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Poster Abstracts

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Poster Number: 1

Response Of 7000 Series Aluminium Alloys To High Temperature Pre-Precipitation Heat Treatment (HTPP)

Presented by: Olayinka Tehinse
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Jonathan Beddoes

Research Area(s): *Crystalline Materials and Nanostructures*

Al-Zn-Mg-Cu (7000 series) aluminium alloys are widely used for airline structures. It is difficult to obtain a combination of optimal strength and stress corrosion (SC) resistance for these alloys. It appears that SC resistance of these alloys is related to grain boundary precipitate morphology. One technique to control the grain boundary precipitate morphology is to introduce a 'stepped' cooling procedure following the solution heat treatment- referred to as High Temperature Pre-precipitation (HTPP) treatment. The results of ten HTPP processes applied to 7075 and 7050 commercial 7000 series alloys are presented in terms of hardness, electrical conductivity and corrosion resistance. Results indicate that subsequent to HTPP processing, the 7050 alloy can be precipitation aged to a higher hardness compared to 7075; this result is associated with the modification of 7050 alloy by zirconium versus chromium in 7075 alloy. It does not appear that HTPP can achieve a combination of hardness, electrical conductivity and corrosion resistance superior to standard T6 and T7X tempers. Future research will aim to elucidate the microstructural response of 7075 and 7050 alloys to HTPP and correlation between electrical conductivity and corrosion resistance.

Poster Number: 2

The Magnetocaloric Effect In Multilayered Cobalt Copper Films

Presented by: Ryan Desautels
PhD Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. J. van Lierop

Research Area(s): *Crystalline Materials and Nanostructures*

The magnetocaloric effect has historically been used to achieve milli-Kelvin temperatures in several types of materials (e.g. paramagnetic salts, manganites and Gd); however, recently their high temperature applicability has seen increased attention as new materials approach the cooling efficiency of current technology. Magnetic nanoparticles provide an alluring alternative to bulk materials because of the inherent control over material properties necessary for the magnetocaloric effect. It has been theorized that the magnetocaloric effect in nanoparticles can be increased by several orders of magnitude compared to these bulk materials resulting from the reduction of the average particle size down to (and below) the single domain limit. At these size scales, several processes begin to play key roles in the physics describing the magnetism. One such process, interparticle interactions, can frustrate the magnetic ordering process. A fundamental understanding of the physics describing the implications of these interactions on the magnetocaloric effect remains elusive. We have demonstrated an innovative way to alter the magnetocaloric properties of a nanoparticle system by controlling simultaneously the blocking temperature and the magnetic ordering temperature (Curie temperature, T_C). Using a dual ion beam deposition technique, we fabricated magnetic multilayer films of alternating layers of cobalt and copper. The thickness of the cobalt layer was altered and subjected to different end-hall ion beam bombardment voltages. The bombardment process altered the multilayer structure of the films into that of cobalt nanoclusters embedded in a copper matrix allowing for a mechanism to control the interparticle spacing and density of the cobalt nanoclusters. Measuring the change in entropy as a function of temperature, we have shown that a change in the blocking temperature of these systems can alter their magnetocaloric properties which may prove useful for magnetic refrigeration.

Poster Number: 3

Shear-Coupled Grain Boundary Motion In Bicrystal Model

Presented by: Mohammad Aramfard
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Chuang Deng

Research Area(s): *Crystalline Materials and Nanostructures*

Nanocrystalline metals have a very high density of interfaces in comparison with coarse grained metals, thus mechanical and physical properties of these materials are governed by the interfaces. Interfaces such as grain boundaries are structural defects of high energies which are thermodynamically unstable. As a result, the grains in nanocrystalline metals usually suffer from grain growth during mechanical deformation or heat treatment. Since the superior properties of these materials are due to their fine grain sizes, it is important to seek solutions of stabilizing the grains. In this study the grain boundary motion due to shear, which is believed to be the main mechanism of grain growth in nanocrystalline materials during severe plastic deformation, is investigated. However it is difficult to make specimen with desired geometry and explore the vast space of grain boundaries in experiments. Therefore in this work atomistic simulations, which are capable of studying the motion of grain boundary with arbitrary geometry, are adopted. Specifically, a rectangular bicrystal model consisting of two grains with a symmetric tilt boundary between them is constructed and loaded with shear by molecular dynamics simulations. The coupling motion of different grain boundaries and the temperature dependence in copper and nickel are examined. Shear coupling factor, which is the ratio between the normal grain boundary velocity to the applied shear, and motion modes in each case are determined.

Poster Number: 4

Gallium Nitride On Indium Nitride Heterostructure Growth By Migration Enhanced Epitaxial Afterglow (MEAglow)

Presented by: Peter Binsted
MSc Candidate at Lakehead University, Semiconductor Research Lab

Advisor: Dr. Dimiter Alexandrov, Dr. K. S. A. Butcher

Research Area(s): *Crystalline Materials and Nanostructures*

Herein we discuss the fabrication of heterostructures consisting of a highly resistive gallium nitride (GaN) film on top of a conductive indium nitride (InN) layer using a process termed Migration Enhanced Afterglow (MEAglow). The MEAglow growth process is a form of chemical vapour deposition (CVD) employing migration enhanced epitaxy (MEE). This type of heterostructure is useful in a novel field effect transistor (FET) based on the tunneling of charge carriers altering the channel conductivity. Further details on the device operation are included. 2 inch sapphire (Al_2O_4) wafers are used as substrates. Growth is accomplished initially without the use of a buffer layer. The thicknesses of the GaN and InN layers are approximately 50 nm and 200 nm respectively. Growth temperatures for the GaN layer are 415 C and InN layer are 330 C. Samples are characterised through x-ray diffraction (XRD), ultraviolet-near infrared-visible spectroscopy (UV-Vis-NIR), auger spectroscopy, scanning electron microscopy (SEM), atomic force microscopy (AFM), and hall effect analysis where possible. Initial results showed a pinhole defect penetrating the top GaN layer down into the InN. Increasing the temperature during the InN growth reduces this defect.

Poster Number: 5

Ageing Processes In Solid Insulation With Nanofillers

Presented by: Mohammad Nadimi
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Derek Oliver

Research Area(s): *Crystalline Materials and Nanostructures*

Insulation materials undergo changes as a consequence of their operating environment i.e. the electric field across them. These changes have been classified into three stages: ageing, degradation and breakdown [1]. The ultimate result of these changes is failure of the insulation material which is both dangerous and costly. The goal of this project is to identify changes in material character that characterize the shift from the initial ageing processes to those classified as degradation. In general terms, ageing effects are apparent only at molecular length scales while degradation is evident on the order of micrometers. This will be accomplished through the use of a novel electrostatic force microscopy technique that has spectroscopic capabilities that provide a limited form of dielectric spectroscopy. Using this technique, changes in polarization character that result from ageing/degradation of the material will be explored. Insulation materials recently-adopted for commercial use incorporate "nanofillers" (nanoparticles with a size distribution in the range 1-10 nm). These materials exhibit improved breakdown voltages and larger dielectric constants than the traditional alternatives [2]. However, less is known about the ageing and lifetime characteristics of these materials [3]. Identifying the transition from ageing to degradation will be a part of developing a better understanding of the performance of these materials and also some understanding of how they change over their working lifetime.

[1] L. A. Dissado and J. C. Fothergill, (ed. G. C. Stevens) "Electrical Degradation and Breakdown in Polymers", Peter Peregrinus Ltd. on behalf of the Institution of Electrical Engineers, 1992.

[2] J. K Nelson, "Dielectric polymer nanocomposites", Springer, 2010.

[3] J. C. Fothergill "Ageing, space charge and nanodielectrics: ten things we don't know about dielectrics" IEEE International Conference on Solid Dielectrics, pp. 1-10, 2007.

Poster Number: 6

Dipolar Hyperkagome Spin Ice

Presented by: Travis Redpath
MSc Candidate at the University of Manitoba, Department of Physics

Advisor: Dr. John Hopkinson

Research Area(s): *Crystalline Materials and Nanostructures*

Non-magnetic doping of the Pyrochlore spin ices $Dy_2Ti_2O_7$ and $Ho_2Ti_2O_7$ has been shown (X. Ke et al., Phys. Rev. Lett. 99, 137203) to exhibit a non-monatonic residual entropy per spin as a function of doping, with an increase near one quarter doping. Hyperkagome corresponds to a disorder-free one quarter doping of the Pyrochlore lattice with a large residual entropy S/N=1/3 ln(9/2). We have studied local Ising spins coupled through antiferromagnetic nearest neighbour exchange and a long range dipolar interaction on this lattice. The dipolar energies were calculated using Ewald summation (M. Enjalran et al., arXiv:cond-mat/0307151v1 unpublished). We have generalized the phase diagram (B.C. den Hertog et al., Phys. Rev. Lett. 84, 3430-3433 (2000)) of dipolar Pyrochlore spin ice to the Hyperkagome case, finding a crossover to a spin ice state followed by a transition to a charge ordered state and finally a transition to an ordered ground state. We have shown that our hybrid single spin flip/loop algorithm Monte Carlo simulations agree with analytical results for small sizes, and present results for systems as large as $12*L^3$ spins with L=4.

Poster Number: 7

The Effect Of Cooling Rate On Non-Equilibrium Formation Of Delta Ferrite During Solidification Of Austenitic Stainless Steels

Presented by: Soheyl Soleymani
PostDoctoral Fellow at the University of Manitoba, Department of Mechanical Engineering

Advisor: Dr. Olanrewaju Ojo, Dr. Norman Richards

Research Area(s): *Crystalline Materials and Nanostructures*

Properties of austenitic stainless steels can be significantly influenced by the presence of non-equilibrium delta ferrite particles within the materials microstructure. In the present work, the effect of solidification cooling rate on non-equilibrium formation of delta ferrite phase in austenitic stainless steels is studied. Austenitic stainless steels with different chemical compositions were melted and allowed to solidify at various cooling rates by using Gleeble thermo-mechanical physical simulation system. The results show that non-equilibrium formation of delta ferrite particles is promoted by an increase in the cooling rate from the melting temperature. Moreover, at a constant cooling rate, the volume fraction of delta ferrite increased with an increase in the ratio of Cr_{eq}/Ni_{eq} of the chemical composition. Possible ways of minimizing delta ferrite formation during austenitic stainless steel solidification, through proper control of cooling rate and alloy chemistry, which may otherwise impair fatigue resistance properties of the material, will be presented.

Poster Number: 8

Thermal And Stress Analysis Of Yb^{+3}:$KY(WO_4)_2$ Laser Crystal

Presented by: Hamidreza Mirzaeian
MSc Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Arkady Major

Research Area(s): *Crystalline Materials and Nanostructures*

High power diode-pumped solid state lasers (DPSSL) are a rapidly growing technology that is attractive for various applications in scientific and industrial fields. Double-tungstate crystals such as Potassium Yttrium Tungstate Yb:$KY(WO_4)_2$ (Yb:KYW) are one of the most popular active materials used in DPSS lasers for generation of continuous wave radiation and ultrashort (i.e. femtosecond, 10-15s) pulses with high average output power. At the same time high pump power of laser diodes results in considerable heat generation in a laser crystal that in turn causes thermal lensing effect. Thermal lensing affects the performance and stability of a resonator, and plays an important role in limiting the output power and degrading the beam quality of solid state lasers. Finite element analysis (FEA) method can be used to calculate the temperature and stress fields in the laser crystal. FEA method allows us to analyze the thermal lensing effect thoroughly and obtain the focal length of the induced thermal lens inside the crystal. In this work, the finite element analysis has been performed to calculate the temperature distribution, stress fields and thermal lensing in the diode-pumped continuous wave Yb:KYW laser crystal. Simulation result obtained from the theoretical model will be compared to experimental results to verify the accuracy of the model. The results obtained from simulation and experiment can be used to propose the optimum crystal geometry and pumping method which results in reduction of thermal lensing effects. The results of this study are important for power scaling of Yb:KYW lasers.

Poster Number: 9

Influence Of The Point Defects On The Selected Properties Of α-PbO

Presented by: Julia Berashevich
Academic Researcher at Thunder Bay Regional Research Institute

Research Area(s): *Crystalline Materials and Nanostructures*

Recent developments in radiation medical imaging technology imposes new requirements on the photoconductive materials: polycrystalline and amorphous the only materials to be applicable in the flat panel detectors with preference given to the high Z polycrystalline semiconductors. In this respect α-PbO is one of the most promising candidates for the Fluoroscopy application. The transport properties of α-PbO are not well established but based on the low mobility-time product the transport is believed to be controlled by trapping on defects. We applied the first principles calculations (GGA) to study the point defects in α-PbO and their properties. Original idea of this research was to explain n- and p-type conductivity observed experimentally in otherwise undoped compound. It was found that oxygen deficiency during compound growth encourages an appearance of the O vacancies. Since the O vacancy is occupied by electrons, it results in excess of electrons thus inducing the n-type doping. For the oxygen rich conditions, formation of the O interstitials has been predicted and this defect being occupied by two holes was found to cause p-type doping. During this research the unique properties of the interstitial defects have been discovered: the Pb interstitial defect is occupied by two unpaired electrons which are ferromagnetically ordered on-site in accordance with Hund's rule. Therefore, this non-magnetic defect acts exactly as the magnetic impurity and is expected to contribute in origin of d^0 magnetism.

Poster Number: 10

Influences Of Solute Atoms On Grain Boundary Motion

Presented by: Hao Sun
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Chuang Deng

Research Area(s): *Crystalline Materials and Nanostructures*

The unique properties of nanostructured materials, when compared to their coarse grained counterparts, are mainly attributed to the presence of a high volume fraction of internal interfaces such as grain boundaries. However, internal interfaces (mainly grain boundaries) in materials are usually of high energies. Since materials all have a tendency to achieve the lowest energy state, nanocrystalline materials are generally thermodynamically unstable. Specifically, the total area of grain boundaries in nanocrystalline materials tends to shrink by increasing the sizes of individual grains upon either heating or mechanical deformation, so that the overall energy of the material can be decreased. This phenomenon is known as grain growth and grain growth has been observed in nanocrystalline Ni, Pd and Cu at temperatures as low as room temperature. Therefore, knowledge concerning methods for stabilizing the microstructure of nanocrystalline materials exposed to high temperatures is highly desirable. Several theoretical analysis and empirical experimental studies have shown that enrichment of the grain boundaries (segregation) with solute atoms with limited solubilities can diminish or even reverse the free energy available for grain growth by forming metastable structures. However, a systematic study of solute effects on the motion of individual grain boundaries is currently missing which motivates this research. The method used in this research is molecular dynamics, which is a computer simulation tool that can reproduce experimental conditions but with better control over both sample preparation and environmental conditions, such as pressure and temperature.

Poster Number: 11

Triple Junction Mobility Extracted By Thermal Fluctuation Method

Presented by: Qingzhe Song
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Chuang Deng

Research Area(s): *Crystalline Materials and Nanostructures*

The motion of triple junctions and grain boundaries is the cause of grain growth, which is one major problem that needs to be addressed before nanocrystalline materials can be widely applied in industry.

Previous work investigating the underlying mechanisms of grain growth focused mainly on the motion of isolated grain boundaries while only a small portion considered the triple junction motion. Among those work involved in the triple junction motion, a driving force was usually applied by using curved interfaces.

However, a curved boundary pulls several negative effects into the model due to a series of driving forces with different orientations. The accuracy of the intrinsic mobility is also potentially affected by an input driving force. Previous studies have shown that the extracted grain boundary mobility would be artificially higher than expected when a high driving force was used. To date, however, no methodology has been proposed to extract the intrinsic triple junction mobility.

Based on molecular dynamic simulation, this research proposes to extract the mobility of triple junctions based on their purely thermal fluctuations, thus eliminating possible artificial effects due to an applied driving force. Specifically, the interface random walk method, which has been used to extract intrinsic grain boundary mobility, will be extended to study triple junctions. Temperature will be varied to study its influence on triple junction motion.

Poster Number: 12

Dielectric Spectroscopy Of Polymeric Thin Films

Presented by: Mina Shenouda
MSc Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Derek Oliver

Research Area(s): *Crystalline Materials and Nanostructures*

Dielectric spectroscopy is a non-destructive technique used to measure the dielectric properties of materials as a function of frequency. The objective of the work is to design a technique for estimating the relative permittivity of polymeric thin films (100-200 nm) over a frequency range (40 Hz – 100 MHz) defined by the optional characteristics of a HP 4294A Impedance Analyzer. The challenge in this project is that most dielectric spectroscopy measurements require bulk samples,which are placed between parallel plates or have electrodes applied as a surface coating. Thin films aren't free-standing samples and need the support of a substrate with embedded electrodes. The measurement electrodes are designed with a compact interdigitated structure. The interdigitated fingers are 20 µm wide and embedded 100 nm in a p-type silicon substrate. The capacitance of the proposed structure is in the order of fF of which the polymer contribution is roughly 7%. The next design cycle will develop differential approaches to achieving this capacitance measurement.

Poster Number: 13

Magnetic Nanoparticles As A Vehicle For Targeted Drug Delivery

Presented by: Yaroslav Wroczynskyj
MSc Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. Johan van Lierop, Dr. Donald Miller

Research Area(s): *Crystalline Materials and Nanostructures*

Magnetic nanoparticles are being used in a variety of medical applications including magnetic resonance imaging contrast agents, and as a vehicle for magnetically directed transport of pharmaceuticals. One area of current significant interest is using magnetic nanoparticles for targeted drug delivery across the blood brain barrier. The use of magnetic nanoparticles as a vehicle for targeted drug delivery requires a thorough understanding of their properties in an applied magnetic field. As such, a unique cell incubator that reproduces the growth environment of human tissue analogues while simultaneously allowing for the application of a spatially uniform magnetic field has been constructed. This permits, for the first time, a rigorous investigation of nanoparticle transport through tissue as a function of magnetic field. Complementary to these experiments, a complete characterization of the magnetic and structural nanoparticle properties is required. By comparing the transport of nanoparticles with different organic coatings I aim to identify the ideal formulation for applications, and gain an understanding of the mechanism of nanoparticle transport through tissue. This will provide ultimately a means to study the effects of clinical preparation (i.e. additional coating) on the magnetic and structural properties of nanoparticles.

I will present preliminary results of nanoparticle transport as a function of magnetic field strength in conjunction with a quantification of their magnetohydrodynamic properties.

Poster Number: 14

A Low-Cost And Portable Microfluidic System For Cell Migration Studies

Presented by: Jiandong Wu
PhD Candidate at the University of Manitoba, Department of Biosystems Engineering

Advisor: Dr. Francis Lin, Dr. David Levin

Research Area(s): *Crystalline Materials and Nanostructures*

Microfluidic systems can better control cellular microenvironments and therefore are increasingly used for cell migration research. However, most existing systems are impractical to use in research labs without specialized facilities and researchers. Toward removing this barrier, we report a low-cost and portable USB microscope-based Microfluidic Chemotaxis Analysis System (UMCAS). This system integrates microfluidic device, gradient and cell imaging, temperature control and data analysis to provide a low cost and portable solution for rapid microfluidic cell migration and chemotaxis experiments with real-time result reporting. Furthermore, a smartphone-based module was developed for remote experiment data monitoring. This developed system was validated by testing neutrophil chemotaxis to an IL-8 gradient and the data was analyzed by both the traditional single cell tracking method and the automated analysis in UMCAS.

Poster Number: 15

Topotactic Reduction And Lithium Intercalation In Layered Manganates

Presented by: Joey Lussier
MSc Candidate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Mario Bieringer

Research Area(s): *Crystalline Materials and Nanostructures*

Optimizing ion conducting materials is key for improving rechargeable battery performance. Crucial for solid state ion conductors is the presence of point defects and defect layers. Layered transition metal oxides are particularly promising systems due to the diverse redox chemistry and lattice topology. We are exploring solid state hydride reductions in an effort to control oxide defect concentrations and transition metal oxidation states. Layered oxide structures can be tuned towards enhanced Li^+ cation mobility.

We are reporting the topotactic reduction of A_2MnO_4 (A = alkaline earth) and related phases in conjunction with lithium cation intercalation. Our work explores the simultaneous intercalation of lithium into these structures forming novel $Li_xA_2MnO_{4-\delta}$ phases. The proposed lithium ion site is in the rocksalt layer of the Ruddlesden-Popper structure. Due to the small electron density and relatively small amount of the lithium ions being intercalated, an accurate lithium ion position in the structure has been challenging to determine. Structure determination using powder diffraction and in-situ diffraction experiments following the oxygen uptake of the reduced phases and associated phase transitions will be discussed.

Poster Number: 16

Multinuclear Magnetic Resonance Investigation Of Phase Distributions Upon Vitrification Of Nuclear Waste

Presented by: Alexander Paterson
Undergraduate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Scott Kroeker

Research Area(s): Soft and Disordered Materials, *Composite Material Systems*, Crystalline Materials and Nanostructures

The nuclear fuel cycle produces waste products containing significant concentrations of radioactive isotopes. The current industry standard for the disposal of high level liquid waste is vitrification. The objective of this study is to use NMR to examine the effectiveness of borosilicate glass at dissolving complex crystalline waste mixtures. Magic angle spinning NMR experiments were carried out on ^{23}Na, ^{27}Al, ^{31}P, ^{95}Mo, ^{133}Cs, and ^{139}La in order to identify and quantify the phases present in both calcined and vitrified materials, and to determine the fractions of all probed nuclei that are incorporated into the glassy phase. In addition to the previously characterized molybdates, minor crystalline phases containing sodium, phosphorus, aluminum and cesium were detected in the vitrified materials. As x-ray diffraction appears unable to identify these low-level precipitates, we use NMR to fingerprint these unknown phases. Vitrified composites are found to be unexpectedly prone to hydration when ground in air. The resulting phases and the extent of their formation are monitored by NMR.

Poster Number: 17

The Application Of Spintronic Microwave Sensor Based On A Magnetic Tunnel Junction For Radar Technique

Presented by: Lei Fu
MSc Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. Can-Ming Hu

Research Area(s): *Composite Material Systems*, Crystalline Materials and Nanostructures

It is recently found that a spintronic device called magnetic tunnel junction (MTJ) can rectify microwave field into a dc voltage by employing Seebeck effect, which makes this device a candidate for microwave sensor. The sensor has been successfully used to detect microwave reflected by object-of-interest (OI). Different from traditional radar antenna, this sensor works in a continuous wave mode which can simplify experiment system and reduce the experiment cost since time-dependent instruments are usually complicated and expensive. In this poster, a phase resolved detection method is developed by introducing a reference signal and a phase shifter which can effectively control the relative phase between signal from OI and reference. The data are collected in circular scan geometry and the scan process is performed by the testing object's rotation. At each scan step, a set of continuous wave with a bandwidth of 9 GHz and a center frequency of 11.5 GHz are radiated. All these data are linked with the object's position which can be picked up and reorganized by the reconstruction program. As soon as the scan process finishes, an imaging indicating where the object's initial position is obtained.

Poster Number: 18

Microwave Pattern Of Four-Arm Spiral Antenna Measured Using A Spin Caloritronic Approach

Presented by: Bimu Yao
PhD Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. C. M. Hu

Research Area(s): *Composite Material Systems,* Crystalline Materials and Nanostructures

Owing to the broad frequency range and compact structure, the Archimedean spiral antenna becomes an excellent candidate for radars, GPS, satellite communications and other various applications. According to diverse requirements, radiation pattern can be regulated by adjusting geometrical and electrical parameters of antenna. In this study, an innovative way to measure the microwave radiation pattern from antenna is presented. It has found the thermal effect is giant in a nano-structured junction, where the Seebeck coefficient can be on the order of 1 mV/K. Under the radiation of microwave, a temperature gradient is produced across a magnetic tunnel junction and consequently, the dc voltage is formed. The magnitude of the Seebeck coefficient indicates that temperature gradients of only a few mK may be required to produce detectable voltage signals of a few μV in these nano-size junctions. Following such a spin caloritronic principle, a microwave sensor based on a magnetic tunnel junction is used to detect the spatial distribution of microwave generated by planar four-arm Archimedean spiral antenna. Particularly, we have measured the evaluation of microwave pattern from near-field to far field. Some interesting features have been revealed, which were rarely observed before. Our work suggests that a spin caloritronic microwave senor can directly measure the microwave spatial distribution in an economic and simple way, which imposes significant impact on improving the performance of antenna.

Poster Number: 19

Self-Assembly And Manipulation Of Liquid Crystal Functionalized Gold Nanorods

Presented by: Xiang Feng
PhD Candidate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Torsten Hegmann, Dr. Michael Freund

Research Area(s): *Composite Material Systems*, Crystalline Materials and Nanostructures

The significant interest in anisometric nanomaterials arises from their unique optical and electronic properties that can easily be tuned through small changes in size, structure and shape. However, the fabrication of orientational ordered arrays of anisotropic nanoparticles from the bottom up remains a challenging quest.

To address this problem, we fabricated hydrophobic gold nanorods coated with liquid crystals organosilanes to trigger the self-assembly of these liquid crystal surface-functionalized gold nanorods (LC-GNRs). Fascinatingly, we found that these LC-GNRs can be manipulated by thermal annealing and with magnetic fields with the LC-GNR orientation following the magnetic field lines. Moreover, we dispersed nematic LC-GNRs in nematic liquid and utilized different types of surface-modified substrates to obtain planar (homogeneous) or homeotropic alignment of liquid crystals and the dispersed gold nanorods. The quality of liquid crystal and nanorod alignment were characterized by polarized optical microscopy and polarized visible spectrophotometry, respectively.

Poster Number: 20

Defect Creation And Structure Evolution In The $YPrO_x$ System

Presented by: Kevin Szkop
Undergraduate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Mario Bieringer

Research Area(s): *Composite Material Systems*

Optimizing the synthesis and properties of ion conducting materials is one of the key issues for the commercialization of rechargeable batteries and fuel cells. The ion mobility in solid state ion conductors is closely related to the presence and distribution of point defects; thus the performance of a solid oxide fuel cell correlates with the number of oxide point defects. Tuning defect fluorite structures through partial reduction is being explored. Investigating the synthetic pathway of potential ion conductors and following the creation and annihilation of point defects during in-situ experiments provide new opportunities for the optimization of solid state electrolytes for future industrial oxide fuel cell applications.

We are reporting the formation of $YPrO_3$ and $YPrO_{3.5}$ structures. This work highlights the reductive and oxidative pathways for the synthesis of these phases in an attempt to control the amount of oxide defects by means of Pr(III)/Pr(IV) redox chemistry. Due to the high inherent stability of Y_2O_3 and mixed praseodymium oxides, it has been challenging to obtain pure product phases with minimal contamination from starting materials. The fluorite phase $Y_xPr_{1-x}O_{2-\delta}$ synthesis with Y and Pr disorder will be presented. Structure details are determined by X-ray powder diffraction and their corresponding structure evolution is being followed by high temperature in-situ diffraction experiments.

Poster Number: 21

Development Of Electrical Contacts And Etching Recipes For A Compensated GaN/InN MOSFET

Presented by: Megan McClarty
MSc Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Derek Oliver

Research Area(s): *Composite Material Systems*

This work aims to design and fabricate a MOSFET from a compensated gallium nitride (GaN) layer that has been grown on indium nitride (InN) using a migration-enhanced afterglow (MEAglow) deposition process. The nitride layers were grown on sapphire substrate and a GaN/InN heterojunction structure was formed at their interface. A key attraction of this design is the ability of GaN to act as either p- or n-type (doped) material depending on the bias voltage applied to gate. A recipe for electrical contacts which can function effectively for both p-type and n-type operation is thus required. These metal contacts must have good ohmic contact after annealing, provide good adhesion, and be thermally and chemically stable. To maintain integrity of the GaN/InN layers, deposition processes must occur below 500 Celsius. A tri-layer contact to the GaN surface consisting of a 38 nm titanium adhesion layer, a 113 nm aluminium layer, and a 180 nm gold cap (to prevent oxidation) has been developed for the source and drain contacts. Following annealing, 4-point probe testing of the contacts showed good ohmic behaviour. To expose InN and provide access for a grounding contact, a wet etching process for GaN has been developed. Initial trials have shown 3:1 ethylene glycol:potassium hydroxide (KOH) to be a successful etchant candidate. The response of this process to variations in temperature and etchant concentration will be discussed, as well as studies undertaken to verify the electrical performance of the contacts and how these impact MOSFET design based on this architecture.

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Poster Number: 22

Preliminary Study Of Failure Of Composite Overwrapped Pressure Vessels Subject To Orbital Debris Impact

Presented by: Aleksandr Cherniaev
PhD Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Igor Telichev

Research Area(s): *Composite Material Systems*

Orbital debris is a recognized threat for any space mission. The term "orbital debris" refers to any man-made object in the Earth orbit that no longer serves a useful function. Millions of such objects with average velocity of 10 − 11 km/s are non-trackable and may collide with operational spacecraft. Gas-filled pressure vessels are recognized as the most critical spacecraft component exposed to the space debris environment due to high possibility to fail catastrophically when impacted. The answer to the question whether the impact damaged pressure vessel would undergo explosion-like failure is crucial for the mission success or failure. Essentially, it quantifies the spacecraft survivability. The current study is focused on the impact response of the composite overwrapped pressure vessels (COPV) for the onboard systems. Fabricated from thin metallic liner and outer composite wrapping these vessels are recognized to be more weight-efficient as compared with the conventional metallic structures. The presented literature review demonstrated that comparing with metallic components the effort to study composite material and composite structural systems under similar impact conditions has been much more limited. It is expected that composite overwrapped pressure vessels subjected to orbital debris impact will demonstrate the more complicated mechanisms of fracture in both composite and metallic parts, as well as in their interface. Basic steps for the numerical simulation of the COPV impact behavior are formulated and discussed.

Poster Number: 23

An Investigation Into Reducing Time Dependent Creep Of A Polyethylene Geotextile Using Glass Yarns

Presented by: Jun Xiong
Undergraduate at the University of Manitoba, Department of Textile Sciences

Advisor: Dr. Mashiur Rahman, Professor Mark West

Research Area(s): *Composite Material Systems*

Polyethylene or PE is being used for fabric form concrete in architectural applications because of its low cost, light weight, versatile shape forming ability, and ease of applications. However, PE has two drawbacks: high creep and instantaneous elongation deflection (IED) because of its higher elongation and low recovery. Two methods of making PE-Glass composite structure using stitching and lamination reinforcement methods to improve the creep and IED of a PE woven fabric has been developed and investigated through an Instron tester using creep testing method. The results showed that reinforcement would significantly reduce the creep and IED as long as the applied stress is lower than the total stress of the glass yarns in the composite PE-Glass composite structure. However, the strength of reinforced fabric depends on the strength of the reinforcement and its original strength from PE yarns only contributes when the glass yarns are all broken.

Poster Number: 24

Investigating The Variable Doping Concept In The Junctions Between Tungsten Oxide (WO_3) and Conducting Polymers

Presented by: Iman Yahyaie
PostDoctoral Fellow at the University of Manitoba, Department of Chemistry

Advisor: Dr. Michael Freund

Research Area(s): Surfaces and Interfaces, *Composite Material Systems*

Tungsten trioxide, WO_3, has long been studied for its interesting structural, electronic, and electrochromic properties. As an indirect n-type semiconductor with a relatively wide band gap (~3eV), tungsten trioxide has been extensively used in gas sensors, production of electrochromic (smart) windows and as a potential photoanode in water splitting applications.

More recently, field-induced change in carrier concentrations (variable doping) in WO_3 in contact with conducting polymers has been used in formation of new dynamic memory structures. In these structures, the field-induced variable doping of WO_3 will result in well-defined variations in the conductivity across the WO_3/polymer system. These variations in the conductivity may then be used to define different memory states. This approach is expected to be relevant to the next generation of molecular memories and may offer new design paradigms.

In this work, the electrical properties of the junctions between WO_3 and a conducting polymer (PEDOT:PSS) have been studied. The concept of variable doping has been investigated by measurements at higher frequencies. In an attempt to make these structures more favorable for integration with standard CMOS technologies, thin films of WO_3 and conducting polymer were grown on glass substrates coated with aluminum and copper, two common contact metals in CMOS technology.

This research will provide an insight in the working mechanism of these junctions and the possibility to integrate them in a standard CMOS device. The outcome of this work may also be interesting as a fundamental viewpoint for other applications involving variable doping concept such as polymer-based transistors.

Poster Number: 25

The Influence Of Gold And Copper At Polymer/ n-Si Microwire Junction For Solar Water Splitting Devices

Presented by: Sommayeh Asgari
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Derek Oliver, Dr. Michael Freund

Research Area(s): *Surfaces and Interfaces*, Crystalline Materials and Nanostructures

The junctions between methyl-terminated n-type silicon microwires and a conductive polymer membrane (polyethylenedioxythiophene/polystyrene sulfonate, PEDOT:PSS) have been investigated using a soft contact formation approach. The electrical behavior of these junctions is critical to the performance of solar water splitting systems. The purposed solar water splitting device being studied uses an array of semiconducting microwires as light absorber components embedded in a membrane barrier for separating the gaseous hydrogen and oxygen products. This design utilizes a pair of light absorbers in series to provide the photovoltage (>1.23 V) required to drive the hydrogen and oxygen evolution reactions. Minimizing the electrical loss to obtain the necessary photovoltages for driving the water splitting reactions requires exploring different polymer/microwire junctions in this configuration. These losses represent a potential barrier for charge transport across the system, particulary at polymer/microwire junctions. Current-voltage characteristics and the junction resistance between the polymer membrane and methyl-terminated heavily doped n type silicon microwires are reported. The results are compared with electrical behavior of the junction between polymer and low-doped n-type silicon microwires with and without copper or gold present at the microwire/polymer interface. The presence of gold at this interface significantly improves the I-V profile and resistance at low bias voltage.

Poster Number: 26

Effect Of Low Power Deposition And Low Oxidation Temperature On The Interfacial And Structural Properties Of Sputtered Hfo$_2$ Gate Dielectrics

Presented by: Gustavo Belo
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. D. A. Buchanan

Research Area(s): *Surfaces and Interfaces*, Crystalline Materials and Nanostructures,

Hafnium dioxide gate dielectrics, prepared by DC magnetron with low-power sputtering deposition followed by a low-temperature thermal oxidation, show greatly improved interfacial and electrical properties. Ellipsometry and X-ray photoelectron spectroscopy (XPS) measurements show a good stoichiometric HfO_2 thin films with a refractive index of 1.9 and an Hf:O ratio of 1:2. The results obtained after analysis, quantification and calculation through XPS depth profile method, angle resolved XPS and interface modeling by XPS data processing software suggest a development of a complex three layer dielectric stack, including hafnium dioxide layer, a narrow interface of hafnium silicate and broad region of oxygen diffusion into silicon wafer. The measured dielectric constant of the HfO_2 was about 22. The film band-gap was found to be ~5.2 eV.

Poster Number: 27

The Relationship Between The Interface Chemistry And Magnetism Of Iron-Oxide Based Core/Shell Nanoparticles

Presented by: Elizabeth Skoropata
PhD Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. J. van Lierop

Research Area(s): *Surfaces and Interfaces*, Crystalline Materials and Nanostructures

The structure and composition of gamma-Fe_2O_3/CoO core/shell nanoparticles is investigated in detail. We find that an interfacial (~0.3 nm) cobalt-doped gamma-Fe_2O_3 phase is formed via the migration of Co^{2+} into octahedral vacancies in the gamma-Fe_2O_3 surface layer. This thin interfacial layer is responsible for the overall magnetic behaviour of the nanoparticle. We show that precise control of the interface is an effective way to tune the magnetic properties of core-shell nanoparticles that enables manipulation (isolation) of surface effects.

Poster Number: 28

Maintaing pH Gradients With Bipolar Membranes For Artificial Photosynthesis Technology

Presented by: Michael McDonald
PhD Candidate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Michael Freund

Research Area(s): *Surfaces and Interfaces*

Earth abundant semiconductors and catalysts operate favourably and stably in different pH and hence a membrane maintaining a pH gradient may be required for efficient artificial photosynthesis. Bipolar membranes (BPMs) consist of an anion and a cation exchange polymer layer laminated together forming a depletion region like a p-n junction. When separating two half cells, migration of solution counterions is excluded by the polarity of the membrane fixed charges. Current is carried by dissociation of water to liberate ions in the depletion region. If the oxygen evolving reaction operates in base against the anion exchange layer and the hydrogen evolving reaction operates in acid against the cation exchange layer, the BPM can in principle maintain the pH gradient for efficient solar electrolysis. The standard electrode potentials decrease to 0.4 V from 1.23 V while he standard water dissociation potential in the BPM is 0.83 V and so the BPM under these conditions contributes no net potential. Optimization of the BPM structure, which is critical to minimizing its impact on the overvoltage of this cell, is investigated. This includes using ion exchange layers consisting of stable polymers that form permselective yet conductive structures and are transparent. Acidic/basic polymers and transparent conducting metal oxide particles are incorporated to maximize water transport and dissociation kinetics in the interfacial region while still meeting the low impact, high function condition for artificial photosynthesis.

Poster Number: 29

Morphological Control Of Conducting Polymer And Metal Oxide Films For Resistive Memory

Presented by: Patrick Giesbrecht
Undergraduate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Michael Freund

Research Area(s): *Surfaces and Interfaces*

A redox-based memory system can be made via a heterojunction between a conducting polymer film ($PT^{+}DS^{-}$, initially doped with Li^{+} counterion to be in its reduced, non-conducting state) and a CMOS (WO_3) film. Through application of a potential across the junction, motion of the Li-ions from polymer to CMOS results in a high, conducting state, allowing distinction between the high and low states of this memory bit through the conductivity of the junction. To retain its high state and prevent Li^{+} ion-drift back to the polymer film, a barrier layer of oxidized conducting polymer ($PPy^{+}DBS^{-}$) may be used between the two layers. In order for this to be applicable at smaller dimensions, the morphology of the films used must be taken into account. It was found that the $PT^{+}DS^{-}$ film exhibits large nucleates; causing an investigation into a different conducting polymer or dopant such that small nucleates are produced. By varying the dopant used for the electrodeposition of the polymer film, a film of $PT^{+}PSS^{-}$ produced the diodic behavior desired when in a heterojunction with WO_3, and exhibited small nucleates, allowing the production and testing of this memory system at the nano-scale.

Poster Number: 30

Effect Of Hydrogel Coating, Water And Surfactant Wetting On The Adherence Of PET Dressings

Presented by: Chenxi Ning
MSc Candidate at the University of Manitoba, Department of Textile Sciences

Advisor: Dr. Song Liu

Research Area(s): *Surfaces and Interfaces*

Considering the increasing concerns of secondary trauma upon wound dressing removal, strategies for decreasing adherence of common dressing materials are urgently needed. An in vitro peeling model based on gelatin was adopted and modified for this study. Gelatin was used to simulate wounds with exudates and fabric/gelatin complexes were dried in an incubator for a period of time to simulate clinical conditions. After drying, gelatin was peeled off from PET fabric with a 180° peeling angle. Drying at 75% RH, 1791.26 J/m^2 could better simulate clinical conditions when compared with a drier environment (<35% RH, 4537.50 J/m^2), and the addition of water/surfactant on the complex could further lower the peeling energy to <500 J/m^2. However, the peeling energy of PET fabrics increased unexpectedly after being coated with polyacrylamide hydrogel. Hydrogel coating increases the surface hydrophilicity and allows penetrating and drying of gelatin solution in the pores of PET fabric, resulting in a higher peeling energy. In order to create a less adherent and potentially bioactive dressing, a silicone layer was first coated on PET fibers and treated with plasma. Hydrogel was then grown from this silicone layer via UV initiation. In this case, super hydrophobic silicone coating prevents gelatin solution from getting into fabric interspaces, while hydrogel can maintain a moist environment and thus help ease the peeling of dressings. The hydrogel layer can also serve as a reservoir for bioactive agents such as biocides and growth factors which can be controlled-released to create a desirable microenvironment for wound healing.

Poster Number: 31

Comparison Of The Atomic Concentrations Of Four Pulp-Capping Material Surfaces

Presented by: Victor Gong
Undergraduate at the University of Manitoba, Department of Restorative Dentistry

Advisor: Dr. Rodrigo França

Research Area(s): *Surfaces and Interfaces*

Objectives: The aim was to determine the chemical composition of the first atomic layers of four pulp-protection agents, because these atoms can be responsible for beginning the pulp healing process.

Methods: Biodentine (Septodont), ProRoot MTA (Dentsply), Dycal (Caulk), TheraCal (Bisco) were mixed according to the manufacturer's instructions (n=3) and afterwards, were analyzed by X-ray Photoelectron Spectroscopy (XPS) (Kratos Axis, vacuum of $2x10^{-9}$ Torr, X-ray gun emission set to 15 mA, X-ray gun anode HT set to 15 kV, and 225W). The elements detected were observed using both survey and high-resolution spectra, with element-dependent probe depths of 4-5nm, and calibrated to C 1s at 285 eV.

Results: Atomic concentrations (at%) of elements detected can be seen in the Table below. Letters within each column designate statistically significant group ($p<0.05$).

	C	O	Ca	Si	S
Biodentine	35.2±2.4 a	39.7±2.8 a	17.7±1.2	4.1±0.2 a	
ProRoot MTA	36.4±12.6 a	43.8±3.2 a	10.7±2.1 a	1.5±0.6	5.3±1.2 a
Dycal	60.1±2.4	28.1±1.3 b	6.5±2.7 a	3.1±1.6 a	
TheraCal	67.1±2.1	25.6±1.4 b	7.1±3.6 a		

Trace amounts of elements (<1%) were also found: Sn for Biodentine; Bi for ProRoot MTA; Na, P, Zn and N for Dycal; and Bi for TheraCal.

Conclusions: XPS results showed that Ca on the external layer could vary from 0 to 18% depending on the brand. Aliphatic Carbons from the polymerization reaction, especially in Dycal and TheraCal, were found to decrease and mask the other components.

Poster Number: 32

X-Ray Photoelectron Spectroscopy Characterization Of Six Dentin Bonding Agents

Presented by: Lindsay Robertson
Undergraduate at the University of Manitoba, Department of Restorative Dentistry

Advisor: Dr. Rodrigo França

Research Area(s): *Surfaces and Interfaces*

Aim: This study analyzed the chemical composition of the first 10nm of the external layer of six dentin bonding agents using X-ray Photoelectron Spectroscopy (XPS). The goal was to compare the surface composition of adhesives from two different generations.

Methods: Adper Easy Bond (AEB), Adper Prompt L-Pop (APL), Xeno III (XE3) Xeno IV (XE4), iBond Self Etch (ISE), and iBond Total Etch (ITE) samples were prepared and polymerized according to the supplier's instructions with a Light-Emitting Diode unit (Ultradent- 750 mW). The samples (n=3) were analyzed by XPS (Kratos Axis, vacuum of $2x10^{-9}$ torr, an x-ray gun emission set to 15 mA, and an x-ray gun anode HT set to 15 kV, which equates to a power setting of 225 W). XPS surveys and high-resolution scans were taken from the external layer (depth = 0nm, (D_0)) and a sub-surface layer (depth = 10nm, (D_{10})) after removing the external surface with Argon etching. C 1s (at 285 eV) and O 1s peaks were used to compare the deconvolution of the peaks.

Results: 1) XPS survey: Statistically significant differences ($p<0.05$) of C 1s and O 1s percentages were found between D_0 and D_{10} for all adhesives. Also, at D_0: C 1s for AEB and APL (80.85±0.91; 61.95±1.31), O 1s for XE3 and XE4 (27.5±0.72; 7.75±1.2), and for ISE and ITE (11.89±0.42; 3.93±0.34) showed significant differences. 2) XPS high resolution: All adhesives displayed contributions from carbon impurities for C 1s at 285 eV at D_0, but not at D_{10}.

Conclusions: All adhesives in this study showed that their atomic compositions in the external layer were not homogeneous, and their compositions varied with depth from the surface.

Poster Number: 33

Chemical Diversity In Electrochemically Deposited Conducting Polymer-Based Sensor Arrays

Presented by: Shaun Ryman
Undergraduate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Michael Freund

Research Area(s): *Surfaces and Interfaces*

A human olfactory system is highly complex. The mechanisms, by which they deliver signals to our brain, are through an array of non-specific binding receptors. Each receptor giving a different response gives a 'fingerprint' signal of the chemical. The integration of chemical sensor arrays into electronic devices has the potential to follow the footsteps of the CCD chip. In this work 55 sensors made of conducting polymers polyaniline and polypyrrole were tested. To increase diversity, the dopants and the electrochemical potential of the electronic conducting polymers (ECP) were modified. Results showed a distinct interaction of the doped and electrochemically modified polymers. Resistance measurements were used to measure the interaction of the sensor with vapor at a controlled flow rate. ECPs go far beyond the lock-and-key design with broadly responsive sensors.

Poster Number: 34

Axisymmetric Finite Element Modeling Of The Assembly Procedure Of Artificial Hip Joints

Presented by: Richard Dyrkacz
PhD Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. U. Wyss, Dr. J. Brandt, Dr. T. Turgeon, Dr. O. Ojo

Research Area(s): *Surfaces and Interfaces*

Corrosion of the head-neck taper interface of artificial hip joints can be a problematic issue for patients due to the release of unwanted metallic debris to surrounding tissues. The formation of a passive oxide film along the surface of CoCr and Ti6Al4V alloys can help prevent corrosion damage from occurring; however, the oxide film can get deteriorated. One potential way that the oxide film can get deteriorated is during the surgical assembling procedure. During the assembling procedure, the head-neck taper connection is secured by delivering multiple hammer blows to the head. The goal of this project is to demonstrate through axisymmetric finite element modeling how the following factors contribute to the destruction of the passive oxide layer during the assembly procedure: head size; material combinations; neck offset; and the coefficient of friction.

Poster Number: 35

Distinguishing Spin Pumping From Spin Rectification Through Line Shape Analysis

Presented by: Paul Hyde
MSc Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. Can-Ming Hu

Research Area(s): *Surfaces and Interfaces*

Spin polarized currents (currents containing an electron polarity imbalance) represent a major step forward in electronic technology. The ability to transmit electronic information through the currently un-utilized channel of electron polarity would allow the charge currents in electrical systems to be greatly reduced; eliminating the amount of power lost to resistance heating and allowing the size of electrical systems (such as data storage technologies) to be reduced. However, detecting spin polarized currents in order to study them is currently very difficult, due to the fact that nearly all detection techniques cannot detect electron polarity in a current. One of the easier spin polarized currents to measure is called a spin pumping current, which is produced during ferromagnetic resonance (FMR) in ferromagnetic/normal metal bilayer systems. However, in these systems, whether a signal arises from a spin pumping current or from a spin rectified current (a non-polarized current produced through spin rectification) can be a contentious issue. This issue can be cleared through the use of a new line shape analysis technique which can conclusively differentiate the two signals. This technique studies the electrical FMR line shape while an external magnetic field is rotated in-plane of the bilayer sample. Using the symmetry properties of spin pumping and spin rectification, this allows us to not only differentiate the two, but also calculate the distribution of the microwave magnetic field incident on the sample.

Poster Number: 36

Characterization Of Chemically Oxidized Ti-6Al-4V Alloy For Bio-Implant Application

Presented by: Ziyuan Wang
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Olanrewaju Ojo, Dr. Malcolm Xing

Research Area(s): *Surfaces and Interfaces*

Titanium and titanium alloys are vital bio-implantable materials due to their excellent corrosion resistance, mechanical properties and bio-compatibility. These properties are enabled by the formation of passive TiO_2 surface film. Various surface modification methods, such as, alkali treatment, acid treatment and thermal oxidation are used to enhance the formation of the oxide film on titanium alloys. In the present work, H_2O_2 is used to treat Ti-6Al-4V for enhanced surface roughness, hydrophilicity and surface hydroxyl group concentration to improve osteointegration. Characterization techniques, including SEM, AFM, XPS and AES are used to analyze the surface characteristics of the H_2O_2 treated Ti-6Al-4V. The surface characterization results, including an important finding of a potentially toxic SnO_2 formed within 15 nm of the surface layer, as revealed by XPS and AES, will be presented.

Poster Number: 37

Redox-Based Memory Devices: Tuning Volatility Using Conducting Barrier Layers

Presented by: Ramesh Kumar Mani
PostDoctoral Fellow at the University of Manitoba, Department of Chemistry

Advisor: Dr. Michael S. Freund

Research Area(s): *Surfaces and Interfaces*

The resistance switching between a metal oxide and covalently bonded molecules (such as conducting polymers) in a hetrojunction is getting great attention for use in memory devices because conducting polymers are being considered as a potential replacement for Si based semi-conductors due their useful electronic properties including memory. Therefore for memory applications, instead of using conventional Si diodes, it is possible to use the redox switching mechanisms that occur between a conducting polymer and metal oxide. In this work, we have developed a redox-based memory device in which electrochemically coated tungsten oxide and compensatively doped polythiophene ($PT{:}DS^{-}Li^{+}$) layers are sandwiched together in a dry state. When potential is applied across the junction, Li^+ ions drift between WO_3 and polythiophene, which increase the magnitude and time-scale of conductivity changes. Besides, by designing a proper barrier material to this ion drift, the volatility of these redox-based memory devices can be tuned. By changing the thickness (0-200 nm), nature (different dopant) and/or the type (different conducting polymers) of barrier polymer, the key performance metric (ratio of retention time to read/write time) can be altered to yield ratios in the range of 1 to 10^9.

Poster Number: 38

Nanoscale Chemical Surface Analyses Of Three Miniscrews For Orthodontic Anchorage

Presented by: Justin Silverstein
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Advisor: Dr. Rodrigo França

Research Area(s): *Surfaces and Interfaces*

Objectives: The goal of this study is to determine the chemical composition of the passivation layer of three clinically available orthodontic miniscrews in different depths: Aarhus Mini-Implant (AAR) [Medicon, Tuttlingen, Germany], IMTEC Ortho (IMT) [3M Unitek, Okla], and VectorTAS (VEC) [Ormco, Glendora, Calif].

Methods: The chemical compositions of the as-received miniscrews (n=4) were determined by X-ray photoelectron spectroscopy (XPS), Kratos Axis Ultra X-ray Photoelectron Spectrometer (vacuum of $2x10^{-9}$ torr, an x-ray gun emission set to 15 mA, and an x-ray gun anode HT set to 15 kV, which equates to a power setting of 225 W). Data was acquired before etching the miniscrews with Argon, as well as at depths of 10 nm, 20 nm, 30 nm, and 80 nm, after etching.

Results: The elements found in all miniscrews were mainly C, O, Ti and other metals in small amount (Al, Si, V, Cr) and traces of N, P, and Ca. Before etching, the percentage of C and Ti show no significant statistical differences ($p<0.05$) between all miniscrews (C 1s/Ti 2p: AAR: 62.9±13.6/5.6±4; IMT 48.4±13.7/6.7±2.9; VEC 43.3±11.3/8.1±2.5). The percentage of O was different only for AAR 19.3±10.4 (IMT 34.1±9.4; VEC 41.2±7). After Argon etching: 1) At 10, 20, 30 and 80nm AAR had no significant difference in O (47.4±10; 48.8±7.1; 50.3±6.5; 37.7±4.7) but in Ti a significant difference was found at 80nm (~20.5±3.3/31.4±4.6). 2) IMT had an increase for Ti and decrease for O. 3) VEC had a similar percentage for O and Ti at all depths.

Conclusions: According to our results the passivation layer of the orthodontic miniscrews has a different composition depending on the depth analyzed. IMT has the thinnest passivation layer and VEC has the thickest layer.

Poster Number: 39

Parameterizing Sea Ice Surface Roughness Using Terrestrial LiDAR

Presented by: Jack Landy
PhD Candidate at the University of Manitoba, Department of Environment and Geography

Advisor: Dr. David Barber

Research Area(s): Surfaces and Interfaces, *Complex Natural Systems*

Microwave backscatter models rely on accurate statistical characterization of surface roughness. Roughness has generally been measured in one dimension with, for example, a stylus, pin profiler, or laser profilometer. However, depending on the length of the measured profile and the sampling interval, these techniques can introduce bias into calculated surface RMS height and correlation length, and can change the shape of the measured autocorrelation function. So a method was developed for characterizing roughness in two dimensions using terrestrial Light Detection and Ranging (LiDAR) technology and implemented for measuring the surface roughness of artificially-grown sea ice in an experimental ice tank at the Sea-ice Environmental Research Facility (SERF) on the University of Manitoba Campus. Early results from this work demonstrate the importance of characterizing roughness in two dimensions, as opposed to just one, and highlight the capability to identify minor variations in roughness that define separate development stages in the backscatter modelled from one type of newly-forming sea ice. Since the surface roughness determines how an incident electromagnetic wave will scatter from a sea ice surface, by improving the roughness characterization, we have the potential to improve upon our ability to track sea ice formation in the Arctic using satellite Synthetic Aperture Radar (SAR).

Poster Number: 40

An Extended Floating Gate Gas Sensor Using Polypyrrole As Sensing Polymer On The Extended Sensor Pad

Presented by: Md. Obaej Tareq
MSc Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Douglas A. Buchanan

Research Area(s): *Complex Natural Systems*

A novel charge sensitive sensor platform using a basic floating gate MOS (FGMOS) transistor has been developed. In this new design, the top metal layer of a standard CMOS process has been used as an extended sensor pad which is connected to the floating gate. An odor sensitive conducting polymer was deposited on this senor pad. The electrical and physical properties of this polymer change during an analyte exposure and produce a change in the drain- source current (IDS) of the FGMOS. The sensor was exposed into the water and methanol vapor to test as a gas sensor and IDS current was measured by sweeping the control gate voltage. The sensor showed significant amount of current change in the voltage sweep measurement. However, the IDS current remain unchanged when a constant potential was applied on the control gate during an analyte exposure. This might happen if the polymer properties changed when a constant potential was applied across the floating gate and the measurement process might alter the sensor response. Therefore, the sensor response was measured with different pulse width and duration to investigate the effect of an electric field on the sensor response.

Poster Number: 41

Investigation Of The Influence Of Hip Replacement Arthroplasty On Bone Mineral Density Using DXA Image

Presented by: Masoud Nasiri Sarvi
PhD Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Y. Luo

Research Area(s): Soft and Disordered Materials, High Performance Computing, *Complex Natural Systems*

The growing volume of hip and knee replacement is contributing to health expenditure growth as these are expensive interventions. Side effects of joint replacement sometimes lead to expensive revision surgery. So investigating the side effects and finding a solution to eliminate them is an interesting area for the researchers.

BMD change is reported as an important side effect of the joint replacement which decreases the strength of the bone and increase the risk of fracture. Different reasons can lead to bone loss such as stress shielding. The reason for the resorption is mainly due to stress-related remodeling during the early postoperative period.

The purpose of this study is to investigate the effect of implantation on BMD change by using DXA image. A method is proposed to measure the BMD of each desired part of the bone and the application of this method is evaluated in tracing the BMD change after hip replacement in a patient.

Poster Number: 42

Experimental Investigation Of Anderson Localization In A 3D 'Mesoglass'

Presented by: Laura Cobus
PhD Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. John H. Page

Research Area(s): Soft and Disordered Materials, *Complex Natural Systems*, Composite Material Systems

Wave localization is characterized by the absence of diffusion; waves (electromagnetic, acoustic, matter, etc.) in a disordered, strongly scattering material can be 'trapped' in space by interference effects. While localization occurs for any amount of disorder in one and two dimensional systems, a material with a very large amount of disorder is required to observe the phenomenon in three dimensions. Localization of classical waves has proven very difficult to observe due to the challenge of creating materials with enough disorder. We present an experimental study of the localization of ultrasonic waves in a sample of disordered sintered aluminum beads _ a mesoscale analogue of an atomic glass. The response of the material to an input wave pulse was probed with both transmission and reflection measurements. In transmission, we measure how localization cuts off the transport of energy from the source position, and compare our results with theory. In the reflection geometry, the wave phenomenon of 'recurrent scattering' was observed, which is related to the probability of a wave returning to its starting spot. The time dependence of the recurrent scattering intensity was found to change dramatically near the transition from diffusive to localized behaviour.

Our different, but complementary, experimental approaches are providing new insights into the phenomenon of Anderson localization.

Poster Number: 43

Synthesis And Functionalization Of Carbon Nanodots

Presented by: Javad Mirzaei
PhD Candidate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Torsten Hegmann, Dr. Michael Freund

Research Area(s): *Soft and Disordered Materials*, Composite Material Systems, Crystalline Materials and Nanostructures

Luminescent carbon nanodots (CNDs) are a new class of carbon nanomaterials with sizes below 10 nm. As zero-dimension carbon nanomaterials, CNDs have gradually become a rising star in the nanocarbon family, due to their benign, abundant and inexpensive nature. In addition, CNDs appear to be a promising alternative to semiconductor quantum dots in many of applications because of their advantages in low toxicity and cheaper cost. Potential applications include photovoltaic devices, energy-efficient displays, biological labelling and bioimaging. In view of their importance, a facile and scalable method for synthesis and functionalization of CNDs is highly desired. Most current methods yield only hydrophilic nanodots and lack feasible protocols on modification of surface functional groups. Our approach consists of thermal decomposition of anhydrous citric acid as a suitable molecular precursor and following silanization using organically modifiable aminosilanes. Both hydrophilic and hydrophobic CNDs were synthesized and characterized. The obtained CNDs show strong fluorescent and stable colloidal solutions in appropriate solvents which make them suitable candidates for applications such as incorporation in liquid crystal composites and hybrid solar cells that normally require non-polar solubility.

Poster Number: 44

Temperature And Spinning Rate Dependence Of Spectral Broadening From Paramagnetic Dopants In Sodium Borosilicate Glass

Presented by: Randilynn Christensen
PostDoctoral Fellow at the University of Manitoba, Department of Chemistry

Advisor: Dr. Scott Kroeker

Research Area(s): *Soft and Disordered Materials*

Paramagnetic ions are found in many commercially important glasses and are sometimes added by researchers to shorten the NMR relaxation time of glass forming cations such as Si. While this decrease in relaxation time can be experimentally favorable, undesirable effects such as changes in chemical shift and signal broadening may also be observed. Although the effects of paramagnetic dopants are well known, their dependence on temperature and spinning rate has not been well studied. Paramagnetic transition metals, Fe, Mn, Cr, and Co were used as dopants in sodium borosilicate glasses. ^{11}B MAS NMR spectra of these glasses were found to have the largest full width half maximum at low temperatures and high spinning speeds.

Poster Number: 45

Identification And Improvement Of Ring Spinning Properties Of Hemp Fibres Using Physio-Chemical Methods

Presented by: Arshad Ali
Undergraduate at the University of Manitoba, Department of Textile Sciences

Advisor: Dr. Mashiur Rahman, Dr. Ying Chen

Research Area(s): *Soft and Disordered Materials*

Some aspects of hemp fiber make it superior than cotton fiber e.g., it requires fewer pesticides as compared to cotton, it is more environmentally friendly, and less water for cultivation. Canada is one of the major producers and has good climatic condition to produce hemp fibers. For apparel application almost half of the fiber used is cotton (40 million tons/year) followed by polyester (36 million tons) while the use of hemp fiber is only 80,000 tons. High quality apparel and smart textiles are produced from finer count yarns (20-50 tex), either from single or blended fibers, which can only be spun on ring spinning systems (RSS). Hemp would make a strong resource for Canadian/Manitoba agriculture if it could be spun through RSS for finer count yarns for apparel and smart textiles. In order to spin the fibre or fibre blend on RSS, a fibre must have five spinnable properties including strength, length and length variation ≤1/8 inch, single fibre entity, fineness and breaking twist angle (BTA). Our research showed that strength, fineness and length variation of hemp fibre are suitable for RSS; however, it lacks two other spinning properties: softness and individual fibre entity. If hemp could be altered to exhibit similar softness to cotton as well as single fibre entity, it could be spun on existing machinery and become a significant Canadian fiber. The present collaborative research between Department of Biosystem Engineering and Textile Sciences is investigating a physio-chemical approach to improve the RSS properties of hemp fibres.

Poster Number: 46

Investigating The Transverse Width Of Ultrasonic Waves In Close-Packed Suspensions Of Aluminum Beads

Presented by: Sébastien Kerhervé
PhD Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. John H. Page

Research Area(s): *Soft and Disordered Materials*

Interest in the physical properties of heterogeneous materials continues to grow, especially in the mesoscopic regime where the behaviour at intermediate length scales can be probed and tuned to reveal novel bulk properties. One powerful way of studying such materials is through measurements of wave transport. During propagation in disordered media, waves may undergo many scattering events. As a result, wave transport may become diffusive, and if the scattering is sufficiently strong, the waves may even become trapped by the disorder, or localized. Such behaviour can in principle be observed for all kinds of waves (electromagnetic, acoustic, matter waves…). Here, we focus on acoustic waves so that we can use ultrasonic techniques to study these fundamental aspects of wave transport.

In our experiments, we measure the transverse width of the acoustic intensity near the sample surface after a pulse is incident at a small spot on the other side. For diffusive behaviour, the width squared grows linearly in time, while for localized waves, the intensity becomes trapped and the width saturates. Our sample consists of aluminum beads randomly packed in ethanol - a two-component medium where diffusive behaviour was expected, based on previous work with glass beads suspensions. Contrary to expectations, we find that the transverse width saturates at long times. This new behaviour may be due to the existence of two propagation modes, a diffusive one traveling mostly through the liquid, and a localized one traveling mostly through the beads, which are coupled together by scattering resonances.

Poster Number: 47

Shaping Complex Fluids: How Foams Stand Up For Themselves

Presented by: Reine-Marie Guillermic
PostDoctoral Fellow at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. John H. Page

Research Area(s): *Soft and Disordered Materials*

A liquid foam is a dispersion of gas into liquid, stabilized by surfactants. This type of material is widely used in industry (food, cosmetic or petroleum industries) in particular for its remarkable rheological properties. Those who manipulate liquid foams tend to find themselves confronted by simple questions: What is the final shape of an amount of foam deposited on a surface? What is a maximum height of a pile of foam? The complex mechanical properties of liquid foams render the answer to such questions anything but simple. Everyday life gives us an impression of this complexity by displaying very different cases: Whilst the froth which crowns a pint flows spontaneously under its own weight, whipped cream or shaving foams can stand alone. These different behaviors find their origin in the complex rheological properties of foams and are linked, in particular, to their yield stress, and therefore to the bubble size and the liquid fraction of the foam. Combining theoretical and experimental investigations, we have been able to establish the interplay between the bubble size, the liquid fraction and the self-standing capacity of a foam, (expressed by the maximum achievable height of a foam pile) for the two limiting cases of foams with high and low yield stress.

Poster Number: 48

Novel Infinite-Range Intensity Correlations In Strongly Scattering Disordered Materials

Presented by: Kurt Hildebrand
PhD Candidate at the University of Manitoba, Department of Physics and Astronomy

Advisor: Dr. John Page

Research Area(s): *Soft and Disordered Materials*

The wave transport characteristics of strongly scattering disordered media play an important role in many systems, such as light scattering through colloids or human tissue, seismic waves in the earth's crust, or electronic conduction in solids. An excellent way of investigating classical wave transport in such systems is via the statistics and correlations of the randomly fluctuating transmitted intensity, or speckle pattern. Previous studies have focussed on both short- and long-range intensity correlations (known as C_1, C_2, or C_3) as a function of frequency, position, or angle. However, when the scattering become sufficiently strong, the speckle pattern changes qualitatively and a new kind of correlations arise that are infinite in range (C_0). These correlations increase rapidly near the onset of Anderson localization, where transport of quantum or classical waves ceases (corresponding to the metal-insulator transition for electronic systems). While Anderson localization and C_0 correlations have been predicted theoretically for some time, Anderson localization was only recently observed directly, and many questions remain about this phenomenon. Our ultrasonic experiments on highly porous aluminum samples constitute the first-ever direct measurements of infinite-range C_0 correlations, and help provide insight into the properties of a wide variety of materials (on a wide range of length scales) wherein the scattering of quantum or classical waves is very strong.

Poster Number: 49

High Temperature MAS NMR Studies Of Nuclear Waste Related Materials

Presented by: John Wren
PhD Candidate at the University of Manitoba, Department of Chemistry

Advisor: Dr. S. Kroeker

Research Area(s): *Soft and Disordered Materials*

The worldwide use of nuclear power produces 10,000 tons of radioactive waste annually. In many countries the spent nuclear fuel rods are reprocessed to extract ^{235}U for use in the production of new rods. The by-product of reprocessing, High-Level Waste (HLW), contains radioactive isotopes with half-lives upwards of millions of years. The long-term storage of HLW can be accomplished through vitrification of the mixture in a borosilicate melt, producing a chemically inert solid. Unfortunately, a prominent element in HLW is molybdenum, which is a poor glass former and can precipitate from the glass melt as water-soluble oxides containing radionuclei. ^{23}Na, ^{95}Mo and ^{133}Cs MAS NMR experiments were performed at temperatures up to 700°C on a variety of alkali molybdates and on model nuclear waste storage materials to characterize their spectral properties at high temperatures. With these spectral “fingerprints”, it is possible to monitor the phase separation behaviour at temperatures relevant to vitrification and long-term geological storage. For example, the conversion of $CsNaMoO_4 \bullet 2H_2O$ into $Cs_3Na(MoO_4)_2$ and Na_2MoO_4 can be followed in situ through MAS NMR.

Poster Number: 50

Synthesis And Characterization Of The New Langasite Compound $Sm_3Ga_2Al_3SiO_{14}$

Presented by: Arzoo Sharma
Undergraduate at The University of Winnipeg, Department of Chemistry

Advisor: Dr. Christopher Wiebe

Research Area(s): *Soft and Disordered Materials*

Langasite and langasite-based structures, with the generalized formula of $A_3B_5XO_{14}$, have held the attention of the solid state community for their unusual magnetism. The kagome nets formed by rare earth ions in the A-sites have led to possible realization of spin liquid phenomena, for example, in $Nd_3Ga_5SiO_{14}$ and $Pr_3Ga_5SiO_{14}$. Unfortunately, the garnet structure tends to be more stable than the langasite structure for ions smaller than Pr and Nd in the series due to the lanthanide contraction. However, we have recently found a way to stabilize the langasite structure for other lanthanides using smaller ions on the B site. We report here the synthesis and characterization of a new langasite compound - $Sm_3Ga_2Al_3SiO_{14}$ - which has partial substitution of Al for Ga on the B site. Magnetic property measurements show a lack of long-ranged magnetic order down to at least 1.8 K.

Poster Number: 51

Optical, Spectral And Phase-Matching Properties Of BiBO, BBO, LBO Crystals For Optical Parametric Oscillation In The Visible And Near-Infrared Wavelength Ranges

Presented by: Reza Akbari
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. A. Major

Research Area(s): *Photonic and Phononic Interactions*

Ultrashort pulse optical parametric oscillators (OPOs) in the visible and near-infrared ranges excited by compact diode-pumped sources have numerous applications. Exploiting classical and newly developed non-linear crystals as the gain medium necessitates a thorough comparison of their optical, spectral and phase-matching properties in order to obtain the desired laser properties. The spectral and phase matching properties of bismuth triborate, lithium triborate and B-barium borate are numerically investigated for OPOs pumped by green femtosecond laser at 520 nm. The phase matching scheme for each crystal is considered in such a way that they exhibit the highest effective nonlinearity and suitable tunability, i.e. angle phase-matching for BiBO and BBO, and temperature phase-matching for LBO. The analysis shows that for the maximum effective nonlinearity, type I phase-matching in BBO exhibits tuning range from 650 nm to deep-infrared for angular change of 2.2°, while BIBO with its superior effective nonlinear coefficient exhibits tuning range of 0.7-2 um with wider angular change of 12.6°. Temperature tuning of LBO with collinear, non-critical phase matching configuration provides a tuning range of 0.65-2.6 um for temperature change from 116 °C to 168 °C. It is shown that pulses experience the highest Group Velocity Mismatch (GVM) and Group Velocity Dispersion (GVD) in BiBO. The spectral gain bandwidth for 1 mm long crystal and pump intensity of 5 GW/cm^2 is investigated. It was found that over the main part of the wavelength tuning range, LBO offers the broadest gain bandwidth and BiBO offers the narrowest bandwidth.

Poster Number: 52

A New, Near Octahedral Bistridentate Co(II) Complex Based On The 2,6-bis(8'-quinolinyl)pyridine Ligand

Presented by: Blaise Frenzel
MSc Candidate at the University of North Dakota, Department of Chemistry

Advisor: Dr. Sean E. Hightower

Research Area(s): *Photonic and Phononic Interactions*

Octahedral bistridentate Co(II) complexes based on polypyridine ligands are particularly attractive for light-induced and energy transfer processes in view of artificial photosynthesis and molecular electronics. Unfortunately, these complexes are practically non-luminescent at room temperature which limits its use as photosensitizers. An often-cited reason for the dearth of luminescence is a weakening of the ligand field caused by the less than octahedral coordination of the tridentate ligand. One alternative is to increase the ligand field by making the tridentate ligand coordinate in a more octahedral fashion.

Herein, we report a new, near octahedral bistridentate Co(II) complex based on the 2,6-bis(8'-quinolinyl)pyridine ligand, bqp. Structural, spectroscopic, and electrochemical characterization of this compound provides evidence that the bqp is a strongly donating ligand that favors the formation of a low-spin complex. The structure is particularly attractive as it leaves the 4'-position on the central pyridine available for future preparation of linear donor-chromophore acceptor assemblies for vectorial electron migration. Because of the strong ligand field, its triplet, metal-to-ligand charge transfer (i.e., ^{3}MLCT) excited state lifetime at room temperature is dramatically increased and emission is observed.

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Poster Number: 53

Tricarbonyl Rhenium Complex of 2,6-Bis(8.-quinolinyl)pyridine: Synthesis, Spectroscopic Characterization, X-ray Structure & DFT Calculations

Presented by: Eric Nagel
Undergraduate at the University of North Dakota, Department of Chemistry

Advisor: Dr. Sean E. Hightower

Research Area(s): *Photonic and Phononic Interactions*

An ideal photosensitizer should have an excited state with high energy and sufficiently long lifetime to promote electron and/or energy transfer processes. Many *facial*-tricarbonyl Re(I)-diimine complexes have demonstrated sufficiently long lifetimes to perform many photosensitized reactions.[1] However, these complexes only utilize small portions of the visible spectrum, thereby, diminishing their overall effectiveness. Recent work has resulted in opening a synthetic route to the meridionally, tridentate *mer,cis*-Re(tpy-κ^3N)$(CO)_2$Cl (tpy = 2,2':6',2"-terpyridine) complex which absorbs light throughout the entire visible spectrum.[1] However, as with many other metal-terpyridine complexes, the *mer,cis*-[Re(tpy-κ^3N)$(CO)_2$L]$^{n+}$ (L = PPh_3, NC_5H_5, PEt_3, and Cl; n = 0 or 1) failed to produce emission at room temperature.[1]

The 2,6-bis(8'-quinolinyl)pyridine (bqp) ligand has been shown to form meridionally, tridentate complexes with Ru(II) with observed room temperature emissions on the order of 3 μs.[2] Results from our laboratory suggest that the *mer,cis*-Re(bqp-κ^3N)$(CO)_2$Cl complex is expected to absorb light throughout the entire visible spectrum at molar absorptivities greater than the *mer,cis*-Re(tpy-κ^3N)$(CO)_2$Cl. This study details initial coordination studies of the 2,6-bis(8'-quinolinyl)pyridine to Re(I).

[1] Black, D. R.; Hightower, S. E., *Inorg. Chem. Commun.* **2012**, 24,16–19.
[2] Abrhamson, M.; Jäger, M.; Ôsterman, T.; Eriksson, L.; Persson, P.; Becker, H-C.; Johansson, O.; Hammarström, L., *J. Am. Chem. Soc.* **2006**, 128(39), 12616−12617

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Poster Number: 54

2D Phononic Crystal With Anomalous Behavior Due To Overlapping Bragg And Hybridization Gaps

Presented by: Eric Jin Ser Lee
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Advisor: Dr. John Page

Research Area(s): *Photonic and Phononic Interactions*

Many of the interesting properties of phononic crystals are due to the existence of band gaps, which may arise from a number of different mechanisms. The most familiar mechanism is Bragg scattering, which causes wave propagation to break down in certain frequency ranges due to the destructive interference of waves from the period structure of the crystals. Band gaps may also be caused by coupling between a scattering resonance and the propagating mode of the embedding medium; such gaps are often called hybridization gaps. Recently, the coexistence of both kinds of gaps in a single system has been shown for both 2D and 3D crystals, leading to remarkably deep and wide gaps in some cases.

In this presentation, we investigate the nature of the interactions between Bragg and hybridization effects in 2D phononic crystals. We have chosen the lattice constant so that both mechanisms occur in the same frequency range, tuning the resonance frequency by varying the temperature to achieve fine control of the overlap between hybridization and Bragg effects. The dispersion relations were measured experimentally from the phase of transmitted ultrasonic pulses and calculated theoretically by finite element simulations. Good agreement between experiment and simulations is found. Our results reveal strikingly atypical behaviour near the resonant frequency, with different phase characteristics being observed for different crystal thicknesses and temperatures. A quantitative interpretation of these results will be presented, showing that this anomalous behavior is a consequence of the coupling between the resonant states of neighboring rods.

Poster Number: 55

Thermal Lensing In Nd:YVO_4 Laser With In-Band Pumping At 914 Nm

Presented by: Tanant Waritanant
MSc Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Arkady Major

Research Area(s): *Photonic and Phononic Interactions*

Nd:vanadate (Nd:YVO_4) laser crystal has been extensively studied as an alternative to Nd:YAG for medium range power applications. However, at high output power, the Nd:YVO_4 laser is limited by the inferior thermal properties which lead to a stronger thermal lensing effect which degrades the efficiency of the laser. To overcome this limitation, recent studies have focused on pumping Nd:YVO_4 lasers at longer wavelengths such as 914 nm to produce 1064 nm laser output. The smaller quantum translates directly to a smaller amount of heat generated within the crystal. This paper presents a study of thermal lensing effect in 914 nm diode pumped Nd:YVO_4 laser. The experiment utilized a 3-mirror laser cavity arrangement with a 0.5 at. % doped Nd:YVO_4 and a 10% output coupler. The focal length of the thermal lens in the crystal is calculated using ABCD matrix method from the experimental data of the output beam diameter measurements performed at different output power levels. The pump beam waist radius in the Nd:YVO_4 crystal is 275 µm. The calculated focal lengths of thermal lens are 624 mm horizontally and 531 vertically at 3 W of output power. M2 is measured to be approximately 1.3 in both directions. The optical efficiency of the laser is 64.9%. The absorbed pump power at threshold is 1.30 W. A numerical comparison of the thermal lensing effect with 914 nm and with a standard 808 nm pumping was also made.

Poster Number: 56

Orthogonally Polarized Dual-Wavelength Lasing Of Yb:KGW Crystals

Presented by: Haitao Zhao
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Arkady Major

Research Area(s): *Photonic and Phononic Interactions*

A coherent dual-wavelength light source produced in a single gain medium is very attractive for applications such as lidar, precise metrology, THz imaging and THz spectroscopy. The previous research, in most cases, is focused on the Nd^{3+}- and Yb^{3+}-doped vanadates with comparable gain between . and 1 polarizations in some wavelength ranges. Compared to these crystals, Yb:KGW crystals are more favorable as the lasing media producing radiation around 1 µm because of their smaller quantum defect, large absorption and emission cross sections and commercial availability. The Yb:KGW crystal exhibits anisotropic properties along its three orthogonally optical indicatrix axes (Nm, Np and Ng), resulting in the emission of different wavelengths with THz frequency offset. Until very recently, the dual-wavelength radiation on Yb:KGW crystals was demonstrated by A. Brenier with the help of chirped volume Bragg gratings and two pump regions in the crystal [1]. In practical situation, however, it is more desired to produce a dual-wavelength radiation in a simple and compact configuration. In this work, we present the realization of the dual-wavelength emission from a simple continuous-wave (cw) Yb:KGW laser oscillator without any extra optical insertions. The two wavelengths at 1029.5 nm and 1037.9 nm were originated from the polarizations Nm and Np.

[1] A. Brenier, "Tunable THz frequency difference from a diode-pumped dual-wavelength Yb3+:KGd(WO4)2 laser with chirped volume Bragg gratings," Las Phys Lett 8, 520_524 (2011).

Poster Number: 57

On The Characterisation Of Gamma Prime Intermetallics In A Powder Metallurgy Nickel-Based Superalloy

Presented by: Gabriel Tellier
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. N.L. Richards, Dr. W.F.Caley

Research Area(s): *High Temperature Aerospace Materials*

Gamma prime (Ni3Al) precipitates greatly influence the elevated temperature performance of nickel-based Superalloys and depending on the processing history of the alloy, several different populations of gamma prime may be present with varying size and shape. In an effort to reduce residual porosity in a powder metallurgy (PM)-produced Ni-Cr-Fe-Al alloy, samples that had been sintered for 2h at 13000C were subjected to a hot deformation solutionising treatment (2min at 12000C) and water quenched using a Gleeble™ thermomechanical test unit. To assess any changes in microstructure, polished sections were prepared, etched and examined using scanning electron microscopy (SEM) for presence/absence of the gamma prime. Whereas mainly sub-micron (~600nm) cuboid precipitates were evident in the as-sintered samples, none were visible at up to 20,000x for the solutionised-quenched material. However, interestingly, Vickers microhardness tests revealed little change between the as-sintered and solutionised-quenched samples suggesting presence of gamma prime that had not been resolved using the SEM. Therefore, samples were further examined using Atomic Force Microscopy (AFM), which revealed the presence of a sub-100nm population of gamma prime in the solutionised-quenched samples. This finding is discussed with a view to enhance the hot deformation of sintered PM nickel-based Superalloys to reduce residual porosity.

Poster Number: 58

Mathematical Modeling Of Laser Processing Parameters Dependence Of Intergranular Cracking In An Aerospace Superalloy

Presented by: Zhiguo Gao
PostDoctoral Fellow at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Olanrewaju Ojo

Research Area(s): *High Temperature Aerospace Materials*

The dependence of grain boundary cracking on multifarious parameters, such as laser power, welding speed and focal position during laser beam processing of an aerospace nickel-base superalloy was studied by a carefully designed experimental investigation coupled with detailed mathematical modeling. The results show that the theoretical model developed in the work can reasonably predict how the extent of intergranular cracking changes with the laser processing parameters. The analyses show that aside from thermo-mechanical stresses generated in the heat affected zone, due to uneven thermal contraction during cooling, which is the main source of thermal stresses considered in most contemporary finite element models, there are other crucial sources of thermally-induced stresses that strongly influence cracking. The newly developed mathematical model and its predicted outputs will be presented.

Poster Number: 59

Increased Fatigue Crack Growth Resistance Of A Newly Developed Aerospace Superalloy Haynes 282

Presented by: Richard Buckson
Phd Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Olanrewaju Ojo

Research Area(s): *High Temperature Aerospace Materials*

The severe operating conditions in aero engine gas turbines makes nickel-base superalloys that are used to manufacture these engine components, susceptible to failure by fatigue. In the present work, the fatigue crack growth (FCG) behaviour of a newly developed Aerospace nickel-base superalloy, Haynes 282, was studied. In comparison to the manufacturer's recommended standard thermal treatment for the superalloy, a new thermal treatment that results in significant improvement in the material's resistance to fatigue crack growth was developed in this work. The fatigue crack growth behaviour of the superalloy, as influenced by thermal treatments, at room and elevated temperatures under different test parameters will be presented.

Poster Number: 60

Numerical Simulation Of Transient Liquid Phase Process Under Temperature Gradient

Presented by: Arian Ghobadibigvand
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing

Advisor: Dr. O. A. Ojo

Research Area(s): *High Temperature Aerospace Materials*

Transient Liquid Phase under Temperature Gradient (TG-TLP) diffusion bonding is a relatively new process of TLP diffusion bonding family for joining difficult-to-weld aerospace materials. Earlier studies have suggested that in contrast with the conventional TLP process, liquid state diffusion drives joint solidification in TG-TLP process, which results in shorter processing time. In the present work, a mass conservative numerical model that considers asymmetry in joint solidification is developed to properly study the TG-TLP process. The numerical results, which are experimentally verified, show that unlike what has been previously reported, solid state diffusion can play a significant role in controlling the solidification behaviour in TG-TLP process. The newly developed model can serve as a vital tool for further elucidation of the TG-TLP process and it will be presented along with predicted results.

Poster Number: 61

Aerogel For Electromagnetic Radiation Shielding

Presented by: Tiroshen Fonseka
Undergraduate at North Dakota State University, Department of Mechanical Engineering

Advisor: Dr. Long Jiang

Research Area(s): *High Temperature Aerospace Materials*, Crystalline Materials and Nanostructures, Surfaces and Interfaces

Electromagnetic radiation is mostly emitted by Electronic devices. This is a form of energy transmitted and absorbed by charged particles. To prevent this radiation from interfering with the functionality of other electronics, an electromagnetic interference (EMI) shield is generally used. Metals or metal reinforced materials are the most common EMI shielding materials. These materials are heavy and prone to corrosion.

The purpose of this project was to create a light-weight electromagnetic shielding material for a wide variety of applications. Silica aerogel comprising homogeneously dispersed graphene nanosheets (GN) and/or carbon nanotubes (CNT) were chosen as a model material because of its unique properties. Aerogels are known for their extremely low density and high porosity, which shows high specific compressive strength but low toughness. Incorporating GN and/or CNT into aerogel matrix, it is expected to improve the strength and toughness of the aerogel. Electrical conductivity of the aerogel, which is logarithmically proportional to its EMI shielding efficiency, is also expected to be significantly increased after the addition of the carbonaceous materials. The high porosity structure of aerogels causes internal multi-reflections of radiation that can attenuate radiation strength and increase shielding efficiency. As such, the proposed model aerogel would be a novel, light-weight and highly efficient EMI shielding material.

Poster Number: 62

Simulation Of The High Strain Rate Deformation Behavior Of Titanium Based Alloy For Biomedical Applications

Presented by: Emmanuel Ocran
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. O. Ojo, Dr. U. Wyss

Research Area(s): *High Performance Computing*

Human body functions as a network of mechanically coupled parts (components) that work together to form a complete system; these body components can experience failure when in service. Specifically, failure such as arthritis may be caused by articulations at the hip and knee joint. One of such solutions to this failure is the total hip replacement. Materials used in this prosthesis, therefore play an important role in the success of the implant. One of the most commonly used implant material in modern day arthroplasty is the Ti6Al4V alloy, because of its excellent biocompatibility in the human body environment. In reality, such implant in service may be subjected to impact, leading to deformation. Typical, examples include an implanted patient involved in an automobile crash, a golf ball hitting an implanted patient at the point of implantation. In this study, the influence of impact velocity on the high strain deformation of Ti6Al4V was investigated using finite element analysis. The well known Johnson Cook model for was employed to characterize the behavior of Ti6Al4V at the strain rate of $1000s^{-1}$, under compressive loading. Simulation was performed at the impact velocities of 0.75, 7.5 and 75 m/s respectively. Results of this work showed that the maximum localized stress of 12, 30.45 and 80.34 N/m2, were obtained at these impact velocities respectively. The result of the simulation also gives an insight into the effect of impact velocity on the high strain rate deformation of Ti-6Al-4V. Also, recommendations were made as to possible coating materials that can act as strength inducing agents in impact conditions.

Poster Number: 63

A Novel Method To Characterize In-Vivo Bone Mechanical Properties Using CT Images

Presented by: Siamak Kazembakhshi
MSc Candidate at the University of Manitoba, Department of Mechanical and Manufacturing Engineering

Advisor: Dr. Yunhua Luo

Research Area(s): Soft and Disordered Materials, *High Performance Computing*, Composite Material Systems

Knowledge of bone mechanical properties has significant effects on understanding of orthopedic disease and bone fragility as well as design, fixation, survival of artificial joints and numerical design and optimization of implants. Consequently the need to improve diagnostic techniques to characterize the architecture of bone tissue in clinical environments has received significant attention. This study attempted to introduce a non- invasive method to determine anisotropic and heterogeneous material properties of in-vivo human bone. In previous studies, using experimental methods correlations between computed tomography (CT) data and material parameters of bone have been estimated. These correlations have been defined with assuming heterogeneity in structure of bone specimen. Results of different studies showed these correlations generate considerable errors because in reality bone structure exhibits both heterogeneous and anisotropic behavior. First part of this study introduces a novel method to determine anisotropic directions in bone from CT image date. In second part a test procedure is proposed to define correlations between CT image data and material parameters via results of combined compression, tensile and shear tests and associated finite element simulation. Finally optimization technique is employed to obtain a relation between elastic constants and mechanical strength of in vivo bone with CT image data. The defined correlations provide a tool to characterize bone mechanical properties none-invasively considering its anisotropy and heterogeneity.

Poster Number: 64

Research Spectroscopy: Approaching Big Data With Compression And User Interaction

Presented by: Yixuan Chen
MSc Candidate at the University of Manitoba, Department of Biosystems Engineering

Advisor: Dr. Jason Morrison

Research Area(s): *High Performance Computing*

As the size of spectroscopic data approaches limits of main computer memory, the need to have a compressed version that can be quickly searched becomes of greater importance. Fortunately the creation of ''succinct'' data structures for quick, compressed text search has been driven by search engines and genome mapping. This research focuses on providing a fast and space efficient data structure to answer information queries on spectroscopic data. Our primary hypothesis was whether a conversion from decimal data to character/integer space could be done in a manner that enabled use of ''succinct'' structures and still provided good compression. The preliminary research shows that the hypothesis is true. For FTIR data the conversion alone provides a high rate of compression and the empirical entropy of the converted text promises a further reduction.

Poster Number: 65

Computational Analysis Of The Dye Regeneration Mechanism In Dye Sensitized Solar Cells

Presented by: Scott McKay
Undergraduate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Georg Schreckenbach

Research Area(s): Soft and Disordered Materials, *High Performance Computing*

Dye Sensitized Solar Cells (DSSC) are a promising new advance in solar conversion technology that offer the possibility of cheap, long term and environmentally friendly ways of meeting our growing energy needs. Unfortunately, the efficiency of these devices has been stuck around 11% since their initial development in the early 90's. The gold standard for a redox couple is currently the I^-/I_3^- system. Champion Ruthenium dyes have been confirmed to regenerate by first forming a rate limiting $[Dye^+...I^-]$ complex and then interacting with a second I^- to form a $[DyeI_2^-]$ complex. The now neutral dye ejects the I_2^- and is free to absorb another photon, beginning the cycle again. Relativistic Density Functional Theory is applied to study the regeneration mechanism in Dye Sensitized Solar Cells for prototypical organic dyes. This mechanism will be tested for several classes of pure organic dyes by calculating kinetics and thermodynamic properties in acetonitrile solution at each step in the reaction mechanism to determine if the formation of the $[Dye+…I^-]$ complex is also the rate-limiting step. Gas phase calculations indicate this is the likely case. We studied the Coumarin, Triarylamine, Indoline and Anthocyanin dyes in this model.

Poster Number: 66

Studying Jurkat Cell Migration Using A PDMS Microfluidic Device

Presented by: Xun Wu
MSc Candidate at the University of Manitoba, Department of Immunology

Advisor: Dr. Francis Lin, Dr. Aaron Marshall

Research Area(s): *MicroElectricalMechanical Systems*

Cell migration guided by chemical concentration gradients, termed chemotaxis, plays important roles for a wide range of physiological and pathological processes. Particularly, chemotaxis is a key mechanism for T cell trafficking in secondary lymphoid tissues (SLT), which is crucial for adaptive immunity. Microfluidic devices can precisely configure chemical gradients and therefore provide a useful research tool for studying T cell migration and chemotaxis in SLT relevant chemical gradients in vitro. In the present study, we employed a PDMS microfluidic device to investigate the migration of Jurkat cells (a human T cell line) expressing transfected chemokine receptor CCR7 in defined gradients of SLT relevant chemokines including CCL19 and CCL21. In our preliminary experiments, we show that the CCR7 Jurkat transfectants migrate toward the CCL19 and CCL21 gradients. Multiple quantitative data analysis methods were applied to compare migration behaviors among heterogeneous CCR7 Jurkat transfectants. In addition, we demonstrate simultaneous monitoring of chemokine gradients, Jurkat cell migration and actin dynamics in the microfluidic device.

Poster Number: 67

Design Of Through Line Microwave Sensor, For Biological Cell Detection In A Microfluidic Channel

Presented by: Kaveh Mohammad
PhD Candidate at the University of Manitoba, Department of Electrical Engineering

Advisor: Dr.Thomson

Research Area(s): *MicroElectricalMechanical Systems*

A microwave frequency sensor has been designed to detect biological cells. The sensor sensitivity is about 670 Zepto Farad, and its signal to noise was measured to be roughly 75. This sensor could be used for biological cell measurements. This system was tested with 6 micron polystyrene spheres which caused about 50aF capacitance change in the system. These particles resemble actual yeast cells. The system is an interferometer with two signal path. One path applies the reference signal at about 2.2GHz to the LO input of the Mixer. The same signal is applied to the other path using a splitter. This path includes a microfluidic chip in which suspended cells inside a fluidic media are passing. The microwave power is applied to the channel using a microwave circulator compared with the old design [1], which a resonator was used for detection. The reflected signal phase is susceptible to the capacitance change in the channel. This signal is applied to the RF input of the mixer to be compared with the reference signal.

Instead of a resonator which needs resonance frequency adjustment, through line measurement make use of electrical path deference. So the sensor adjustment could be done only by adjusting the RF generator frequency. On the other hand, through line measurement has the capability of system integration in future, compared with the old design. Both systems have roughly the same sensitivity.

Poster Number: 68

Membrane Deformable Mirrors For Adaptive Optics

Presented by: Yu Zhou
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Cyrus Shafai

Research Area(s): *MicroElectricalMechanical Systems*

Adaptive deformable mirrors are used in telescopes to actively compensate for light propagation through non-homogeneous atmospheric conditions. This research focuses on a new mirror-membrane design to overcome the drawbacks of the conventional membrane deformable mirror, such as low resonant frequency (reducing mirror adaption frequency) and de-localization of mirror deflection between elements in multi-element mirrors. The proposed mirror possesses a supporting grid-mesh on the back-side of the mirror-membrane. Different material combinations for the membrane and grid-mesh are investigated through FEM analysis. Polymer materials are selected as the candidates of the membrane material for their greatly smaller Young's modulus, that allows larger deflection and easiness in fabrication. For the grid-mesh, both silicon and polymer materials are considered. Simulations have shown that this hybrid membrane can provide a much better localization of the deflection, and also provide a much higher resonant frequency.

Poster Number: 69

MEM Electric Field Sensor Using Force Deflection With Capacitance Interrogation

Presented by: Tao Chen
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Cyrus Shafai

Research Area(s): *MicroElectricalMechanical Systems*

For many years, electric field mills have been used to measure electric fields under HVDC transmission lines and for various atmospheric analyses. Conventional field mills with electric motors are currently employed but it is not straightforward to use these devices for long-term electric-field measurements. In recent years, various groups have worked to develop micromachined electric field mills (MEFMs). Various MEFM devices have implemented micromachined vibrating shutters. However, such devices have drawbacks, such as resonance shifts due to temperature change and charging over time. Therefore, there is a tendency to develop non-shuttered electric field sensor. In our work, A MEM based electrostatic field sensor is developed which uses capacitive interrogation of an electrostatic force deflected microstructure. Experimental measurements showed successful detection of a switched DC electric field. The designed range for this prototype sensor is from 10 kV/m to 1 MV/m. With an interrogating electrode located near the sensor, we achieved the resolution of this prototype sensor of 16.2 kV/m.

Poster Number: 70

A Volatile Absorption Wireless pH Sensor Using Hydrogel And pH Electrode

Presented by: Sharmistha Bhadra
PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

Advisor: Dr. Greg E. Bridges

Research Area(s): *MicroElectricalMechanical Systems*

We present a wireless pH sensor which utilizes amorphous hydrogel as an absorptive medium for acidic or basic volatiles. In the sensor unit a pH-sensitive mixed metal oxide (MMO) electrode and a reference Ag/AgCl electrode is coated with approximately 1.5 mm thick amorphous hydrogel. The potential difference across the electrodes changes in response to acidic or basic volatile absorption. The electrodes can be connected in parallel to a LC sensor whose resonant frequency shifts with the change of potential difference across the electrodes. An interrogator coil is inductively coupled to the sensor coil and remotely tracks the resonant frequency of the sensor. The sensor is demonstrated to detect different concentration of acetic acid, ammonium hydroxide and carbon dioxide. The sensor will have potential application in food spoilage detection where acidic and basic volatiles are produced during spoilage process.

Poster Number: 71

Growth, Positioning, Migration And Sorting Of Adipose-Derived Stem Cells In Microfluidic Devices

Presented by: Kanmani Natarajan
MSc Candidate at the University of Manitoba, Department of Biological Sciences

Advisor: Dr. Francis Lin

Research Area(s): *MicroElectricalMechanical Systems*

Stem cells hold great promise for treatment of various degenerative diseases. However, clinical studies have only shown very moderate benefits of cell therapy. We believe that insufficiency of therapeutic benefits is due to limited homing of implanted stem cells to targeted organs. Microfluidic devices are a very useful research tool for quantitative characterizations of stem cells and have the potential for deriving stem cell related biomedical applications. The present study first assessed the effects of epidermal growth factor (EGF) and direct current electric field (dcEF) on the growth and trafficking of adipose-derived stem cells (ASC). It was found that EGF did not affect cell proliferation in cell-culture flasks. However, ASC proliferated at a higher rate in microfluidic devices with continuous infusion of EGF. Furthermore, we found that ASC migrated toward an EGF gradient in microfluidic devices. Moreover, we found that ASC tended to position perpendicularly to dcEF. The results suggest that EGF and dcEF may be effective in guiding homing and trafficking of implanted ASC. Based on ASC chemotaxis to EGF, we further developed a microfluidic strategy for sorting chemotactic ASC, which can potentially improve stem cell delivery for transplantation therapies.

Keywords: microfluidics, adipose-derived stem cells, epidermal growth factor, cell migration, chemotaxis, electrotaxis, cell sorting.

Poster Number: 72

Evaluation of Electrical Insulation Degradation by Optical Imaging and Spectroscopy

Presented by: Nathan Jacob[1] and Hamid Hassanzadeh[2]

[1] PhD Candidate at the University of Manitoba, Department of Electrical and Computer Engineering

[2] MSc Candidate at the University of Manitoba, Department of Biological Sciences

Advisor: Dr. S. Sherif, Dr.B.Kordi

Research Area(s): *Photonic and Phononic Interactions,* Surfaces and Interfaces

Electrical insulation commonly used in large utility power transformers consists of oil-impregnated kraft paper layered on or around energized conductors. A known failure mechanism for this type of electrical insulation system is caused by the loss of mechanical tensile strength in the paper component due to thermal aging.

Transformers produce heat internally as part of their normal operation; over time this heating thermally ages the insulation paper making it 'brittle'. When this deterioration becomes significant, it limits the papers ability to maintain its electrical insulating properties and catastrophic failures of the power transformer can occur.

The deterioration of the insulation paper produces actual changes in its morphology and structure. Other work in industry has demonstrated that these morphological changes may be observed by means of spectroscopy in the visible light range, or SEM imaging of the microstructure.

In this work, it is anticipated that spectroscopy and optical coherence tomography (OCT) methods will be used to characterize changes to the paper morphology and relate this data with the remaining tensile strength (lifetime) of the electrical insulation paper. This will be accomplished by analyzing multiple paper samples which have undergone various degrees of thermal aging. Spectroscopy and OCT methods are desirable for this application because they are potentially non-invasive and accurate alternatives for evaluating the paper component of the electrical insulation.

Poster Number: 73

^{13}C and ^{15}N Solid-State NMR of Luminescent Group 2 Gold Cyanide Coordination Polymers

Presented by: Heather Cavers
Undergraduate at the University of Manitoba, Department of Chemistry

Advisor: Dr. Scott Kroeker

Research Area(s): *Crystalline Materials and Nanostructures*

Heather A. Cavers[1], John E. C. Wren[1], Daniel B. Leznoff[2], Scott Kroeker[1]
[1] University of Manitoba, Department of Chemistry;
[2] Simon Fraser University, Department of Chemistry

Coordination polymers containing gold cyanide $[Au(CN)_2]^-$ ligands have shown promise in a variety of applications, ranging from chemical sensors to birefringent materials. Group 2 (Ba^{2+}, Sr^{2+}, Ca^{2+} and Mg^{2+}) gold cyanide complexes, $M[Au(CN)_2]_2$, exhibit intense luminescence with cation-dependant wavelengths. It has been proposed that this is the result of aurophilic interactions, but complete structural characterization by diffraction-based methods is limited by structural disorder in these systems. Solid-state ^{13}C and ^{15}N MAS NMR experiments using direct- and cross-polarization were employed as structural probes of the cyanide units and their connectivity, while also giving insight into the role of interstitial water in the production of these luminescent properties.

Poster Number: 74

Survey Of The Inorganic Crystal Structure Database: Patterns In Coordination Number And In Bondlength Variations For Atoms Bonded To Oxygen

Presented by: Olivier Gagné
PhD Candidate at the University of Manitoba, Department of Geological Sciences

Advisor: Dr. Frank Hawthorne

Research Area(s): *Complex Natural Systems*

A comprehensive survey of bond lengths from the International Crystal Structure Database (ICSD) for all atoms of the periodic table that bond to oxygen, in various oxidation states and coordination numbers, is presented. A rigorous filtering process resulted in 139 different ions in 473 configurations (coordination numbers), and 33,546 cation coordination polyhedra for a total of 189,430 bond distances. The bondlength data, shown as histograms for every configuration, yields an immense amount of information. Of particular interest here is the visual aspect of the histograms. Comparing these plots under different criteria (e.g. configuration, family, period) shows trends across the periodic table of elements that are less obvious in individual case studies. Subtleties in bondlength distributions for specific ions become more evident, and allow us to examine the underlying principles giving rise to these distributions. While known electronic effects such as the "Jahn-Teller" effect are observed where theory predicts, the bond-length distributions of some other ions deviate from a normal distribution to various degrees, from shoulders on the distribution of "spherical" atoms, to multimodal distributions in elements of later periods.

Poster Number: 75

Use Of Mechanical Properties of E-GFPR To Analyze Curved Laminated Beam

Presented by: Hanan Alhayek[1] and Sami Alshurafa[2]

[1] PhD Candidate at the University of Manitoba, Department of Civil Engineering
[2] Prince Sultan University, Saudi Arabia

Advisor: Dr. Dagmar Svecova

Research Area(s): *Composite Material Systems*

The poster will include information on the preparation of E-Glass Fiber Polymer coupons according to ASTM Standards D3039 (2008), D3410 (2003) and D5379 (2005) for test in tension, compression and shear to determine material properties required in FEA to analyze Wooden Arch and curved beam.