed for temperatures and pressures in excess of 500ºC and 5000 PSI is presented.

A two-electrode electrochemical testing method is presented to assess the stability of quasi reference electrodes. Open Circuit Potential (OCP) measurements are also presented. The effects of pressure, and combination of pressure and temperature on OCP both in aerated and de-oxygenated environments using a Nickel alloy (Ni-66.5%, Cr-21.0%, Fe-4.4%, Nb-2.7%, S-2.7%) working electrode are also discussed.

The test results provide in-depth information as to the influence of Sub/Supercritical temperatures and pressures on the corrosion behaviour of metals and alloys in a dynamic system.

Electrical and Magnetic Properties of Carbon/Fe_3O_4 Nanofibre Composites

Masoumeh Bayat
Heejae Yang, Frank Ko
Department of Materials Engineering,
Advanced Fibrous Materials Laboratory, University of British Columbia

Research Summary:
The aim of this research is to examine the electrical conductivity and magnetic properties of C/Fe_3O_4 electrospun composite nanofibres. Polyacrylonitrile (PAN) has been used as a matrix for making the composite nanofibres containing different contents of magnetite nanoparticles (1, 5 and 10wt% Fe_3O_4). Electrospun composite nanofibres were pyrolized at two different temperatures 700°C and 900°C for a comparative study. As a result, electrically conducting magnetic carbon nanofibre composites were produced with a wide range of application. The nanocomposite fibres were characterized by Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, four-point probe technique and Superconducting Quantum Interference Devices (SQUID). SEM showed the formation of uniform fibres with a diameter of about 550nm which decreased to 370nm after carbonization. XRD and Raman results indicate that graphitization degree of carbon fibres increases due to the introduction of Fe_3O_4 nanoparticles into the PAN matrix. They also confirmed the presence of both Fe_3O_4 and graphite after heat treatment. According to the 4-point probe measurement and SQUID results, electromagnet composite nanofibres have been produced with electrical conductivity of 11S/cm and saturation magnetization of about 17emu/g obtained for the highest concentration of Fe_3O_4 nanoparticles (10wt%) carbonized at 900°C.

Electrospinning of Nanocrystalline Cellulose Reinforced Nanocomposite Fibres

Yingjie Li[1], Yuqin Wan[1], Wadood Hamad[2] and Frank K. Ko[1]
1. Advanced Fibrous Materials Laboratory, University of British Columbia
2. FP Innovations-Paprican, Vancouver, BC, Canada

Research Summary:
The incorporation of small amounts of high-stiffness, high aspect ratio nanometer-sized fillers into polymers can lead to nanocomposite, which displays a significant mechanical reinforcement when compared to the neat polymer. Furthermore, current interests in the development of sustainable bio-based products have been triggered by the emerging shortage of petrochemical raw materials. To this end, this work is aimed at transferring outstanding properties of biomass nano-fillers into the nanocomposite materials.

Nanocrystalline cellulose (NCC), obtained by acid hydrolysis of cellulose, is currently attracting significant interest in the research area, mainly due to its intriguing mechanical properties and the abundance of source. Although it is confirmed that NCC/polymer nanocomposites can be produced by electrospinning technique, is challenging to make a homogeneous dispersion of NCC in a polymeric matrix for obtaining well-defined mechanical properties and consistent performance of the final composite material.

Therefore, the main goal of this work is directed to (1) provide a novel composition in which NCCs can be uniformly dispersed in polymer solutions, and this formula can be electrospun into NCC fibres in which NCCs are uniformly distributed; and (2) to demonstrate that the incorporation of NCCs can improve the mechanical properties of resulting fibre products.

Electrochemical Dissolution and Passivation Behavior of Pure Iron in Ammoniacal Solution

Subrata Roy
Edouard Asselin
Department of Materials Engineering
University of British Columbia

Research Summary:
The electrochemistry of metal-water-ammonia systems is of significant concern to the extractive metallurgical industry due to the electrochemical nature of leaching reactions. The recovery of nickel and cobalt by the Caron process occurs through the reductive roasting of limonitic laterite ores followed by atmospheric leaching of this reduced ore in an ammonia-ammonium carbonate solution. The reductive roast results in the formation of a Fe-Ni-Co alloy and the leaching behavior of nickel and cobalt strongly depends on the dissolution and precipitation behavior of this alloy. The main advantages of the Caron process are the selectivity of the leach to nickel and cobalt and the recyclability of ammonia. However, poor recoveries of Ni/Co are experienced in the Caron leach. In particular, the passivation of the iron based alloy is associated with pay-metal losses during the extraction of Co and Ni .These poor recoveries (~50% for Co and ~80% for Ni) are believed to be due to either adsorption on Fe hydroxides or the passivation of the alloys formed during the reduction step.

This work was undertaken to examine the electrochemical passivation of pure Fe in ammoniacal solution and to determine the stability of both Fe-oxides and Fe-ammines during anodic polarization. Potentiodynamic experiments were performed on a pure iron sample in Caron leach solution in naturally aerated, oxygenated and de-aerated conditions at different temperature and pH. These measurements show that the dissolution rate and the window of iron ammine stability increased with temperature. Solution and surface analyses confirmed the rate of dissolution and the nature of the product film which enabled the calculation of metastable Pourbaix diagrams for the system.

Constitutive Model to Describe the Nonlinear Behavior of Coated Airbag Fabrics Under Deployment

Steven Zacharski
Frank K Ko and Reza Vaziri

Research Summary:
Of fundamental importance to airbag performance is the mechanical properties of the airbag fabric. The fabric constructed of a plain weave, Nylon 6,6 high tenacity yarn with a silicone coating exhibits a highly nonlinear and anisotropic mechanical behavior while undergoing complex modes of deformation until failure. In order to accurately simulate deployment and impact conditions, the material behavior as well as the boundary conditions have to be carefully formulated.

In this presentation, the formulation of a unit cell based constitutive model to describe the nonlinear behavior of coated-airbag fabrics under deployment has been developed. The unit cell representative of a two yarn crossover with a sinusoidal yarn profile is constructed considering geometric and mechanical properties of the yarn and coating. Deformations arising from yarn extension, coating extension, crimp interchange, yarn compression, and frictional effects that arise from yarn rigidity and coating shear interaction are included.

The model is inputted into the commercial explicit finite element code LS-DYNA as a User Material Routine for deployment simulation purposes. Preliminary results of the biaxial response of the constitutive model are presented.