Manitoba Materials Conference 2015

May 12th, 2015 Engineering & Information Technology Complex Atrium

Poster Abstracts

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The abstracts contained within the document represent a selection of work undertaken within MIM over the last year. This internal document is not intended for publication or dissemination.

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Poster Number: 1

Microwave holography using a spintronic microwave sensor

Presented by: Lei Fu
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Advisor(s): Can-Ming Hu

Co-Author(s): Y. S. Gui, L. H. Bai, H. Guo, H. Abou-Rachid, and C.-M. Hu

Research Area(s): Crystalline Materials and Nanostructures

In this work a spintronic sensor based microwave holographic imaging system is developed, demonstrating the feasibility of microwave holographic imaging applications using a spintronic microwave sensor. The high sensitivity of the microwave phase measurement allows the coherent imaging of the target reconstructed in noise environments. Adapting the broadband measurement, not only the shape but also the distance of target can be determined, which implies that a three-dimensional imaging is achievable using a spintronic device.

Poster Number: 2

Spin rectification for collinear and non-collinear magnetization and external magnetic field configurations

Presented by: Yan Huo
Ph.D. Candidate in the Department of Physics and Astronomy

Advisor(s): Yizheng Wu, Can-Ming Hu

Co-Author(s): L. H. Bai, P. Hyde, Y. Z. Wu and C.-M. Hu

Research Area(s): Crystalline Materials and Nanostructures

Spin rectification in a single crystal Fe/Au/Fe sandwich is electrically detected for collinear and non-collinear magnetization and external magnetic field configurations. The line shape, linewidth and signal polarity are analyzed. The spin rectification theory has been much extended by taking the magneto-crystalline anisotropy and shape anisotropy into account, which explains non-collinear resonances and agrees very well with experimental data. Thus, a comprehensive understanding of spin rectification in ferromagnetic metal is demonstrated in this work.

Poster Number: 3

The Structural and Electronic Properties of Pristine and Doped Polythiophene: Periodic Versus Molecular Calculations

Presented by: Thaneshwor Kaloni
Postdoctoral Fellow in the Department of Chemistry

Advisor(s): Georg Schreckenbach, Michael Freund

Co-Author(s): Georg Schreckenbach and Michael Freund

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

The structural and electronic properties of polythiophene in periodic and oligomer forms have been investigated. In particular, the effects of Li or Cl adsorption onto a monolayer and Li or Cl intercalation into bulk or bilayer polythiophene are addressed using periodic as well as molecular calculations. The HOMO-LUMO gap and charge transfer are analyzed. It is found that the parallel bulk or bilayer structure is energetically favorable compared to flipping the second layer by 180 degree. Moreover, for Li adsorption, polarons are found to be more stable than bipolarons, while the situation is opposite for Cl adsorption. The detailed analysis of the present study will be useful to construct polythiophene-based electronic devices. [Reference: Thaneshwor P. Kaloni, Georg Schreckenbach, and Michael S. Freund, J. Phys. Chem. C 119, 3979 (2015)]

Poster Number: 4

Experimental and theoretical NMR analysis of paramagnetic $M(acac)_3$ M = Cr, Mn coordination compounds

Presented by: Kirill Levin
M.Sc. Candidate in the Department of Chemistry

Advisor(s): Scott Kroeker

Co-Author(s): Scott Kroeker

Research Area(s): Crystalline Materials and Nanostructures

Solid state nuclear magnetic resonance (NMR) spectroscopy is a widely used technique for the characterization of materials. The versatility of NMR spectroscopy stems from its sensitivity to variations in local structural environments. However, a recognized drawback of NMR is its limited applicability to paramagnetic systems such as organic radicals, metals, conductors and some organometallic complexes, where the presence of unpaired electrons introduces an additional layer of difficulty to spectral acquisition and interpretation. Recent advances in instrumentation have reopened the investigation of paramagnetic solids.

We are studying a series of isostructural metal acetylacetonate complexes to better understand the experimental and analytical particularities of such systems. 13C magic-angle spinning NMR of $M(acac)_3$ (M = Cr, Mn, Co, Al) reveals interesting spectral differences which are related to the electronic structure and bonding, thereby providing valuable clues about optimizing acquisition and inferring electronic distributions. For example, $Cr(acac)_3$ and $Mn(acac)_3$ produce dramatically different NMR spectra due to the presence of t_2g_3 and $t_2g_3eg_1$ configurations, respectively.

Density functional theory provides detailed electron distribution maps of the complexes which are used to assign crystallographic sites and delineate spin-transfer mechanisms. Molecular orbital theory renders the analysis more intuitive and facilitates extensions to other materials. The use of simple model coordination compounds is intended to provide the foundation for a more general approach to utilizing unpaired spin density as a new tool for structural analysis of paramagnetic materials.

Poster Number: 5

Stabilization of the Defect Fluorite Structure in the Sc-V-O System

Presented by: Joey Lussier
Ph.D. Candidate in the Department of Chemistry

Advisor(s): Mario Bieringer

Co-Author(s): Fabian Simon, Mario Bieringer

Research Area(s): Crystalline Materials and Nanostructures

Fuel cells are vital technologies for the future of alternative energy due to their fuel flexibility, low emissions and high conversion efficiency. Ion conductors as solid-state electrolytes play a crucial role in improving alternative energy conversion devices. Shafi, et al.[1,2] showed that the structural relationship between the bixbyite (ABO_3) and fluorite (ABO_4) structures permits control of oxidation states and oxygen defects (A=Sc,In; B=Ti,V). Some problems that arose in these systems include that the defect fluorite $ScVO_{3.7}$ undergoes a non-topotactic (reconstructive) oxidation and results in the formation of an ordered zircon structure. This oxidative transition occurs below the typical operating temperature of solid oxide fuel cells (SOFC) and will destroy the solid state electrolyte. Furthermore the limited oxidation state of titanium only allows the oxidation to $ABO_{3.5}$ affecting the ion conductivity. We will present our recent work to stabilize the defect fluorite structure beyond the operating temperature of common SOFCs in these systems and eliminate the problems mentioned above. We report synthesis, structural characterization, thermal analysis, ion conductivity measurements and reactivity studies using in situ x-ray diffraction.

Poster Number: 6

Spherical and non-spherical iron oxide nanoparticles with bio-compatible coating materials

Presented by: Palash Kumar Manna
Postdoctoral Fellow in the Department of Physics and Astronomy

Advisor(s): Johan van Lierop, Donald Miller

Co-Author(s): P. K. Manna, Yaroslav Wroczynskyj, Zhizhi Sun, Donald W. Miller and Johan van Lierop

Research Area(s): Crystalline Materials and Nanostructures

The development of surface-functionalized magnetic nanoparticles, with a bio-compatible material, opens up the possibility of several biomedical applications, such as targeted drug delivery, cellular therapy, tissue repair, hyperthermia, etc. It is also possible to bind drugs, proteins and antibodies to the magnetic nanoparticles, and direct those to any damaged tissue or organ by an external magnetic field. It has, generally, been found that larger nanoparticles (>1 micron, including the coated material) accumulates in the liver and lungs, medium sized nanoparticles (10-300 nm) populates the bone marrow, spleen, liver and lymph nodes, whereas smaller nanoparticles (<10 nm) goes to the kidney. Therefore, depending upon the location of the targeted area, the size of the nanoparticles needs to be tailored. The shape of the nanoparticles also plays an important role in such biomedical applications. For example, non-spherical nanoparticles (rods, discs, etc) were shown to be more effective to target damaged cells than the spherical ones. Keeping this in mind, we have synthesized spherical magnetite nanoparticles of different sizes and coated those using a bio-compatible material, N-(trimethoxysilylpropyl)ethylenediaminetriacetate (EDT). The crystallite size has been determined from the Rietveld refinement of the x-ray diffraction pattern and the success of the coating has been verified using Fourier transform infrared spectroscopy (FTIR) technique. We have also synthesized non-spherical (doughnut-shaped) hematite particles to transform in to magnetite. Finally, we aim to study the effect of nanoparticle size and shape in targeted drug delivery.

Poster Number: 7

Low Temperature Physical Properties of La_2CuSnO_6 a CuO Layered Perovskite

Presented by: Cole Mauws
Undergraduate Student in the Department of Chemistry

Advisor(s): Christopher Wiebe

Co-Author(s): Arzoo Sharma, Harlyn Silverstein, Paul Sarte, Mario Bieringer, Christopher Weibe

Research Area(s): Crystalline Materials and Nanostructures

The double perovskite La_2CuSnO_6 has attracted attention as a potential superconductor, due to the presents of CuO layers associated with superconductivity. Past attempts at inducing superconductivity have failed. This research intends to determine the reason behind the lack of superconductivity, through magnetic susceptibility and heat capacity measurements. The compound was synthesised with a minimal, non-magnetic impurity phase. Magnetic susceptibility shows a field cooled, zero field cooled splitting indicative of a ferromagnetic or glassy transition. The Curie-Weiss fit of the magnetic susceptibility yields a Weiss temperature of 233 K and a magnetic moment, obtained from the Curie constant, of 0.522 μB compared to the expected magnetic moment of 1.9 μB for Cu^{2+}. Heat capacity measurements show no large release in entropy near the splitting in the magnetic susceptibility, indicating that no ordering of the spins is achieved. The disagreement of the experimental and expected magnetic moments of Cu^{2+} along with the lack of ordering in the heat capacity data do not indicate a ferromagnetic transition, or a previously argued spin-canted ferromagnetic transition. The true magnetic ground state has not been determined. However the data does not support the existence of a Mott Insulating anti-ferromagnetic ground state, typical of type 2 superconductors, which may explain the lack of superconductivity. Future neutron scattering experiments could provide conclusive evidence for the magnetic ground state of La_2CuSnO_6.

Poster Number: 8

Observations on the chemical properties of in service aged XLPE insulators

Presented by: Mohammad Nadimi
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Derek Oliver

Co-Author(s): Dr. Derek Oliver

Research Area(s): Crystalline Materials and Nanostructures

In operation, cable insulation materials undergo changes as a consequence of their operating conditions i.e. thermal and electrical stresses. This work presents observations on the chemical properties of in service aged XLPE (cable insulator) using ATR-FTIR spectroscopy. Ten different samples were randomly selected from in-service aged cable sections. Each sample was studied at 128 scans with a resolution of 4 cm^{-1} in the range of 650-4000 cm^{-1}. The FTIR absorbance spectra of all samples are almost the same except one of them (sample S2) which provides two strong peaks around 1720 cm^{-1} and 1740 cm^{-1}. These peaks could be the indicators of the presence of carbonyl groups of ketones and aldehyde/esters, respectively. In order to obtain quantitative information on chemical degradation of different samples, the carbonyl index, defined as the relative intensities of the carbonyl band (1740 cm^{-1}) to a region where oxidation has little effect (methylene band at 1471 cm^{-1}), was calculated for each sample. The carbonyl index of sample S2 is three times bigger than of other samples. These data suggest that the region of sample S2 studied was partially oxidized during its operation in service conditions. However, independent data such as measurement using x-ray photoelectron spectroscopy is needed to support the attribution of what was observed.

Poster Number: 9

Magnetism as a Probe to Quantify the Active Sites for NO Reduction by CO in Ceria-Supported Iron Catalysis

Presented by: V K Paidi
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Advisor(s): Johan van Lierop

Co-Author(s): Charles A Roberts, Johan van Lierop

Research Area(s): Crystalline Materials and Nanostructures

Catalysis with nanosized transition metal supported oxides has attracted significant attention due to their high selectivity over the extensively studied and utilized platinum group metal catalysts. Yet, issues such as identifying and quantifying the active sites remains a open question. Here, we present a novel way of using the magnetism of the catalysts in order to identify number of active sites in ceria-supported iron catalysts. Fe-coated CeO_2 nanoparticles were prepared using a sodium Fe(III) ethylenediaminetetraacetate (NaFeEDTA) precursor with varying Fe surface densities (0 - 1.5 Fe/nm^2), and the number of Fe ions/g were identified by ICP and BET surface areas. Steady state catalytic activities as a function of Fe surface density were obtained and correlated to the magnetic measurements. Magnetic ions/g were distinguished (paramagnetic and ferromagnetic) by Curie-Weiss analysis and transition temperatures. Our studies highlight the importance of magnetism's intrinsic relation to the active sites, and their role in catalysis.

Poster Number: 10

Investigation of the solid solution $Sc_2VO_{4.5+\delta}$ ($0 \leq \delta \leq 1.0$)

Presented by: Golnaz Samandari
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Advisor(s): Mario Bieringer

Co-Author(s): Mario Bieringer

Research Area(s): Crystalline Materials and Nanostructures

The RVO_3 (R= Y, La-Lu) structures form cation ordered perovskite phases which display interesting physical and in particular magnetic properties. In contrast the smaller R^{3+} cations Sc^{3+} and In^{3+} form cation disordered bixbyite (c-Mn_2O_3) structures with an ordered oxide defect sublattice which is closely related to the disordered oxide defect fluorite structures . The structures of high temperature oxide ion conducting phases are characterized by point defects and are often based on fluorite structures. Those materials are used as solid state electrolytes in solid oxide fuel cells (SOFC). We are investigating the cubic bixbyite (c-Mn_2O_3) and fluorite structures for the $Sc_2VO_{4.5+\delta}$ system in an effort to follow the formation and annihilation of point defects. Particular emphasis is placed on competing ordered oxide defect structures. The main focus of the work is the investigation of solid state reaction pathways and enhancing the structural control during the formation of scandium vanadate phases. For $Sc_2VO_{4.5}$ (space group Ia-3 (206) a=9.6846(2) Å) an optimized synthesis method is presented and the oxidative evolution of the parent cubic bixbyite structure will be illustrated. We provide in-situ X-ray diffraction combined with thermogravimetric and differential thermal analysis experiments to clarify the topotactic oxidation pathway, ordering temperature, and phase separation.

Poster Number: 11

Study of New Beryllium Substituted Langasites $A_3Ga_3Ge_2BeO_{14}$ (A=Pr, Nd, Sm)

Presented by: Arzoo Sharma
M.Sc. Candidate in the Department of Chemistry

Advisor(s): Chris Wiebe

Co-Author(s): H. J. Silverstein

Research Area(s): Crystalline Materials and Nanostructures

Langasites have attracted a lot of attention because of their spin-liquid like characteristics. The magnetic ions in these compounds interact in a trigonal crystal structure and occupy the corners of the triangular network forming a distorted 2-D Kagome lattice.
A greater understanding of their ground state is limited by difficulty in synthesizing new members belonging to this series due to formation of competing phases like the garnet phase. Recently we were able to synthesize three new members $A_3Ga_3Ge_2BeO_{14}$ (A=Pr, Nd, Sm) belonging to this class by substitution of Be^{2+} in the 2d tetrahedral site (D site). The substitution leads to a decrease in ratio of magnetic ion to gallium from 3:5 to 1:1 and reduces the stability of garnet structure. These compounds were characterized by x-ray diffraction, hysteresis, magnetic susceptibility and heat capacity measurements. No evidence of long range ordering was observed down to 0.350 K for all three compounds.

Poster Number: 12

Direct measurement of the spin gap in a quasi-one-dimension clinopyroxene: $NaTiSi_2O_6$

Presented by: Harlyn Silverstein
Ph.D. Candidate in the Department of Chemistry

Advisor(s): Chris Wiebe

Co-Author(s): Alison Smith, Cole Mauws, Doug Abernathy, Haidong Zhou, Zhiling Dun, Johan van Lierop, Chris Wiebe

Research Area(s): Crystalline Materials and Nanostructures

True inorganic spin-Peierls materials are extremely rare, but $NaTiSi_2O_6$ was at one time considered to be an ideal candidate owing to its well separated chains of edge-sharing TiO_6 octahedra. At low temperatures, this material undergoes a phase transition from C2/c to P-1 symmetry, where Ti^{3+}. Ti^{3+} dimers begin to form within the chains. However, it was quickly realized with magnetic susceptibility that simple spin fluctuations do not progress to the point of enabling such a transition. Since then, considerable experimental and theoretical endeavors have been undertaken to find the true ground state of this system and explain how it manifests. Here, we employ the use of x-ray diffraction, neutron spectroscopy, and magnetic susceptibility to directly and simultaneously measure the symmetry loss, spin singlet-triplet gap, and phonon modes. A gap of 53(3) meV was observed, fit to the magnetic susceptibility, and compared to previous theoretical models to unambiguously assign $NaTiSi_2O_6$ as having an orbital-assisted Peierls ground state.

Poster Number: 13

Magnetism of ferromagnetic bulk MnBi phases made from MnBi nanoparticles - A new route to nanocomposite permanent magnets

Presented by: Elizabeth Skoropata
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Advisor(s): Johan van Lierop

Co-Author(s): John W. Freeland, Michael P. Rowe, Johan van Lierop

Research Area(s): Crystalline Materials and Nanostructures

For over fifty years MnBi has been pursued as a fundamentally interesting and highly useful rare-earth replacement candidate material due to the unique quality of an anisotropy which increases with increasing temperature when the "low-temperature phase" (LTP) is formed. However, to date, LTP MnBi has been produced mainly in small quantities and through highly laborious mechanical techniques. In addition, work is ongoing to understand better the close relationship between magnetic anisotropy, structure and composition to optimize the useful magnetic properties. To study further the interesting magnetism of ferromagnetic MnBi species, we have developed MnBi synthesis in large (gram-scale) quantities using a wet chemical method, followed by a single hot-pressing step. Here, we report the structure and magnetism of the products obtained from different hot-pressing conditions. Hysteresis loop measurements for the as made MnBi indicated a ferromagnetic phase with a small saturation magnetization and coercivity (Hc), indicating a ferromagnetic phase other than LTP MnBi. Interestingly, hot-pressing resulted in multiple ferromagnetic MnBi species with LTP-like (but different) anisotropies, whose preferential formation depended on the hot-pressing conditions (time and temperature) that were used. X-ray absorption experiments indicated similar Mn valence and coordination environments for all samples, suggesting, rather, that a change in stoichiometry or microsctucture were the source of the changes in the overall magnetism. Consistent with these findings, x-ray diffraction revealed Mn, Bi, and an LTP MnBi occurring with different relative amounts and compositions, depending on the hot-pressing conditions used.

Poster Number: 14

Molecular Dynamic Simulation of alkanethiol self-assembled monolayers on gold surface

Presented by: Aoran Wei
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Advisor(s): Chuang Deng

Co-Author(s):

Research Area(s): Crystalline Materials and Nanostructures, High Performance Computing

Self-assembled monolayers (SAMs) of organic thiols on gold have been extensively studied, due to their multiple applications and contribution to understanding organic interface. In this paper, molecular dynamics simulations of self-assembled alkanethiol monolayers (SAMs) chemisorbed on the Au (111) surface have been carried out using an all-atom model to investigate their structural properties. The interaction between Au-S was modeled using Morse potential, while for the Au-Au interactions, an embedded-atom (EAM) method was used. The simulation result showed that this system forms forms a well-ordered ($\sqrt{3}$x$\sqrt{3}$) R30° triangular lattice at 300 centigrade, which is consistent with the experimental results.

Poster Number: 15

Quantifying the surface charge of functionalized nanoparticles using electroacoustics: Working towards targeted drug delivery.

Presented by: Yaroslav Wroczynskyj
Ph.D. Candidate in the Department of Physics and Astronomy

Advisor(s): Johan van Lierop

Co-Author(s): Zhizhi Sun, Donald Miller, John Page and Johan van Lierop

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

Fundamental to the successful use of magnetic nanoparticles for biomedical application is a thorough understanding of not only their magnetic and surface properties, but also the effects that complex media (e.g. biological tissue) have on these quantities for directed transport. Limitations of current methods used to assess nanoparticle surface properties (e.g. light scattering requiring dilute suspensions in optically transparent media) have precluded a proper qualitative understanding in conditions suitable for application, and at pharmacologically relevant concentrations. Using an AC electric field, pressure oscillations can be induced in colloidal nanoparticle suspensions, and these oscillations provide information about nanoparticle size and surface charge (zeta-potential) with no restriction on medium or concentration. Electroacoustics allows for the concurrent determination of the properties of colloidal suspensions in application conditions, allowing for the first time a rigorous examination of the behaviour of nanoparticles suspended in complex media.

Here, I present results which demonstrate the feasibility of this method for the measurement of nanoparticle surface properties. Changes in the pressure oscillations produced by various nanoparticle formulations with known zeta-potentials are used to scale measurements obtained for nanoparticles with unknown surface charge. Discrepancies from theories describing classical colloids (e.g. micrometre-sized) are highlighted.

Poster Number: 16

The tunneling magnetoresistance current dependence on cross sectional area

Presented by: Zhoahui Zhang
Ph.D. Candidate in the Department of Physics and Astronomy

Advisor(s): Can-Ming Hu

Co-Author(s): Z. H. Zhang, Lihui Bai, C.-M. Hu,S. Hemour, K.Wu, X. L. Fan, D. S. Xue

Research Area(s): Crystalline Materials and Nanostructures

The magnetoresistance of a MgO-based magnetic tunnel junction (MTJ) was studied experimentally. The magnetoresistance as a function of current was measured systematically on MTJs for various MgO cross sectional areas and at various temperatures from 7.5 to 290.1 K. The resistance current dependence of the MTJ was also measured for different angles between the two ferromagnetic layers. By considering particle and angular momentum conservation of transport electrons, the current dependence of magnetoresistance can be explained by the changing of spin polarization in the free magnetic layer of the MTJ. A phenomenological model is used which avoid the complicated barrier details and also describes the data. This work is useful for further study of the mechanism of the current dependence in MTJ.

Poster Number: 17

Experimental Stress Analysis of an Axially Compressed Elastomeric Annular Seal in a Pressurized Environment

Presented by: Alix Bartel
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Advisor(s): Christine Wu

Co-Author(s): Doug Krokosz

Research Area(s): Mechanics of Materials and Structures, Soft and Disordered Materials

The characterization of the behavior of elastomers as well as the stress analysis of pipes are both subjects of interest in the field of solid mechanics. To perform sealing operations on pipes, annular elastomeric seals are aligned concentrically with a pipe and axially compressed to deform radially into the pipe wall providing sealing capability. The behaviour of the elastomer seals and the interaction between the seals and the pipe is largely unexplored. A previous analysis focused on experimentally characterizing the behavior of the elastomer seals and the resultant effects on the surrounding pipe. An experiment was designed to simulate the sealing action and to control the operational parameters of the seal. These parameters include seal and pipe dimensions, contact surface friction, and axial compression. Output data produced a load-displacement relationship, a contact pressure distribution, a contact area distribution, and pipe membrane strain measurements. The results drawn from experimentation determined that the seals exhibit linear elastic material properties up to an axial compression of 18.2%, the seal stiffness is dependent on friction and seal dimensions, and pipe strain is inversely proportional to seal stiffness. In continuation with the previous analysis, it is proposed to develop specific material models and an improved experimental methodology in conjunction with a finite-element model. The subsequent experimental tuning of the finite-element model will simulate the compressive and frictional behaviour of an elastomeric annulus in sealing applications.

Poster Number: 18

Density of States and Level Repulsion of Sintered Aluminum Beads

Presented by: Laura Cobus
Ph.D. Candidate in the Department of Physics and Astronomy

Advisor(s): John Page

Co-Author(s): Eric Jin Ser Lee

Research Area(s): Mechanics of Materials and Structures, Soft and Disordered Materials

We investigate the vibrational density of states (DOS) of sintered aluminum beads. The DOS is a fundamental intrinsic property of any system, and can strongly influence ultrasound propagation. Sintered aluminum bead samples were chosen for study since they constitute the first three-dimensional system to exhibit Anderson localization of ultrasound.

The DOS was measured directly by counting modes in the frequency domain experimentally. Mode counting was also performed using COMSOL simulations (FEM). The total number of modes is proportional to the number of beads in a sample. The DOS was approximately independent of frequency below the first resonant frequency of a single bead; however, the overall frequency dependence was found to be consistent with traditional DOS models at higher frequencies. As the sample size increases, pass bands are formed around the eigenmodes of a bead, as in the tight binding model of electronic energy bands. When the coupling between beads is not too strong, band gaps are formed where the DOS drops to zero, at frequencies between pass bands.

This systematic study allowed the conditions to be determined under which level repulsion occurs. For a single bead, the probability distribution of normalized nearest neighbour level separations is close to the Poisson distribution. When the sample is larger and there are more modes, they start to overlap and repel each other so that level repulsion effects become important. Consequently, the level statistics were observed to become closer to GOE predictions as the sample size increased.

Poster Number: 19

Frozen Convenience Noodles: Use of Ultrasound to Study the Influence of Preparation Methods on their Rheological Parameters

Presented by: Daiva Daugelaite
Ph.D. Candidate in the Department of Food Science

Advisor(s): Dave Hatcher, John Page, Martin Scanlon

Co-Author(s): Anatoliy Strybulevych

Research Area(s): Mechanics of Materials and Structures, Soft and Disordered Materials

Demand in convenience stores for frozen goods, whose quality should be equivalent or very similar that of the fresh product, is increasing. We investigate the effects of addition of glucose oxidase (GOx) as an improving ingredient on noodle texture and mechanical properties using traditional texture measurements and novel ultrasound techniques. Fresh alkaline noodles, prepared from strong Canadian Wheat class (CWRS) flour, with or without the enzyme GOx, were either frozen immediately after production, blanched for 3 min prior to freezing, or fully cooked prior to freezing before being stored at -20 °C for 1 or 4 weeks. The frozen noodles were then cooked and their rheological properties determined by longitudinal wave ultrasonic measurements (at 11 MHz), using customized ultrasonic transducer assemblies attached to a texture analyzer. Frozen storage of flash frozen raw noodles for 4 weeks results in a decline in rheological parameters. Similar trends in rheological parameters are seen for noodles that were either blanched or cooked prior to flash freezing. Significant differences between fresh, raw, blanched and cooked noodles were observed by ultrasonic test parameters, and these correlated well with stress relaxation measurements. The data presented show the ability of ultrasonic technique to detect changes due to method of preparation and formulation on the rheological parameters of noodles.

Poster Number: 20

A Study on the Accuracy of BWIM and WIM Systems using Piezoelectric Sensors

Presented by: Sofia Faraz
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Advisor(s): Aftab Mufti

Co-Author(s): Dr Aftab Mufti

Research Area(s): Mechanics of Materials and Structures

Bridge weigh in motion (BWIM) systems provide useful information to understand live loads moving on the bridges. BWIM system is based on the measurement of the deformation of bridge and the use of measurements to estimate unknown parameters of passing vehicles. Dynamic response of a bridge due to concentrated and pulsating load to predict accurately Gross Vehicle Weight (GVW) and velocity are investigated analytically. Sources of Dynamic response were also investigated and the accuracy of filtering techniques to eliminate them was compared.

First signal is simulated by considering a simply supported beam excited by a concentrated and pulsating load traveling at different velocities. This signal is modified with different kinds and magnitudes of electric noise extracted from field raw sensor data. Different filtering and smoothing techniques are applied to extract the static response of the bridge. In order to validate the BWIM and Signal Processing procedures adopted for simulated signal, a scaled model of bridge is under construction in the laboratory. The scaled model is designed to represent the static and dynamic similitude of Prototype Bridge selected. It is instrumented for BWIM and WIM at different locations using Electrical and Piezoelectric Sensors. The simulated results will be compared to experimental and field data to validate the accuracy of data processing algorithm adopted for predicting GVW and velocity.

Poster Number: 21

Experimental Study of Load Transfer in the Structure with U* index Method

Presented by: Khashayar Pejhan
Ph.D. Candidate in the Department of Mechanical Engineering

Advisor(s): Christine Wu, Igor Telichev

Co-Author(s): Qingguo Wang, Christine Wu, Igor Telichev

Research Area(s): Mechanics of Materials and Structures

Load Transfer Analysis studies the path, on which imposed load are being transferred in the structure. This aspect of structural analysis had been over shadowed by conventional stress analysis for many years. However, in last decade many designers, especially in field of automotive engineering, have applied the load transfer analysis methods to improve the design of their structures for carrying more load with lighter weights. There are two main approaches in literature for load transfer analysis. The first one is the stress trajectory method, which uses the principal stress values to follow the load path in the structure. The second method, which has achieved more popularity in industry, is the U* index theory for load transfer analysis in the structure. The U* index is a mathematical index that can be calculated using strain energy of the system. The U* index quantifies the internal stiffness of the structure and claims to able to predict the load path in the structure. Although it has been applied in several studies to detect the load path and improve the design, there has been no experimental study to prove ability of U* for load path detection in the structure. In this study, the first experimental validation of U* theory is presented. Two experimental tests are designed and implemented to show that points with higher U* index value, indeed carry more load in the structure. These tests include structures with both separated and continuous supporting points to provide a reliable experimental basis for U* index theory.

Poster Number: 22

Parameter Identification of Lugre Frication Model: Experimental Set-Up Design and Measurement

Presented by: Yun-Hsiang Sun
Ph.D. Candidate in the Department of Mechanical Engineering

Advisor(s): Christine Wu

Co-Author(s): Tao Chen, Christine Q. Wu, Cyrus Shafai

Research Area(s): Mechanics of Materials and Structures

Friction is present in all mechanical systems and has an impact on a system's dynamics in a wide range of applications. In some control mechanisms, the frictional forces indeed notably dominate the systems' behavior, which hinder the system in meeting the desired characteristics. Therefore, it is nature for researchers to expect a suitable friction model that adequately captures all sophisticated friction features with reasonable model complexities. Such a model can be used to predict/compensate for the friction for the applications of interest. LuGre friction model has been proved to succeed in accounting for many characteristics of friction, the parameter identification of which is however a well-known challenging task.

In this work, to facilitate the identification procedure, a dedicated motor-driven one-dimensional sliding block is proposed and fabricated to carry out the identification. The rig design is simple over other existing designs but features the flexibility in terms of changing contact conditions and the sensitive measurement. It has been shown experimentally the rig can be readily used in providing the realistic parameters for the LuGre model. Such a completed LuGre friction model is valuable for the development of advanced friction compensation and the numerical study of friction features. The experimental results allow a complete LuGre model, which facilitates, but not limited to, other advanced friction modeling and high performance controller design if needed.

Poster Number: 23

Theoretical Extension of U* Index to Orthotropic and Nonlinear Materials

Presented by: Qingguo Wang
Ph.D. Candidate in the Department of Mechanical Engineering

Advisor(s): Christine Wu, Igor Telichev

Co-Author(s): Khashayar Pejhan, Christine Q. Wu, Igor Telichev

Research Area(s): Mechanics of Materials and Structures

Load transfer analysis is a new paradigm for lightweight vehicle design. The load transfer index (U*) has been proved to be an effective indicator of the load path for loading bearing structures. U* index represents the degree of the connectivity between loading point and arbitrary point within the structure and indicates the parts with higher U* values transfer the more loads. The fundamental equations of the U* theory are based on isotropic, homogenous, and linear elastic assumptions for the materials. Thus, it is inadequate for anisotropic and nonlinear elastic materials. However, the fiber reinforced composite materials are being widely used to reduce the weight and improve the strength for vehicle structures. The material property of this kind of composite is orthotropic rather than isotropic. Meanwhile, the real mechanical behavior of the material should be nonlinear. In this study, two new load transfer indexes, U*O and U*NL are proposed for the first time inspired by the basic U* theory for composite and nonlinear elastic materials, respectively. The effectiveness of the new indexes on load path prediction is demonstrated by two case studies. The new indexes eliminate the limitations of the basic U* theory and are capable to evaluate the accurate load path for the composite specimen or the structures with nonlinear elasticity. By contrast, the basic U* analysis shows the incorrect results. In conclusion, the proposed U*O and U*NL indexes can lead to a better vehicle design than the basic U* index for the structure which is made by composite materials or considered as nonlinear elastic.

Poster Number: 24

Energy Absorption Characteristics in Low Velocity Impact (LVI) for a Component in Vehicle Parcel Rack

Presented by: Wei Zhou
Ph.D. Candidate in the Department of Mechanical Engineering

Advisor(s): Christine Wu

Co-Author(s):

Research Area(s): Mechanics of Materials and Structures

As in a coach roll-over accident, the parcel rack should remain its structural integrity under the impact, which avoids the penetration of survival space of passengers.

Composite and polymer materials are largely used in vehicle nowadays. To build a good model using FEM tool to predict the structural performance, this project studies energy absorption characteristics in a low velocity impact based on a simplified strut model.

Two loading boundary conditions of impact for a strut model (Nylon) are implemented in Ansys workbench LS-DYNA: quasi-static and dynamic loading. Cases of different impact velocities are carried out. Energy absorption percentage is compared accordingly.

Results demonstrate that low velocity impact can be treated as a quasi-static process within a certain velocity region and the accuracy of impact velocity would become secondary, when compared with material property, geometry and boundary conditions. Other parameters such as friction coefficient, material plasticity shall also be studied to get a better strut model.

Poster Number: 25

Multi-Frequency DEP Cytometer Employing a Microwave Interferometer for the Dielectric Analysis of Micro-particles

Presented by: Samaneh Afshar Delkhah
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Greg Bridges

Co-Author(s): Elham Salimi, Katrin Braasch, Michael Butler, Douglas Thomson, and Greg Bridges

Research Area(s): MEMS/Microfluidic Systems

We present a multi-frequency dielectrophoresis (DEP) based microfluidic device for characterizing the complex dielectric properties of single micron-sized particles while in flow. It would enable identification of dielectric changes of both the membrane (changes that occur in conjunction with exposure of phosphatidylserine to the extracellur surface) and of the cytoplasm (change of ionic concentration). The device employs a multi-electrode transmission line sensor coupled to a microwave-interferometer, capable of sub-attofarad sensitivity, for detecting the DEP-induced translation of the particle under study. DEP actuation of the particle at different frequencies- which is related to its dielectric response - is sensed as it travels along the sensor. The multiple-frequency DEP cytometer technique is capable of characterizing the dielectric properties of micron-sized particles while in-flow. Dielectric properties at two specified frequencies in the beta-dispersion (kHz-MHz) range are determined by measuring the sign and magnitude of the particle's DEP actuation as it flows over a microwave-sensing array. We demonstrate the technique with polystyrene microspheres.

Poster Number: 26

Single cell tracking of apoptosis using Dielectrophoresis during controlled starvation

Presented by: Azita Fazelkhah
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Douglas Thomson

Co-Author(s):

Research Area(s): MEMS/Microfluidic Systems

In this work we are using Dielectrophoresis (DEP) to monitor programmed cell death (apoptosis) of single cell during controlled starvation. In this method, a set of coplanar electrodes used to detect and actuate single cell in a microfluidic channel. We analyze the experimental signatures to calculate dielectric properties and viability of the cells to track the transition of the cells from healthy to an early apoptotic state. We compared our results with Annexin V which is a protein that distinguishes early apoptotic stage of cells.

To perform the experiment, a batch of Chinese Hamster Ovary Cell (CHO cell) culture was created and then cells were taken out from regular BioGro medium with glucose at day 3, seeded into a glucose-free media and the DEP response of the cells monitored over 48 hours. Simultaneously the cell culture was monitored with Annexin V. Two different sets of data were acquired during the final 48-hours to observe the apoptosis transition: 4 hours after initiated starvation, then in 12 hour intervals after the initial starvation. The results show that the estimation of the viability using DEP cytometer matched with Annexin V assay and The CHO cell's starvation dielectric response is similar to the batch culture's declining phase.

Poster Number: 27

An Integrated GHz Frequency Sensor for Detection and Analysis of Single Biological Cells

Presented by: Kaveh Mohammad
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Douglas Thomson

Co-Author(s):

Research Area(s): MEMS/Microfluidic Systems

A Gigahertz frequency sensor is designed for detection and analysis of single biological cells. The sensor includes a mixed signal integrated circuit designed and implemented on a chip using 0.35µm CMOS technology. The circuit is connected to differential microelectrodes at the top layer which are in contact with fluid medium carrying single cells. In presence of a cell, the microelectrodes capacitance change. This change is then detected by the circuit.

The circuit is composed of two GHz ring oscillators each connected to a pair of microelectrodes. The oscillation frequency of oscillators changes in presence of a cell. This shift in frequency is detected in the output of an XOR gate, and is filtered to remove high frequency components. The design is made compatible to work with biological medium.

The advantage of the design compared to the previous interferometric sensors is that the complete detection system is implemented on a chip. The new detection system does not need a separate microfluidic chip, lock-in amplifier, RF generators, and other bulky microwave components. This results in a highly portable low cost Lab-on-a-Chip sensor that can be used for analyzing single biological cells.

Poster Number: 28

A Low Current MEMS Lorentz Deformable Mirror (LCL-DM) System for Adaptive Optics.

Presented by: Byoungyoul Park
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Cyrus Shafai

Co-Author(s):

Research Area(s): MEMS/Microfluidic Systems

Micro-electro-mechanical (MEMS) actuators are required in many applications that displace out-of-plane from the substrate such as adaptive optics and steering mirrors. Four main transducing mechanisms, electrostatic, piezoelectric, thermal and magnetic, have been proposed and developed to produce a motion from electrical signal in microsystems. Within the enormous variety of actuators, electromagnetic actuators have the advantage of requiring low voltage drive with high stroke and frequency (over 1 kHz).
The actuator consists of two crystalline silicon (c-Si) two loops serpentine flexures on the each end of a 25 μm thick c-Si cross-bar. These serpentine flexures provide current and heat transport pathway. Calculation results shows 1 N/m spring constant with 40 μm (width) x 3760 μm (length) x 7 μm (thickness) of two loops serpentine flexures. To determine the spring constant of the overall system, square shape SU-8 membrane was studied, with resulting spring constant of around 2 N/m for 5 μm thickness with 2000 μm actuator pitch. By combining both spring constant of actuator and membrane, the crosstalk was about 10 %. The total required force to get ±5 μm deformation of the membrane is around 11 μN. This force will be coupled to the membrane through a small bonding area on the long crossbar which presses against the membrane. Therefore, the crossbar will be reinforced with thick c-Si by bulk micromachining technique to prevent its bending.

Poster Number: 29

Opto-electrical Nanodevices for the Local pH Monitoring and pH Controlling of Chemical and Biological Reactions

Presented by: Hagit Peretz-Soroka
Postdoctoral Fellow in the Department of Physics and Astronomy

Advisor(s): Francis Lin

Co-Author(s): Hagit Peretz Soroka, Alexander Pevzner, Guy Davidi, Reuven Tirosh and Fernando Patolsky

Research Area(s): Crystalline Materials and Nanostructures, MEMS/Microfluidic Systems

Quantitative detection of biological and chemical species is critical to numerous areas of medical and life sciences. In this context, information regarding pH is of central importance in multiple areas, from chemical analysis, through biomedical basic studies and medicine, to industry. Therefore, a continuous interest exists in developing new, rapid, miniature, biocompatible and highly sensitive pH sensors for minutefluid volumes. Here, we present a new paradigm in the development of opto-electrical sensing nanodevices with built-in self-calibrating capabilities.
The proposed electrical devices, modified with a photoactive switchable molecular recognition layer, can be optically switched between two chemically different states, each having different chemical binding constants and as a consequence affecting the device surface potential at different extents, thus allowing the ratiometric internal calibration of the sensing event.
In this framework, we applied these devices for real time monitoring of extracellular acidification as a quantitative measurement of cellular metabolic activity. This method has a potential as a future tool for the performance of basic cell biology studies and high-throughput personalized medicine-oriented research, involving single cells and tissues.
The development of HPTS modified pH nanosensors have been recently expanded to include optical activation, or deactivation, of various surface-attached pH-sensitive chemical and biological reactions. By the use of nanowire-based FET devices we showed the capability to modulate the on-surface pH, by the application of intensity-controlled light stimulus, while simultaneously and locally controlling and monitoring pH-sensitive biological reactions on the nanodevices surfaces, such as the local activation and inhibition of proteolytic enzymatic processes, as well as dissociation of antigen-antibody binding interactions.

Poster Number: 30

Quantitative characterizations of neutrophil chemotaxis in COPD using a microfluidics-based approach

Presented by: Jiandong Wu
Ph.D. Candidate in the Department of Biosystems Engineering

Advisor(s): Francis Lin David Levin

Co-Author(s): Jiandong Wu, Craig Hillier, Paul Komenda, Ricardo Lobato de Faria, David Levin, Michael Zhang, Francis Lin

Research Area(s): MEMS/Microfluidic Systems

Chronic Obstructive Pulmonary Disease (COPD) is a common lung disease and one of the leading causes of death worldwide. COPD is associated with chemotactic recruitment of neutrophils to the airways. Evidently, COPD patients' sputum can attract blood neutrophils as shown by conventional cell migration assays in vitro, suggesting the potential of neutrophil chemotaxis as a new diagnostic measure of COPD. In this study, we employed a microfluidic device to quantitatively characterize neutrophil chemotaxis to sputum samples from COPD patients. Neutrophil chemotaxis to sputum from COPD patients was significantly elevated compared to healthy individuals. Moreover, Chemotactic Index of neutrophil chemotaxis to COPD sputum exhibited a trend of increase with decreasing spirometry data of the patients. ELISA measurements showed higher level of IL-8 in COPD patients' sputum compared to healthy individuals. Consistently, neutrophils displayed similar characteristic morphology in a COPD sputum gradient or an IL-8 gradient. Collectively, our study provided quantitative characteristics of neutrophil chemotaxis induced by COPD sputum using microfluidic devices. Further development of this microfluidics-based approach has the potential to enable new method for COPD diagnosis at the point-of-care

Poster Number: 31

Quantum-Dot Saturable Absorber and Kerr Lens Mode-Locked Yb:KGW Laser with >400 kW of Peak Power

Presented by: Reza Akbari
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Arkady Major

Co-Author(s): H. Zhao, A. Major, K.A. Fedorova, E.U. Rafailov

Research Area(s): Photonic and Phononic Interactions

Current advances in quantum-dot semiconductor saturable absorber mirror (QD-SESAM) design have enabled robust ultrashort pulse passive mode locking of solid-state and fibre lasers. On the other hand, recent work based on the dual action of Kerr lens and quantum-well saturable absorber mode locking (KLAS) demonstrated generation of ultrashort pulses with high average and peak powers. Therefore, QD-SESAMs owing to the faster recovery times when compared to their quantum-well counterparts, present an attractive alternative for KLAS mode locking. In this work we explored this possibility and demonstrated generation of 97 fs pulses with 3.2 W of average power (>400 kW of peak power) from a diode-pumped Yb:KGW laser. To the best of our knowledge, this is the most powerful femtosecond laser based on the QD-SESAMs to date.

Poster Number: 32

Magnon/Photon Coupling inside a microwave cavity towards cavity spintronics

Presented by: Lihui Bai
Researcher in the Department of Physics and Astronomy

Advisor(s): Can-Ming Hu

Co-Author(s): M. Harder, Y.P. Chen, X.Fan, J.Q.Xiao

Research Area(s): Photonic and Phononic Interactions

The electronics industry is quickly approaching the limitation of Moore's Law due to Joule heating in high density-integrated devices. To achieve new higher-speed devices and reduce energy consumption, researchers are turning to spintronics where the intrinsic spin, rather than the charge of electrons, is used to carry information in devices. Advances in spintronics have led to the discovery of giant magnetoresistance (GMR) which is used in hard disk readers and was awarded with the Nobel prize in 2007. Another subject, cavity electrodynamics, promises a completely new quantum algorithm by studying the properties of a single electron interacting with photons inside of a cavity. By merging both spintronics and cavity electrodynamics, a new cutting edge field called Cavity Spintronics is forming, which draws on the advantages of both subjects to develop new devices with higher-speed and less energy consumption.

In this work we use innovative spintronics method to study microwave cavity electrodynamics, which reveals interesting features such as the coupling of spin dynamics and Cavity modes, the correlation and evolution of spintronic and photonic damping, etc. We also built a classical model that explains very well our experimental results. This experimental and theoretical work lays a new stone on the foundation of the emerging field of Cavity Spintronics, which paves new ways for controlling spin current in next generation devices utilizing light-matter interaction.

Poster Number: 33

Exploring the Possibility of Creating an Acoustic Double-Negative Metamaterial with Bubbly Drops

Presented by: Reine-Marie Guillermic
Postdoctoral Fellow in the Department of Physics and Astronomy

Advisor(s): John Page

Co-Author(s): Reine-Marie Guillermic, Valentin Leroy, Fabrice Lemoult, John H. Page

Research Area(s): Photonic and Phononic Interactions, Soft and Disordered Materials

Interest in metamaterials (artificial materials with subwavelength internal structures, which can profoundly affect the propagation of waves, leading to unusual behaviours) has been steadily increasing since the pioneering work of Veselago and Pendry in electromagnetism. Finding acoustic analogues to electromagnetic left-handed metamaterials is also a very vibrant subject. Ten years ago, Jensen Li and C.T. Chan predicted theoretically the existence of an acoustic doubly negative metamaterial exhibiting both effective negative bulk modulus and negative density, but the experimental observation of such a system has still not been made. Double-negativity means that the material displays an anomalous response at some frequencies, such that it expands upon compression (negative bulk modulus) and when pushed moves in the opposite direction (negative density). The double-negativity induces an acoustic negative refractive index, i.e., a wavevector opposite to the propagation direction, and simultaneously a high transmission.
We discuss the possibility of using bubbly drops to create a double-negative metamaterial and propose possible designs to create such a material. Theoretical predictions using an effective medium model, and simulations results (Finite Element Method with COMSOL) shows that bubbly drop systems in water can in principle exhibit doubly negative behaviour, that can be tuned with various parameters (size of the drops, gas filling ratio, distance between drops…), but that dissipation is an important factor that can strongly damp all effects. Some experiments have been performed with alginate bubbly drops in an agar gel matrix and show a very interesting behaviour in transmission.

Poster Number: 34

Active Voltage Control of Electromagnetically Induced Transparency in Metamaterials

Presented by: Sandeep Kaur
Undergraduate Student in the Department of Physics and Astronomy

Advisor(s): Can-Ming Hu

Co-Author(s): Bimu Yao, Yongsheng Gui

Research Area(s): Photonic and Phononic Interactions, Composite Materials Systems

Active control of Electromagnetically Induced Transparency (EIT) in metamaterials working in the microwave frequency regime is demonstrated using a varactor loaded metamaterial structure, which combines a cut wire and a split ring resonator. When the resonance frequency of the split ring resonator matches the resonance frequency of the cut wire, the mutual coupling between them generates EIT which corresponds to the appearance of a narrow transmission window centered on the original resonance frequency. The transparency window associated with EIT can thus be opened by changing the resonance frequency of the varactor loaded split ring resonator by applying an appropriate voltage bias. These experimental results can be well explained by the coupled LCR circuits and the transmission line matrix model built to describe the EIT phenomenon in metamaterials. Based on our experimental results, a novel device can be fabricated whose frequency response can be changed from being opaque to transparent by changing the applied voltage.

Poster Number: 35

Continuous-Wave Yb:CALGO Laser with Tunable Dual-Wavelength Output

Presented by: Sujith Manjooran
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Advisor(s): Arkady Major

Co-Author(s): R. Akbari, A. Major

Research Area(s): Photonic and Phononic Interactions

This work reports a tunable dual-wavelength diode-pumped Yb:CALGO laser using a single birefringent plate filter which covers a tuning range of approximately 1020 nm to 1070 nm.

Poster Number: 36

Effect of Transient Liquid Phase Bonding on Corrosion Performance of Single Crystal Aerospace Superalloy

Presented by: Olaniyi Adebajo
M.Sc. Candidate in the Department of Mechanical Engineering

Advisor(s): Olanrewaju Ojo

Co-Author(s):

Research Area(s): High Temperature Aerospace Materials

Superalloys are widely used for aerospace applications due to their excellent corrosion resistance in high temperature gaseous environment, however, a fundamental flaw in their application is high susceptibility to cracking during conventional welding processes. Transient Liquid phase bonding (TLP) has evolved as a viable method of joining superalloys with potential of producing joints with comparable mechanical properties to the base material. Although the high temperature mechanical properties of aerospace superalloys have been studied extensively, there is little information on the corrosion behaviour of these special class of materials that had been subjected to TLP bonding. In this work, electrochemical assessment of corrosion behaviour of a TLP bonded nickel-based superalloy was performed. It is found that aside from the mere presence of chromium, which is widely recognised as necessary for corrosion resistance, its uniform distribution within the joint region is imperative for achieving adequate corrosion resistance. The results will be presented and discussed.

Poster Number: 37

Microstructural Characterization of Electro-Spark Deposited Aerospace Superalloy

Presented by: Evgeny Anisimov
Ph.D. Candidate in the Department of Mechanical Engineering

Advisor(s): Olanrewaju Ojo

Co-Author(s): Abdul Khalik Khan, Olanrewaju Akanbi Ojo

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

Electro-spark deposition (ESD) has generated a great deal of interest for processing difficult-to-weld advanced structural materials like the precipitation strengthened aerospace nickel-based superalloys without the problem of welding cracking that often plaque these materials. The short duration of current pulses involved during the ESD process results in extremely rapid thermal cycle that has been suggested could preclude the formation of segregation-induced secondary phases during solidification. In the present work, the microstructure of an electro-spark deposited superalloy was studied by the use scanning electron microscopy and analytical transmission electron microscopy techniques. The results show that in contrast to general assumption, the extreme rapid cooling rates involved in the ESD process did not produce partition-less solidification that is devoid of secondary solidification microconstituents in the material. Extremely fine second phase particles that could not be analyzed by conventional scanning electron microscopy were found formed along the intercellular regions within the microstructure of the ESD layer. The nature of these particles and possible implications of their formation on mechanical properties of ESD processed material will be presented and discussed.

Poster Number: 38

Investigating solution conformation of the 3'-terminal regions (3'-TR) of the WNV genome and its interaction with both the 5'-TR and OAS1

Presented by: Soumya Deo
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Advisor(s): Sean McKenna

Co-Author(s): Soumya Deo, Trushar R. Patel, Grzegorz Chojnowski, Amit Koul, Edis Dzananovic, Kevin McEleney, Janusz M. Bujnicki, Sean A. McKenna

Research Area(s): Complex Natural Systems

Upon binding viral double-stranded RNA, OAS enzymes produce 2'-5'-linked oligoadenylates that stimulate RNase L and ultimately slow viral propagation. Truncations/mutations in the smallest human OAS isoform, OAS1, results in susceptibility to West Nile virus (WNV). We have previously demonstrated in vitro the interaction between OAS1 and the 5'-terminal region of the WNV RNA genome. Here we report that the 3'-terminal region is also able to mediate specific interaction with and activation of OAS1. Binding and kinetic experiments identified a specific stem loop within the 3'-terminal region that is sufficient for activation of the enzyme. The solution conformation of the 3'-terminal region was determined by small angle X-ray scattering, and computational models suggest a conformationally restrained structure comprised of a helix (3'-SL) and short stem loop (3'-SS). Structural investigation of the 3'-terminal region in complex with OAS1 is also presented, where the SAXS data and the computational 3D modeling indicates the interaction of OAS1 with the helix (3'-SL). Biophysical investigation of the 5'-TR interaction with the 3'-TR was performed using isothermal titration calorimetry, size exclusion chromatography and dynamic light scattering. Finally, we show that genome cyclization by base-pairing between the 5'- and 3'-terminal regions, a required step for replication, is not sufficient to protect WNV from OAS1 recognition in vitro. These data provide a physical framework for understanding recognition of the highly structured terminal regions of a flaviviral genome by an innate immune enzyme.

Poster Number: 39

Biophysical characterization of interaction between dsRNA-binding protein kinase and its inhibitor Adenovirus virus-associated (VA) RNA I

Presented by: Edis Dzananovic
Ph.D. Candidate in the Department of Chemistry

Advisor(s): Sean McKenna

Co-Author(s): Edis Dzananovic, Trushar R. Patel, Grzegorz Chojnowski, Michal J. Boniecki, Soumya Deo, Kevin McEleney, Stephen E. Harding, Janusz M. Bujnicki and Sean A. McKenna

Research Area(s): Complex Natural Systems

PKR is interferon inducible Ser/Thr RNA-dependent Protein Kinase (PKR) that binds viral dsRNAs followed by its dimerization and autophosphorylation. Interestingly, viruses can evade this line of defense by transcribing non-coding RNA molecules that have double-stranded secondary structural elements that mimic the dsRNA-binding and also include a PKR-inhibitory stem-loop that inhibits it from performing its enzymatic reaction. One such RNA is Adenovirus VAI RNA. The secondary structure of VAI consists of three major domains; apical stem-loop (dsRBMs-binding stem), central stem-loop (inhibitory stem), and terminal stem. High-resolution information on tandem PKR-dsRNA complex has been difficult to obtain, likely due to the flexibility of both the interdomain linker between dsRBM1 and 2, the long linker connecting the dsRBD with the kinase domain and the inherent flexibility of stem-loop RNA structures. The SAXS on the other hand can overcome these problems, even though its limitation to low-resolution structural information. Recently we have showed the solution conformation of tandem dsRBMs of PKR in complex with an imperfectly base-paired (in vitro transcribed) viral dsRNA stem-loops using small-angle X-ray scattering (Dzananovic et. al. 2013). We use both dynamic light scattering and analytical ultracentrifugation to cross-validated our SAXS results. Furthermore, SAXS envelopes were used as a constraint for the in silico modeling of tertiary structure for RNA and RNA-protein complex. These results provided insight on how tandem dsRBMs are capable of interacting with wide range of sequence and structurally different RNAs to function in the innate immune response to viral infection.

Poster Number: 40

The Effects of Gluten, Starch and Water Contents on the Bubble Size Distribution and Its Evolution in Nonyeasted Gluten-Starch Blend Doughs Investigated by an Ultrasonic Transmission Technique

Presented by: Filiz Koksel
Postdoctoral Fellow in the Department of Food Science

Advisor(s): Martin Scanlon, John Page

Co-Author(s): Anatoliy Strybulevych, John H. Page, Martin G. Scanlon

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

The aerated structure of bread depends mainly on the bubble size distribution within the dough (a viscoelastic matrix) at the end of dough mixing. This makes bubble changes in dough very important since it forms the basis for predicting the final product quality at earlier stages of the breadmaking process. However, predicting these changes is extremely challenging since dough is a fragile soft solid and it is optically opaque. Moreover, bubbles in dough change very rapidly. Low-intensity ultrasound is very sensitive to the large density and compressibility difference between the dough matrix and the bubbles. Furthermore bubbles in the dough hugely attenuate sound around the resonance frequency of bubbles, so the presence of bubbles can be readily detected by measuring ultrasound propagation through the dough. Model doughs (blends of gluten and starch) with a range of volume fraction of bubbles were prepared and their acoustic properties were monitored as a function of time after mixing. Ultrasonic results indicated that an increase in gluten and a decrease in water caused an increase in the bubble sizes. This was attributed to shorter mixing times for these doughs, and thus with a lower number of mixer revolutions there are fewer bubble subdivision events during mixing. Time evolutions of the ultrasonic parameters for blend doughs had the same trend as those of wheat flour doughs, with a shift in peak maxima to lower frequency. However, these shifts were noticeably slower for G-S blend doughs, meaning that G-S blend doughs were more stable against disproportionation.

Poster Number: 41

Time Dependent Behavior of Chemical Sensor Arrays and its Implication for Machine Olfaction

Presented by: Shaun Ryman
M.Sc. Candidate in the Department of Chemistry

Advisor(s): Michael Freund, Neil Bruce

Co-Author(s): Dr. Neil D. B. Bruce, Dr. Michael S. Freund

Research Area(s): Complex Natural Systems

Machine olfaction has been lagging behind machine vision, a camera can easily fit in your pocket yet advanced chemical sensing systems are larger, more expensive, and less available to the masses. However with the rising computational power, new methods for pattern and signal analysis have garnered more interest. To mimic human olfaction the system should be able to rapidly learn, adapt and predict odors in varying contexts. Artificial neural networks (ANNs) are a viable alternative to incorporate these complex types of analysis into artificial systems. This work characterizes the temporal responses of sensor arrays through highly controlled and dynamic conditions. Expansion into larger sensor arrays and more complex methods of analysis will require some form of higher processing, experimentation with ANNs demonstrates their practicability. Challenges faced by incorporating ANNs into a real-time system for olfactory perception are demonstrated and discussed. Some potential applications for this research include robotics, environmental monitoring, as well as diagnostic functions in healthcare.

Poster Number: 42

An ultrasonic study of the mechanical properties of Asian noodle doughs

Presented by: Ali Salimi Khorshidi
Ph.D. Candidate in the Department of Food Science

Advisor(s): Martin Scanlon, John Page, Dave Hatcher

Co-Author(s): Anatoliy Strybulevych, Daiva Daugelaite, Martin G. Scanlon, John H. Page, Dave W. Hatcher

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

Mechanical behavior of soft food materials has always been a major concern for process design and end-use quality enhancement purposes, since it has a significant effect on process efficiency and the perceived texture of dough-based products such as Asian noodles. The complex structure of the wheat flour dough used for preparation of Asian noodles raises the need for an accurate determination of the rheological parameters responsible for variations in the texture of the final product if health-promoting ingredients such as barley β-glucan (BBG) are to be incorporated. To address this need, ultrasonic transducers mounted on a conventional food texture analyser allowed longitudinal ultrasound wave measurements (1.4 MHz) to be performed simultaneously with stress relaxation measurements. Asian noodle doughs prepared with various BBG addition rates and manipulation of work input during the sheeting process were evaluated for their effect on the noodle sheet's rheological behavior. Rheological characteristics of raw noodles including longitudinal storage modulus (M'), loss modulus (M") and loss tangent (M"/M'), determined using the wave's velocity, attenuation coefficient and the raw noodle's density demonstrated the strengthening effects of the sheeting work input and BBG incorporation on the protein network developed during the sheeting process. Same effects were observed when parameters obtained from stress relaxation measurements, K2 (extent of relaxation), stress relaxation and elastic index, were used. A comparison between parameters derived from the ultrasonic measurements and those obtained from stress relaxation tests illustrated the capability of the ultrasound technique to evaluate the mechanical properties of Asian noodle doughs fortified with BBG.

Poster Number: 43

Geochemistry and Geochronology of the Andrew Lake Deposit, Thelon Basin, Nunavut, Canada

Presented by: Brandi Marie Shabaga
Undergraduate Student in the Department of Geological Sciences

Advisor(s): Mostafa Fayek

Co-Author(s): Mostafa Fayek, Dave Quirt, Bill Davis, Tom Pesja, Charlie Jefferson

Research Area(s): Crystalline Materials and Nanostructures, Complex Natural Systems

The Thelon Basin, Nunavut, Canada, is an intracratonic Paleoproterozoic basin that shares many similarities with the U producing Athabasca Basin, Saskatchewan, Canada. However, there are geological differences that highlight the need to better characterize the Thelon U systems. The Kiggavik project area comprises a series of deposits along an ~18km long NE-SW structural trend, of which, the Andrew Lake deposit is the southernmost end-member. Mineralization is hosted within Neoarchean metasedimentary rocks informally termed the Woodburn Lake group. The objectives of this study are to: (a) characterize the deposit mineralogy, (b) determine the ages of U minerals, and (c) develop a genetic model for the Andrew Lake deposit for comparison to other deposits along the trend, such as the Bong deposit.
Five generations of U minerals have been identified: (1) disseminated uraninite (U1), (2) vein-type uraninite (U2), (3) small-scale roll-front uraninite (U3), (4) coffinite, and (5) boltwoodite. Alteration of vein-type (U2) and roll-front (U3) uraninite alter to stage 4 coffinite, which is characterized by elevated and variable SiO_2 contents ranging from 9.35 to 20.97 wt.%. Stage 5 boltwoodite occurs in veins and clusters, as well as halos around coffinite.
Based on major element chemistry and U-Pb isotopic analysis of U minerals, both U and Pb were remobilized by a hydrothermal silica-rich fluid event at around 528 ± 34 Ma. Further work is required to establish how these stages of U correlate with hydrothermal fluid events recorded in other deposits in the Kiggavik area.

Poster Number: 44

Anomalous uranium concentrations and selenium minerals from the Viking showing, Labrador Trough, northern Quebec

Presented by: Raven Sharma
Undergraduate Student in the Department of Geological Sciences

Advisor(s): Mostafa Fayek

Co-Author(s): Raven Sharma, Mostafa Fayek, Alfredo Camacho, Quentin Yarie, Craig Scherba

Research Area(s): Complex Natural Systems

The Sagar property, located within the Romanet Horst in the central part of the Labrador Trough, northern Quebec, Canada is host to a number of mineral showings. Although numerous companies have explored the Sagar property, the genetic history of mineralization is poorly understood. The Sagar property has anomalous amounts of uranium, gold, copper, lead and zinc which have been interpreted to be part of an IOCG system. More recently, anomalous nickel, cobalt and selenium have been reported at the Viking showing, but the source of these elements is unknown. The objective of this research is to characterize the minerals from the Viking showing to determine if the mineralization at Sagar is consistent with an IOCG system. Anomalous uranium concentrations were found at the Viking showing and are associated with siderite and ilmenite. Selenide minerals were also found and include, penroseite $(Ni,Co,Cu)Se_2$, molybdomenite ($PbSeO_3$), umangite (Cu_3Se_2), and wilkmanite (Ni_3Se_2). Selenide minerals are less common in ore deposits than sulfide and telluride minerals despite the greater crustal abundance of selenium in comparison to tellurium. The Viking showing experienced high-temperature (~400°C) albite alteration earlier in its history, with anomalous uranium concentrations associated with siderite and ilmenite. Late selenide minerals form from lower-temperature hydrothermal fluids (<300°C), and replace earlier selenium minerals that are stable at higher temperatures (>300°C). In addition, the occurrence of hematite and carbonates suggest that the Viking showing is part of the Hematite-group IOCG polymetallic (U) system.

Poster Number: 45

Micron-scale Imaging of Strained Collagen Fibres using Polarized Infrared Light

Presented by: Richard Wiens
Researcher in the Department of Chemistry

Advisor(s): Kathleen Gough

Co-Author(s): Michelle McLellan, J. Michael Lee, Samuel Veres, Kathleen Gough

Research Area(s): Mechanics of Materials and Structures, Complex Natural Systems

Soft tissue injuries affect both the elderly (as a result of falls and immobility) and the young (as a result of overuse). The data presented in this poster is part of a larger CHIR project with the end goal being the identification of strategies to modulate inflammation and improve healing of soft tissue injuries.

Control and stressed tendon from bovine tails were acquired from Dalhousie University, frozen in liquid nitrogen cooled isopentane. 8 micron thick sections were prepared using a cryotome at St. Boniface Hospital and mounted on BaF_2 windows for FTIR imaging.

Sections were imaged using an Agilent 670 spectrometer coupled to an Agilent 620 imaging microscope equipped with optics allowing for high spatial resolution FTIR imaging. Sections were imaged using normal magnification optics (5.5 micron pixel size) and high magnification optics (1.1 micron pixel size) under ordinary and polarized light.

FTIR images obtained using polarized infrared light revealed differences in the Amide I:Amide III ratio of the stressed tendon compared to the control tendon. These changes in relative intensity of the polarized data are the result of disorder in the strained collagen fibres at a nano-scale level.

Poster Number: 46

Imparting commercial antibacterial dressings with low-adherence to burn wounds

Presented by: Sogol Asghari
M.Sc. Candidate in the Department of Textile Sciences

Advisor(s): Song Liu

Co-Author(s): Sarvesh Logsetty, Song Liu

Research Area(s): Surfaces and Interfaces

The objective of our study was to decrease the wound adherence of existing Ag based wound dressings by depositing a non-adherent layer (NAL). Our hypothesis was the NAL will impart the commercial antimicrobial dressing with low adherence to burn wounds without compromising the antimicrobial activity or increasing the cytotoxicity.
A Polyacrylamide (PAM) layer was grafted on two commercial silver antibacterial dressings (silver nanocrystal dressing (NC) and silver plated dressing (SP)) using a proprietary technique. Dressing adherence was measured with a previously published in vitro gelatin model using an Instron mechanical force testing instrument. The dressings were challenged with two clinically retrieved bacterial strains (MRSA and multidrug resistant P. aeruginosa) in an antimicrobial disk susceptibility test using Zone of Inhibition (ZOI). The cytotoxicity of samples to human neonatal fibroblast cells was evaluated with MTT assay.
Both untreated dressings showed high peeling energy: 2070±453 J/m^2 (NC) and 669±68 J/m^2, (SP) that decreased to 158±119 J/m^2 (NC) and 155±138 J/m^2 (SP) with the PAM grafting. In the disk diffusion test, addition of the PAM non-adherent layer in NC and SP against both bacteria caused no significant difference in ZOI ($p>0.05$). Survival of fibroblasts was improved by the PAM grafting from 48±5% to 60±3% viable cells in NC and from 55±8% to 61±4% viable cells in SP, $p<0.05$.
The PAM non adherent layer can significantly decrease the adherence of these two commercial antimicrobial dressings in an in vitro gelatin model while preserving their antibacterial efficacy, and reducing the cytotoxicity.

Poster Number: 47

Functionalization of Silicon Surfaces for Improved Junction Behavior in Artificial Photosynthetic Devices

Presented by: Patrick Giesbrecht
Undergraduate Student in the Department of Chemistry

Advisor(s): David Herbert

Co-Author(s): Jared P. Bruce; Michael S. Freund

Research Area(s): Surfaces and Interfaces

Silicon is a promising semiconducting material for use as a photocathode in a membrane-bridged artificial photosynthetic system due to its relative abundance, cost, and band edge alignment with the hydrogen reduction potential. Integrated photoelectrochemical water splitting proposes the photocathode, membrane and photoanode to be electrically connected in series with the photogenerated carriers performing hydrogen reduction and water oxidation. Minimization of iR losses in this system is extremely important to attain a high photon - to - fuel efficiency. Previous work has investigated these iR losses in a model system using H-terminated n- and p-doped silicon microwires embedded in a Nafion/poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) composite film. A reduction in the charge transfer efficiency was observed over time due to the formation of a passivating oxide layer on the microwire surface. Covalent attachment of a methyl group limited this oxidation process, but resulted in an enhanced rectification and large junction resistance due to the formation of a surface dipole at the n-Si/PEDOT:PSS interface under light-limited solar operating conditions. To reduce this resistance while maintaining the stability offered by a covalently-bound organic species, thiophene and EDOT units were attached to Si(111) surfaces, with the degree of attachment to the surface determined through XPS. The resulting electrical properties of these surfaces in contact with PEDOT:PSS were characterized under dark and AM1.5G illumination conditions. From this, it was observed that the attachment of EDOT and thiophene units on the surface increases the threshold voltage, while decreasing the junction resistance in forward and reverse bias, relative to the methyl surface.

Poster Number: 48

Methyl-Termination of planar Si(110) surface

Presented by: Ankit Gupta
M.Sc. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Derek Oliver, Michael Freund

Co-Author(s): Jared Bruce, Derek Oliver, Michael Freund

Research Area(s): Surfaces and Interfaces

Methyl-terminated planar Si(110) surface prepared using the two step chlorination/alkylation process had been investigated using X-Ray photoelectron spectroscopy (XPS) and Fourier-transform infrared (FTIR) spectroscopy. FTIR spectrum for the H-terminated silicon surface showed a sharp peak at 2088.63 cm^{-1} corresponding to the monohydride stretch mode. No surface silicon oxide peak was observed in the high-resolution silicon XPS for the methyl-terminated surface. XPS data showed near full monolayer coverage of methyl on the silicon surface. This surface preparation method can be utilized for an efficient functionalization of silicon microwires, used in proposed solar cell device.

Poster Number: 49

Analytes Discrimination with Chemically Diverse Sensor Array Based on Electrocopolymerized Pyrrole and Vinyl derivatives

Presented by: Akin Iyogun
Ph.D. Candidate in the Department of Chemistry

Advisor(s): Michael Freund

Co-Author(s): M. S. Freund, D. A. Buchanan

Research Area(s): Surfaces and Interfaces

The high capacity to discriminate odorants displayed by mammalian olfactory system in engaging up to 1000 non highly specific receptors shows the level of diversity inherent in that system. This capacity have not been replicated in any known artificial device due to some major difficulties which include, the ability to fabricate a large array of chemically diverse sensors at low cost and limited number of monomers. The use of intrinsically conducting polymers sensors with easily tunable properties presents such an opportunity. This work demonstrates methods of generating various chemically diverse copolymer sensors in an array and their ability to discriminate classes of analytes. An array comprising twenty seven chemically different sensors were generated to effectively discriminate twelve analytes ranging from homologues of alcohols (methanol, ethanol and 2-propanol), to fuels (JetA, AVG, Petrol, Kerosene and Diesel) and organic analytes (toluene, dichloromethane, acetonitrile) and water. Their interaction with these analytes resulted in differential resistance responses. Preprocessing of data was done to obtain normalized resistance responses thereby building a large database of signature patterns. This can useful for training and identification, leading to unique classification. Analysis of data with principal component analysis and linear discriminant analysis (calculating resolution factor, rf) show array capacity in discrimination and better classification of chemically similar analytes. The ease of electrochemical deposition and modification involving the use of growth potential, as a means of achieving increased number of chemically diverse sensors will be discussed while another dimension to sensor modification was added by changing dopant type to further enhance chemical diversity.

Poster Number: 50

Synthesis and Characterization of Mixed Methyl/Vinylferrocene Monolayers on Planar Si (111) Surface and Si Microwires

Presented by: Onkar Kang
Postdoctoral Fellow in the Department of Chemistry

Advisor(s): Michael Freund David Herbert

Co-Author(s): Jared Bruce, David Herbert, Michael Freund

Research Area(s): Surfaces and Interfaces

Passivation of silicon surfaces toward oxidation is critical for photovoltaic devices and for the production of fuels from sunlight. One approach that has been used involves hydrosilylation for the H-terminated Si surfaces, however functionalization is typically incomplete and the surface is easily oxidized.[1] A two-step halogenation/alkylation method results in methyl terminated silicon surfaces with complete surface coverage and resists oxidation of the silicon surface in air for a longer period of time. In addition, methyl terminated surfaces show increased resistance to oxidation in electrochemical and photoelectrochemical cell applications.[2] Limitations of the methyl surface towards subsequent functionalization for attachment of a molecular catalyst make this surface less desirable for use in an integrated artificial photosynthetic device. One approach being pursued to facilitate molecular attachment whilst preserving stability at modified Si surfaces is to create mixed monolayers.[2]
Silicon microwire arrays are structured to orthogonalize light absorption and charge carrier collection allowing low quality, cost effective materials to have similar characteristics to high quality materials. A recent report characterizing mixed methyl/vinylferrocene planar Si (111) surfaces has shown excellent electron transfer while maintaining stability towards oxidation.[2] In this work, the surface of planar Si (111) and silicon microwires have been functionalized with mixed monolayers of vinylferrocene and methyl groups. Attachment of vinylferrocene to planar and wire surfaces is carried out by a thermally activated hydrosilylation with Cl-terminated and H-terminated surfaces. X-ray photoelectron spectroscopy and electrochemistry are used to characterize surface attachment and coverage. With mixed methyl/vinylferrocene monolayers good surface coverage is observed in both microwires and planar silicon surfaces. The surfaces are stable to air ambient and electrochemical oxidation.

References:
(1) Royea, W. J.; Juang, A.; Lewis, N. S. App Appl. Phys. Lett. 2000, 77, 1998-1990.
(2) Lattimer, J. R. C.; Brunschwig, B. S.; Lewis, N. S.; Gray, H. B. J. Phys. Chem. C 2013, 117, 27012-27022.

Poster Number: 51

The University of Manitoba SIMS Laboratory

Presented by: Ryan Sharpe
Researcher in the Department of Geological Sciences

Advisor(s):

Co-Author(s): Mostafa Fayek

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

Secondary ion mass spectrometry (SIMS) is a surface analytical technique, where a solid sample is sputtered with a primary beam of ions that have a few keV energy. During sputtering a fraction of the particles emitted from the sample are ionized. These ions are sorted using an electrostatic analyzer and a magnetic section. This setup makes the SIMS a double focusing mass spectrometer. The instrument provides extreme sensitivity (detection limits down to ppb levels for many elements), high mass resolution (>4000 MRP) and high dynamic range (more than 5 decades).

In 2004, the University of Manitoba was awarded $7.4 million from the Canada Foundation for Innovation to establish the Manitoba Regional Materials and Surface Characterization Facility. In 2006, the SIMS laboratory was established in the department of Geological Sciences as part of this facility. Our Cameca IMS7f is one of five SIMS facilities in academic institutions in Canada. Over the past nine years, research has been largely focused in four broad areas: (1) fluid-rock interaction and ore deposit research, (2) material science with an emphasis on diffusion in natural and engineered materials, (3) archaeometry, and (4) gem minerals.

Poster Number: 52

Evaluation for Textile and Spinning Properties of Brassica Fibres

Presented by: Md Rabiul Islam Khan
M.Sc. Candidate in the Department of Textile Sciences

Advisor(s): Mashiur Rahman, Robert Duncan

Co-Author(s): Mashiur Rahman; Robert W. Duncan

Research Area(s): Soft and Disordered Materials

Brassica seed, which is commonly known as canola, is the largest source of edible oil in Canada. The remainders of the brassica plant, such as stems, remain unused and are left in the field. An investigation has been conducted to extract, characterize and modify the fibre materials from the brassica stems for textile and apparel applications. It is found that the virgin retted fibres from the brassica plants exhibit most required textile properties, such as dye absorbency, strength, fineness and thermal behaviour. However, the virgin retted fibres do not have the required spinning (yarn transformation) properties such as softness, flexibility and individual fibre entity. In order to modify the brassica fibres for spinnability, three treatment procedures were applied: Method A - alkali, acid and softener treatment; Method B - pectinase enzyme treatment; and Method C - enhanced enzyme treatment. When evaluating according to AATCC Method 5, brassica fibers obtained from treatment methods B and C showed similar spinning properties to each other and to cotton, and demonstrated superior spinning properties to brassica fibres obtained from the treatment method A. Treatment methods B and C are therefore suitable for producing brassica fibres fit for textile and apparel applications. The current research suggests that producing fibers from this waste stream of canola could be an alternative income source for canola farmers.

Poster Number: 53

An analysis for water and energy requirements to convert blue denims into distressed denims.

Presented by: Marjia Khanom
M.Sc. Candidate in the Department of Textile Sciences

Advisor(s): Mashiur Rahman

Co-Author(s): Dr. Mashiur Rahman

Research Area(s): Soft and Disordered Materials

Across the world, about 20% of total industrial water pollution is generated from the dyeing, printing and finishing of textile fabrics including blue denim and distressed denim processing. The only purpose of producing distressed denim is its aesthetic appeal. To this end, the main method of producing distressed denim is an acid bath treatment requiring several chemicals, water and energy consuming steps (Blue denims > De-sizing > Bleaching > Neutralization > Brightening treatment > Softening > Hydro-extraction > Drying). We have conducted empirical research to determine the amount of water and energy needed to convert blue denims into distressed denims. To calculate water consumption (for transforming blue denims to distressed denims), we used fabric weight per linear meter using standard denim fabric construction specifications and materials (M) to water (L) ratio of 1:5: [7 Ne x 72 E/inch x 60" (W) x M (1) x L (5)/1P]/(6 Ne x 44 F/inch)/1P. Our research has shown that 55.5 liters of water is required to produce one pair of distressed denims from blue denims. In terms of annual water consumption worldwide, 275 billion liters of water are used to produce 5 billion distressed denims. The cost of this aesthetically pleasant distressed denim is equivalent to a one-year water supply for 50 million people in Africa. Further, to produce one pair of distressed denims uses 4324.8 KJ of energy, or approximately 21 trillion KJ energy to produce 5 billion distressed denims: sufficient energy for four hundred thousand houses in Manitoba for a year. The research concludes that consumer awareness is needed to select more environmentally friendly apparel products.

Poster Number: 54

Effects of water and NaCl on mechanical properties of wheat flour dough

Presented by: Xinyang Sun
Ph.D. Candidate in the Department of Food Science

Advisor(s): Martin Scanlon

Co-Author(s): X. Sun, F. Koksel, M. G. Scanlon, M. T. Nickerson

Research Area(s): Soft and Disordered Materials

Wheat flour dough has a relatively complicated mechanical behavior due to its mixture of a variety of materials (i.e. flour, water and salt). Water influences the mechanical properties of dough by acting as a mobility enhancer, whereas salt (e.g., NaCl) plays a magnitude of roles including strengthening the gluten network in order to form a viscoelastic material. The mixograph is an instrument used to investigate the effects of ingredients on the mechanical properties of dough in order to predict breadmaking performance and quality of the final product (i.e., loaf of bread). The mixograph acts by determining the resistance (torque) the dough exerts on the mixer pins as a function of mixing time. The objective of this research was to evaluate the effects of NaCl, water and their interaction on the mechanical properties of wheat flour doughs with a range of breadmaking strengths using mixograph. Results showed that water, salt and their interactions significantly affected the rheological properties of the dough ($P<0.05$). The addition of NaCl was also found to be positively correlated with dough development time and maximum resistance (maximum torque) because of its strengthening effect on the gluten network. The addition of water was found to be positively correlated with dough development time, however was negatively correlated with maximum resistance (maximum torque), suggesting that excessive hydration softens the dough and delays its optimum development time. In conclusion, NaCl and water levels generally exert independent effects on the mechanical properties of the dough, therefore both need to be considered separately when tailoring dough formulations to optimal processing performance and product quality.

Poster Number: 55

CMOS-Compatible Polymer-based Memory Structures on Copper Substrates

Presented by: Ehsan Tahmasebian
Ph.D. Candidate in the Department of Electrical and Computer Engineering

Advisor(s): Cyrus Shafai, Michael Freund

Co-Author(s): Onkar S.Kang, Michael S. Freund, Cyrus Shafai

Research Area(s): Soft and Disordered Materials

Complex fabrication process and poor signal scaling laws of the silicon-based memory devices have increased the interest in perusing non-transistor-based memory structures. Previously a redox-based memory system based on variable doping has been demonstrated by our group. This memory system consists of a solid-state junction between compensatively-doped polymer and undoped WO_3 in a net low conductivity state formed by electrochemical deposition. In the presence of a sufficiently high electric field, dopant ions relocate into the metal oxide layer, resulting in an n-doped metal oxide and p-doped polymer with a net high conductivity state. This system is capable of producing transient current-voltage characteristics that can be controlled by electric field and act as a memory. As a non-transistor memory structure, this system has the potential to be integrated into standard CMOS technology. To do so, the junctions should be formed on metals commonly used in CMOS technology. In recent work, our group has focused on use of copper as a CMOS compatible metal. The goal of the current work is to show the capability of junctions' deposition on copper and their ability to act as a memory. The other important goal is to develop an equivalent electronic model for the junction that can be used in simulation before designing the CMOS chip.

Poster Number: 56

Rheological behavior of aqueous suspensions of native corn and potato starch

Presented by: Nasibeh Y. Sinaki
Ph.D. Candidate in the Department of Food Science

Advisor(s): Martin Scanlon, Trust Beta, Raghavan Jayaraman

Co-Author(s): Martin G. Scanlon

Research Area(s): Soft and Disordered Materials

Starch is a natural polymer which is completely biodegradable with low cost and renewability. Because of these unique properties, starch is a good option for developing new sustainable materials. Development of these materials requires a good understanding of their process behavior. In this study, the relationship between the relative viscosity of native potato and corn starch suspensions with varying solid contents was studied as a function of temperature. All suspensions were prepared with a continuous phase of 60% sucrose solution to have a density matched suspension at 20°C. Flow behavior was evaluated using a rheometer by applying steady simple shear flow and dynamic oscillation (0.1-50 Hz) at 20, 50 and 80°C. The starch suspensions exhibited nearly Newtonian behavior at all solid contents. The relative viscosity of suspensions increased with increasing starch content, but decreased with increasing temperature. Gravitational displacement of the starch granules which occurred in non-density-matched suspensions at 50°C and 80°C created a depleted layer of liquid to make lower-viscosity suspensions. Oscillatory viscosity results showed the formation of weak structures at high solid volume fractions (20% and 25%) which were readily disrupted by testing. This phenomenon caused a deviation in relative shear and dynamic viscosity data for high solid volume fractions in which the relative shear viscosity was higher than the relative dynamic viscosity. The data in this study provide critical information on the flow behavior of starch polymer suspensions which is vital for different processing operations such as pumping.

Poster Number: 57

Atomistic simulation of cold rolling-induced amorphization of Cu-Zr multilayers

Presented by: Ehsan Alishahi
Ph.D. Candidate in the Department of Mechanical Engineering

Advisor(s): Chuang Deng

Co-Author(s):

Research Area(s): Crystalline Materials and Nanostructures, Mechanics of Materials and Structures, Composite Materials Systems

The microstructural evolution of Cu-Zr crystalline multilayers during cold rolling process was studied using molecular dynamics simulations. Specifically, the cold rolling processwas performed by using a method called "folding-and-rolling". In this process layers of elemental foil were stacked and cold-rolled to force consolidation into multilayers, which were then folded in half and cold-rolled again to their original thickness. This procedure repeated for 7 steps and in each step, the multilayered structure experienced 50% compressive strain. The results shown that after several steps of cold rolling, mechanical alloying of Cu and Zr occurred and strain-induced amorphization of the originally crystalline multilayers can be identified. Furthermore, different compositions of Cu and Zr contents were investigated in order to capture the influence of each individual elements on the amorphization process. The results indicated that it is possible to achieve an amorphous-crystalline nanocomposites during the cold rolling process which might lead to optimized combination of ductility and strength of Cu-Zr multilayers. Finally, some mechanisms have been discussed in justification of the obtained results for both amorphizaiton and amorphous-crystalline nanocomposites.

Poster Number: 58

Comparison Of Seven Flowable Resin Composites: Degree Of Conversion, Wettability, And Roughness

Presented by: Rodrigo Franca
Professor in the Department of Dentistry

Advisor(s):

Co-Author(s): FRS Nunes, MA Atmanspacher, VC Jesus, E Vendrame

Research Area(s): Complex Natural Systems, Composite Materials Systems

Purpose: The aim of this study is to compare seven types of Flowable Resin Composites: Tetric EvoFlow (TEF), N'Durance Dimer Flow (NDF), Clearfil Majesty Flow (CMF), Synergy D6 Flow (SDF), Flows-Rite (FRP), Filtek Bulk Fill (FBF), G-Aenial Universal Flo (GUF), according to their degree of conversion (DC), their wettability by contact angle (CA), and their surface roughness (Ra).
Materials and Methods: Disc-shaped specimens (2mmx6mm) (n=3) of each Flowable Resin Composite was produced using a silicone matrix, a polyester strip, and a glass plate to obtain a flat surface. The Flowable Resin Composites were cured with LED (Valo Cordless, standard potency of $1000mW/cm^2$) for 20s. The DC was measured using cured and uncured materials by FTIR spectroscopy (Thermo Scientific, Nicolet 6700) comparing the peaks at $1640cm^{-1}$ of aliphatic C=C stretching frequency, and at $1610cm_{-1}$ of aromatic C-C stretching frequency. A goniometer (ramé-hart, inc.) was used to measure the CA and to determine their wettability. The Ra was measured using a roughness tester (Mitutoyo, Surftest SJ-210). Statistic analyses were made using one way ANOVA and a post hoc Tukey test ($p<0.05$).
Results: The results of DC, CA, and Ra showed statistically significant differences ($p<0.05$). The DC and standard deviation values are ilustrated in Figure 1, and the statistical differences between NDF-TEF, CMF-NDF, SDF-NDF, FRP-TEF, FRP-NDF, FRP-CMF, FBF-NDF, FBF-FRP, GUF-NDF were observed. The increasing order of CA is FRP (68.3±0.2), SDF (70.1±2.3), TEF (78.9±0.8), NDF (79.8±1.8), FBF (90.0±0.0), GUF (94.9±5.2), CMF (100.1±8.4), and no differences between NDF-TEF, FRP-SDF, GUF-CMF, and GUF-FBF were observed. The decreasing order of Ra (.m) is: FBF (0.742±0.052), GUF (0.329±0.008), SDF (0.176±0.084), CMF (0.150±0.060), TEF (0.137±0.106), NDF (0.116±0.012), FRP (0.086±0.011), and the differences were observed between FBF-TEF, FBF-NDF, FBF-CMF, FBF-SDF.
Conclusions: This study indicated that the higher and lower values of DC are NDF and FRP, respectively. The higher values of CA are CMF and GUF, respectively, implicating that the lowest hydrophilic can lead to a less water absorption from the environment. With regards to surface roughness, the lower values of Ra are FRP and NDF, respectively, which may result less accumulation of bacterial plaque in restorations.

Poster Number: 59

Assessment of the Degree of Conversion of Four Self-etching Resin Cements: Effect of Storage Time and Light Curing Technique.

Presented by: Rodrigo Franca
Researcher in the Department of Dentistry

Advisor(s):

Co-Author(s): B. Dimarco, C. Solomon

Research Area(s): Complex Natural Systems, Composite Materials Systems

Purpose: The aim of this study was to analyze the degree of conversion of four Self-etching Resin Cements according to two light curing sources and during three different periods of time.
Materials and Methods: Four different commercial brands of Self-etching Resin Cements were used (n=6): RelyX Unicem 2 (3M Inc.), Bifix SE (Voco GmbH), BisCem (Bisco, Inc.) and Embrace WetBond (Pulpdent Inc). For these Resin Cements, two different polymerization techniques were used: quartz-tungsten-halogen (QTH) light curing (Max_Caulk, Dentsply) versus light-emitting diode (LED) curing (Valo Cordless, Ultradent Products Inc.). The QTH light had an intensity of 450 mW/cm^2, and the LED light had an intensity of 750 mW/cm^2. The degree of conversion (DC) was performed using a Fourier Transformation Infrared (FTIR; Nicoler-6700). After polymerization, samples were stored at 37C. DC data was recorded in three different time increments: 10 min, 24h and 15 days. DC was calculated utilizing C=C (1640 cm^{-1}) and C=C (1608 cm^{-1}) ratio between polymerized and unpolymerized resin cements. Data were analyzed by a two-way ANOVA and Bonferroni post hoc test. ($p < 0.05$).
Results: Table below reports the average percent (DC) and the standard deviations:
Curing Time RelyX 2 Bifix SE BisCEm Embrace
LED 10 min 31.0 (±6.4) 29.5 (±2.0) 29.5 (±2.0) 13.1 (±1.9)
24 hours 34.0 (±5.2) 21.6 (±3.0) 38.4 (±3.0) 17.8 (±3.0)
15 days 37.4 (±1.7) 27.5 (±5.2) 32.2 (±5.2) 22.6 (±6.7)
Halogen 10 min 31.5 (±3.4) 23.5 (±3.1) 23.5 (±5.2) 29.7 (±3.9)
24 hours 36.9 (±4.2) 30.3 (±1.9) 30.3 (±1.9) 30.4 (±3.1)
15 days 35.7 (±3.0) 28.2 (±5.5) 28.1 (±5.4) 28.1 (±5.6)
Conclusion: Factors: Light curing technique, Time and Resin Cements and the interaction between them are significantly different ($p<0.05$). Depending on the brand, the choice of the curing technique should be used to improve the degree of conversion.

Poster Number: 60

Electrically conducting Collagen and Collagen-Mineral Composites for Current Stimulation

Presented by: Ramesh Kumar Mani
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Research Area(s): Composite Materials Systems

Bifunctional films with higher electrochemical and bioactive properties have many promising applications including tissue engineering, drug delivery, nerve regeneration and bone healing. Since bone possesses natural bio-potential and electromechanical properties, the idea of utilizing small electrical pulses to induce bone-tissue growth has been explored in recent decades. Studies have revealed that electric stimulation (in the order of μV) has positive effects on the Osteogenesis, and enhances the mineral formation in osteoblast-like cells. However, the mechanisms behind these effects are not well understood. Electric stimulation is generally performed through the implantation of metal electrodes that need to be removed after the treatment. This sometimes requires surgery that can lead to complications including infection and damaging newly formed bone-tissue. Therefore, in the search for new implant materials that are bioactive (allowing different cells to grow over it) and electrically conductive (to perform electrical stimulation), a composite material has been synthesized by integrating the electro-active properties of the conducting polymer (poly-3,4-ethylene dioxythiophene, doped with polystyrene sulfonate, PEDOT:PSS) with the biological properties of collagen (protein, which is majorly present in cornea) and collagen-calcium phosphate membranes (which mimics the composition of bone). It is shown that by varying the concentration of PEDOT:PSS, the composite (collagen-PEDOT:PSS) or the hybrid (collagen-hydroxyapatite-PEDOT:PSS) membrane could be altered to be highly biocompatible and highly electrically conductive.

Poster Number: 61

Crack Detection in Steel Girders of Bridges Using a Binary Sensor

Presented by: Farnaz Raeisi
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Research Area(s): Composite Materials Systems

Many bridges across North America are reaching the end of their service lives which will cause deficiencies in their use. In Canada, more than 40% of bridges were built over 50 years ago and most of them need rehabilitation or repair.
A steel bridge subjected to cyclic loading from truck traffic can be susceptible to fatigue cracking in its structural members. Since crack propagation may cause failure of the member, inspection of aging structures has become one of the major consideration of engineers.
Although visual inspection is typically used to assess the condition of a bridge, small fatigue cracks are harder to detect and can be missed.
The objective of this research is to develop a binary sensor which can be easily deployed on large structures at low cost and is able to detect the presence of a crack in a steel girder.
The sensor is a composit material which is made of wire and adhesive. The sesnor is designed in a way that when a crack of less than 0.2 mm width forms in a structure, the local increase in strain will cause the wire to break. The break can be easily detected by measuring the electrical resistance of the wire.
In order to develope this sensor, the proper material for wire and adhesive should be selected. Then materila properties of wire and adhesive will be measured by executing ASTM tests to complete the Finite Element Simulation.
Sensitivity of the sensor to temperature will be investigated.

Poster Number: 62

Acoustic Emission (AE) Event Detection: An important Step for Determination Of Damage In Fiber Reinforced Polymer (FRP) Materials

Presented by: Mohammadhadi Shateri
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Research Area(s): Composite Materials Systems

Acoustic Emission (AE) signal analysis has been widely used to monitor the occurring and progressing of damages in the FRP materials. For this end, a reliable AE event detection algorithm is needed. Most of the real-time commercial parameter based AE systems are using a threshold based technique for AE event detection. Most of the AE signals have strong burst events, or have two or more events close to each other, which this technique fails to detect them separately in both cases. In this work a new methodology for separate detection of AE events is introduced. In this method, first some intervals that have at least one event in them are founded. Second a joint valley-peak finding algorithm with a floating threshold based on each pair of valley-peak is applied to them, which detect events separately. This method was applied to the data obtained from experimental tensile test on FRP bars. The results were compared with the threshold based technique. A Study of 4180 events in this data shows 7.5% error in our method versus 43.6% error in threshold based method. This indicates that our detection method is more reliable for determination and separation of AE events.