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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

Thermal Conductivity Regulation Using Effective Hempcrete Design Ratios

Presented by: Mehdi Md Iftekharul Alam
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Advisor(s): M. Kavgic

Co-Author(s): Miroslava Kavgic

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Hempcrete construction works has become one of the superior eco-friendly and green alternative solutions for constructing light weight houses in present times. This technology is considered as a healthy and carbon negative construction works which also deals with the thermal regulation as well as energy consumption of the building. This study paper shows that a potential construction work using hempcrete depends upon the best mix design ratios. Later, a relationship between the design density and thermal regulation was established and two framing system was verified with the same design ratios to measure the potentiality of the hempcrete insulation. A Carbon sequestration study is also carried out to check the feasibility of hempcrete as a carbon negative construction materials. The study found that at 330 to 350 kg/m^3 density with the ratio [hemp: lime: metakaoline (1:0.5:0.5)] results the best U-value 0.25. Carbon sequestration results shows that the insulation works with the design density will restored 40% to 50% more CO_2 compared to the conventional mix ratios.

Poster Number: 2

Nanoindentation Studies of Metallic Crystalline – Amorphous Composites Synthesized by Accumulative Roll Bonding

Presented by: Ehsan Alishahi
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Advisor(s): Dr. Chuang Deng

Co-Author(s): Chuang Deng

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Materials with microstructural heterogeneity have recently attracted dramatic attention in the materials science community. Although most of the metals are identified as crystalline, the new class of amorphous alloys, sometimes are known as metallic glasses (MGs), have exhibited remarkable properties, particularly high mechanical strength and elastic limit. The unique properties of MGs led to the wide range of studies in developing and characterizing of new alloys or composites which met the commercial desires. In spite of applicable properties of MGs, commercializing of metallic glasses was limited due to a major drawback, the lack of ductility and a sudden brittle failure mode. Hence, crystalline-amorphous (C-A) composites were introduced almost in 2000s as a toughening strategy to improve the ductility of MGs. Despite the considerable progress, there are still challenges in both synthesis and characterization of metallic C-A composites. In this study, accumulative roll bonding (ARB) was used to synthesize bulk crystalline-amorphous composites starting from crystalline Cu-Zr multilayers. As a result of mechanical alloying mechanisms, CuZr phases were formed during the rolling process which was reflected in SEM-EDS analysis. EDS elemental analysis showed the variation in composition of CuZr phases such as 38-62, 50-50 to 68-32 at Cu-Zr % respectively. Moreover, TEM with electron diffraction analysis indicated the presence of both crystalline and amorphous structures for the new formed CuZr phases. In addition to the microstructural analysis, the mechanical properties of the synthesized composites was studied using the nanoindentation technique. Hysitron Nanoindentation instrument was used to conduct nanoindentation tests with cube corner tip. The maximum load of 5000 μN was applied in load control mode to measure the elastic modulus and hardness of different phases. The trend of results indicated three distinct regimes of hardness and elastic modulus including pure Cu, pure Zr and new formed CuZr phases. More specifically, pure Cu regions showed the lowest values for both nanoindentation hardness and elastic modulus while the CuZr phases take the highest values. Consequently, pure Zr was placed in the intermediate range which is harder than pure Cu but softer than CuZr phases. In overall, it was found that CuZr phases with higher hardness were nucleated during ARB process as a result of mechanical alloying phenomenon.

Poster Number: 3

Improving the Ballistic Impact Resistance of an Aerospace Superalloy Produced by Additive Manufacturing Process

Presented by: Gbenga Asala
PhD Candidate at the University of Manitoba, Mechanical Engineering

Advisor(s): O.A. Ojo, J. Andersson

Co-Author(s): O.A. Ojo, J. Andersson

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Additive manufacturing (AM) is a rapidly emerging technology that is fueling a revolution in the manufacturing industries. This process of fabricating parts by sequentially adding layers of material with the use of 3D model data, has shown good potential to produce functional metallic parts, especially aerospace components with a low fly-to-buy ratio, thus minimising raw material wastage and reducing costs parts. However, the repeated solidification and multiple thermal cycles during the AM process can significantly distorts the microstructure and adversely influence the mechanical properties. In particular, the AM produced parts may find applications in abnormal mechanical environments where components are subjected to impact loading. Understanding the impact resistance of AM alloy is critical for applications in terms of reliability, particularly, when compared to wrought materials. This study comparatively investigate the impact response of additively manufactured (AMed) and wrought ATI 718Plus, using a direct impact Hopkinson pressure bar system and electron microscopy techniques. The study shows that the impact resistance of the AMed alloy, in both the as-processed and the recommended heat treatment conditions, is inferior to that of the wrought alloy. A novel post-process thermal treatment is used to eliminate the deleterious brittle microconstituent responsible for the poor impact resistance and improve the dynamic response of the AMed alloy.

Poster Number: 4

Characterization of Cattail Fibres Functional Groups by Infrared Spectroscopy (FTIR).

Presented by: Koushik Chakma
MSc Candidate at the University of Manitoba, Biosystems Engineering

Advisor(s): Dr. Mashiur Rahman

Co-Author(s): Nazim Cicek

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

In this study, the Fourier-transform infrared spectroscopy (FTIR) was conducted to determine the chemical structures composed of cellulose, hemicellulose, lignin, pectin, protein, wax, and oil content as well as structural water in cattail fibres. The study discovered that cattail fibre contains cellulosic group in the wavelength of 3433.25 cm^{-1}, 3430.08 cm^{-1}, 3415.95 cm^{-1} and 3452.24 cm^{-1} and these absorption bands corresponded to H-bonded OH stretch with cellulose, and hemicellulose contents. Further, the symmetric aliphatic CH_2 stretch with wax content was found in the peak at 2850.79 cm^{-1}. The wavenumber at 1737.58 cm^{-1} showed characteristic features that belongs to C=O stretch in –COOH, which is an indication of hemicellulose, lignin, and pectin content. The infrared band assignment positions at 1635.49, 1635.02 and 1634.94 cm^{-1} adsorbed H_2O. It was discovered at 1249.39 cm^{-1} that C=O stretching vibration of ketones, carboxylic group and esters in lignin and acetyl ester groups in xylan. In addition, the spectra from the FTIR graph also found at 893.93 cm^{-1} and 896.85 cm^{-1} which represent asymmetric out of phase ring stretch: C1-O-C4, .-glucosidic bond. The IR spectra of cattail fibres was compared with cattail plant and found very similar spectra except slight shift in peak for cellulose and hemicellulose which was found at 3404.75 cm^{-1} for cattail plant. Moreover, the IR spectrum of cattail fibre is almost similar to that of cotton, hemp, typha leaf, flax and kapok spectrum. From this study, it can be concluded that cattail fibre may be classified as cellulosic fibre.

Poster Number: 5

Textural Analysis of Puffed Red Lentil and Yellow Pea Snacks Produced by Blowing Agent Assisted Extrusion Cooking

Presented by: Elyssa Chan
Undergraduate Student at the University of Manitoba, Food and Human Nutritional Sciences

Advisor(s): F. Koksel

Co-Author(s): F. Koksel

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Extrusion is an efficient method to mix, shear, cook and create aerated foods such as expanded snacks and breakfast cereals. Some of the highly desired properties of these foods include textural qualities; such as hardness, crunchiness and crispiness. In this study, extrudates were prepared at constant moisture content (18%) and temperature (150°C), but varied in starting material (red lentil flour (RL) or yellow pea flour (YP)) and blowing agent (none (conventional), N_2 or CO_2). The textural properties of extrudates were measured using a texture analyzer. The conventional RL had higher hardness and crispiness levels, but a lower crunchiness relative to the N_2 enhanced RL samples. Conventional YP however had consistently higher levels of hardness, crunchiness, and crispiness in correspondence to the N_2 enhanced YP samples. CO_2 enhanced YP samples had the highest level of hardness, crunchiness and crispness of all samples tested. As measured by SEM, addition of N_2 increases the number of smaller bubbles where-as CO_2 creates fewer, larger bubbles relative to conventional extruded products. These results indicate that there is potential to use CO_2 as a blowing agent for higher protein extruded products to enhance their textural properties.

Poster Number: 6

Three Dimensional Characterization of Pore-Tunable Carbon Foam from Bread

Presented by: Chyngyz Erkinbaev
Postdoctoral Fellow at the University of Manitoba, Biosystems Engineering

Advisor(s): J. Paliwal

Co-Author(s): Jitendra Paliwal

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Development of low-cost and multifunctional carbon foam with tunable porous structure is very challenging task. In this work, stiff, lightweight, and temperature resistant carbon foam were fabricated from the whole wheat bread via two main processes: fermentation and carbonization. Desired pore structure of carbon foams were adjusted by optimizing the fermentation process (i.e. yeast or water concentration, and mixing time). Three dimensional (3D) multiscale structures of dough, bread, and carbon foam samples was non-destructively scanned, reconstructed and analyzed using X-ray Microcomputed Tomography technique. The morphometric parameters such as number of closed and open pores, total porosity, specific surface area, and connectivity of the 3D composite materials were quantified. These novel features could be in used in various structure-property simulation tasks. Our results demonstrate that multifunctional carbon foam obtained from inexpensive material such as bread has a promising application in industry (i.e. aerospace, construction, oil refinery, gas adsorption, packaging, and electrical). 3D multiscale modelling provided better understanding the fundamental properties (i.e. hydrophobic surface nature, thermal stability, high electrical conductivity) of carbon foams.

Poster Number: 7

Proantocyanidin: Cross-linker agent to improve acid etching in dentin

Presented by: Ana Carla Fernandes
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Advisor(s): R. França

Co-Author(s): Yumi C Del Rey, Ana Carla Fernandes, Cristina Fiuza, Lourenço MR Roselino, Rodrigo França, Regina G Palma-Dibb

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Proanthocyanidin (PA), a collagen cross-linker agent widely found among plants, has been recognized by its ability to increase the resistance of collagen fibrils and to inhibit the activity of matrix metalloproteinases (MMPs). However, the literature lacks conclusive studies regarding methods of PA incorporation into a restorative protocol in an effective manner and without compromising clinical time. The aim of the present study is to evaluate the effect of proantocyanidin on elemental composition of the dentin surface. Method: Etched dentin surfaces from extracted sound molars were randomly bonded according to the groups: self-etch system – control (SE), total-etch system 35% phosphoric acid – control (TE), 35% phosphoric acid – experimental (EXP); PA incorporated into 35% phosphoric acid – experimental (EXP+PA). The chemical composition in 0nm and 10nm depth of four treated dentin were analyzed using X-ray photoelectron spectroscopy (XPS). Also, the chemical composition each solution was performed. For energy-dispersive X-ray spectroscopy (EDX) and scanning electron microscope (SEM) analysis, additional teeth were prepared and filled with 2 increments of 1 mm Flow resin (SDR SureFil Flow Universal Shade, Dentsply Caulk, Milford, DE, USA), light cured for 20 seconds. After that, the samples were sliced vertically, embedded in acrylic resin, and polished. To allow the visualization of composite resin tags on SEM, demineralization and deproteinization procedures were performed. Results: PA in the experimental acid reduced: the demineralization of dentin and the amount of phosphorus in the solution. Conclusion: Proantocyanidin is effective to improve phosporic acid in dentin.

Poster Number: 8

Characterization of the mechanical behavior of lithium disilicate glass ceramics by nanoindentation

Presented by: Cristina Fiuza
PhD Candidate at the The Univertisity of Manitoba, Restorative Dentistry

Advisor(s): R. França

Co-Author(s): Mohammad Aramfard, Chuang Deng, Rodrigo França

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Background Mechanical property determination of lithium dissilicate glass ceramics (LDGC) is essential for successful application as structural elements in restorative dentistry. Nanoindentation test provides a good method to obtain mechanical behaviour of materials at lower scales. Elastic modulus and hardness of LDGC should be highlighted since these properties establish the deformation responses of wear and machinability of these materials. Objective Evaluate the hardness and elastic modulus of LDGC by nanoindentation.

Methods LDGC blocks were cut using a slow-speed water-cooled diamond saw to obtain 2mm-thick slice of each group (IPS emax CAD, Vita Suprinity, Celtra Duo and N!ce). According to manufacturer recommendation the slices received a heat treatment except for N!ce and one group of Celtra Duo that were left without sintering. All the five groups were mounted in acrylic resin and polished with SiC papers with decreasing abrasiveness. The mechanical tests were performed by nanoindentation instrument with a Berkovich indenter tip. Around 350 indentations were carried out on each sample and the results of Elastics Modulus (E) and Hardness (H) were reported as the average of the tests and were statistically analyzed. Results The mechanical results demonstrated difference among the groups for both hardness and elastic modulus. Elastic modulus ranged from 93 to 118GPa and the hardness mean values from 7.59 to 10.83GPa with significant scatter among some of them. Conclusions Lithium disilicate glass ceramics presented mechanical properties that lead for an elevated quality of indirect restorative material even without the heat treatment process.

Poster Number: 9

Effect of anisotropy on the transport of classical waves in 3D media

Presented by: Antton Goicoechea
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Advisor(s): J. H. Page

Co-Author(s): S. Skipetrov, J. H. Page

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

The transport of energy by multiply scattered classical waves in disordered materials can often be well described using the diffusion approximation. Here, we focus on strongly disordered systems for which this approximation breaks down. We investigate signatures of Anderson localization in a system which is anisotropic in the sense that transport in different spatial directions is not equivalent. An experimental system, in which the effects of anisotropy on transport properties may be realized in practice, is an elastic network of irregularly shaped (roughly ellipsoidal) aluminium particles oriented in a particular direction. We therefore have a diagonal diffusion tensor with only two independent coefficients. We perform transverse confinement experiments to characterize the transport regime inside a slab sample for a certain orientation of the particles.

Poster Number: 10

Synthesis and Characterization of Novel Bioplastics

Presented by: Kathryn Hall
MSc Candidate at the University of North Dakota, Chemical Engineering

Advisor(s): Dr. Surojit Gupta

Co-Author(s): Matt Fuka, Maharshi Dey, Yun Ji, Surojit Gupta

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Sustainability has become an important constituent of research in this century. In this poster, we will present some of the recent results in developing multifunctional bioplastics. We will discuss some of the best practices in manufacturing them.

Poster Number: 11

Analysis and Prediction of the Fiber Yield (%) Obtained from the Waste Biomass of Typha latifolia (Cattail) Using a Mathematical Model

Presented by: Mahmudul Hasan
MSc Candidate at the University of Manitoba, Biosystems Engineering

Advisor(s): Dr. Rahman, Dr. Cicek

Co-Author(s): M. Rahman, N. Cicek

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

An investigation was carried out to predict the fiber yield (%) extracted from the waste biomass of *Typha latifolia* (cattail) plants by treating with fixed concentration (10% W/V) of aqueous NaOH in a fixed range of time (t) and temperature (T). Only soft-stem cattail plants were used for this experiment in a completely randomized design with 3 levels of time (4 hours, 8 hours, and 12 hours) and 4 levels of temperature (70°C, 80°C, 90°C, and 95°C).

The current research found that the fiber yield (%) decreased linearly with increasing treatment time (hour) and temperature (°C). However, the effect of temperature ($r = -0.68$, $P < 0.0001$) on yield (%) was found more pronounced than the effect of time ($r = -0.51$, $P = 0.0004$). In this research, Model: $y_i = b_O + b_1x_{1i} + b_2x_{2i} + e_i$ (where, x_1 = Time, b_1 = slope of time, x_2 = Temperature, b_2 = Slope of temperature, b_O = y-axis intercept, e_i = error deviations) was used to estimate the parameters for prediction and the significance of the model was examined using an F-test (F value = 114.86, $P < 0.0001$). In order to examine the significance of the slopes of both variables, an ANOVA was conducted using Type-I Sum of Squares and both slopes were found significant. The final model for predicting fibre yield (%) was found to be $\hat{y}_i = 116.30 - 2.02*t - 0.85*T$. The model is valid for $4 \le t \le 12$ and $70°C \le T \le 95°C$.

Poster Number: 12

A study of cyclic oxidation performance of three Ni-based superalloys and lifetime prediction by COSP-modelling

Presented by: Mallikarjuna Heggadadevanapura Thammaiah
PhD Candidate at the University of Manitoba, Mechanical Engineering

Advisor(s): W. F. Caley, N. L. Richards

Co-Author(s): William F. Caley, Norman L. Richards

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Ni-based superalloys are the most prominent materials for high-temperature applications such as aerospace gas turbine engines and nuclear power plants. Since these alloys are exposed to high-temperature exhaust gasses, they should have excellent oxidation and corrosive resistance. In this work, three Ni-based superalloys, namely, polycrystalline IN738LC, directionally solidified Rene 80 and single crystal N5 were used to study their oxidation kinetics and spallation behaviour at 900°C in air under cyclic conditions for up to 1000 cycles. The kinetics revealed that N5 was the most oxidation resistant alloy with two orders magnitude lower oxidation rate compared to IN738LC and Rene 80. The SEM and XRD analyses showed that the IN738LC and Rene 80 are chromia formers, whereas, N5 was an alumina former. The IN738LC and Rene 80 alloys exhibited severe scale spallation resulting in negative weight change due to elevated Ti content (3 and 5 wt. % respectively). Also, the rate of spallation in Rene 80 after 700 cycles increased due to the presence of a high (4 wt. %) Mo. The COSP- model predicted good cyclic oxidation resistance for IN738LC, whereas finding a reasonable fit for Rene 80 and N5 was difficult due to severe scale spallation.

Poster Number: 13

The Role of Segregation in Diffusion Induced Grain Boundary Migration Studied by Molecular Dynamics Simulations

Presented by: Navjot Kaur
PhD Candidate at the University of Manitoba, Mechanical Engineering

Advisor(s): O.A. Ojo, C. Deng

Co-Author(s): C. Deng O.A. Ojo

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Diffusion-induced grain boundary motion (DIGM) can be caused when solute atoms are diffused out of grain boundary (GB) in the presence of solute sink or diffuse into the GB in the presence of solute source thereby causing the boundary to migrate and produce de-alloyed (solute depleted) and alloyed zones (solute enriched). In this work, molecular dynamic simulations using Embedded Atom Method potentials and LAMMPS codes are performed to investigate the role of solute segregation in DIGM. It is suggested that the presence of solute sink/source will break the equilibrium between the GB and the bulk, and in order to reduce the overall energy of the system and regain equilibrium, the GB needs to migrate. The present study is focused on DIGM when solute sink is present. It is observed that depletion of GB solute content to below the equilibrium level (due to diffusion of solute from GB to sink), causes the boundary to move through high solute field to regain equilibrium thereby creating de-alloyed zone. The DIGM is quantified in terms of driving force, concentration of solute atoms in bulk, number of atoms segregated at the GB and distance moved by the GB. The simulation results show that segregation plays a very important role in promoting DIGM. All observations made during the simulations are supported by the atomic configurations and graphical analysis at different stages of the process.

Poster Number: 14

Durability of GFRP reinforcement bars

Presented by: Huma Khalid
Postdoctoral Fellow at the University of Manitoba, Civil Engineering

Advisor(s): A. Mufti

Co-Author(s): Basheer Algohi, Aftab Mufti

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Numerous reinforced concrete structures are unlikely to reach their expected service life when they are exposed to harsh environmental conditions such as severe climate and de-icing salts. These conditions cause corrosion which is a prime factor that causes deterioration of conventional reinforced concrete structures. In Canada, it is estimated that more than 40% of all the bridges 50-years old or more and multistory parking garages are structurally deficient mainly due to corrosion caused by de-icing salts and severe climate [1,2]. Glass Fibre Reinforced Polymer (GFRP) can be one of the potential solutions to solve the problem regarding steel corrosion by a replacement of traditional steel re-bars but uncertainty still exists about the long term performance of GFRP structures in their service environment. Consequently, it is highly important to investigate the durability of GFRP bars to make reliable predictions regarding the long term performance of GFRP. The objective of this work is to obtain field data with respect to the durability of GFRP in concrete exposed to natural environments and to analyze GFRP for its physical and chemical composition at the microscopic level. It is anticipated that the results of this study will gain wider acceptance of GFRP as a replacement for conventional steel reinforcement among civil engineering community.

1. Benmokrane, B. and R. Masmoudi, Flexural response of concrete beams reinforced with FRP reinforcing bars. Structural Journal, 1996. 93(1): p. 46-55.

2. Mufti, A., et al., Studies of concrete reinforced with GFRP specimens from field demonstration projects. ISIS Canada Research Network Technical Report, 2005.

Poster Number: 15

Mechanical Properties of Hempcrete

Presented by: Mohammad Amil Khan
MSc Candidate at the University of Manitoba, Civil Engineering

Advisor(s): M. Kavgic

Co-Author(s): M. Kavgic

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Hempcrete, made of the inner woody core of the hemp plant mixed with a lime-based binder, is a particularly promising lightweight, porous and breathable bio composite material that offers the potential to significantly reduce the embodied energy related to the construction of buildings while improving indoor environmental quality. Hempcrete can be used to build walls as well as to insulate floor slabs or roofs. However, hempcrete properties and performance greatly depend on the ingredients and the type of binder used. This study characterizes physical and mechanical properties of two hempcrete mixes that are based on binders with different properties namely, widely used Portland Cement (PC) and new eco-friendly, cost-effective and locally sourced pozzolanic binder. Since hemp particles' porous nature stores water inside their structure, the bulk density of hemp was measured, followed by oven drying for measuring variation in density. Sieve analysis was performed to determine the ease of separation of hemp particles where fibers prevented separation of particles. Cylindrical samples were casted, cured, then tested for compressive strength according to ASTM standard. Samples of PC were cured in higher Relative humidity (RH) of 80-90% for the hydration of cement. They achieved 28th day compressive strength of 0.24 MPa. Samples of locally sourced pozzolanic binder achieved a compressive strength of 0.4 MPa. Density of the samples was greatly affected by the water content, and compaction done whilst casting. Characteristics of natural materials vary, resulting in non-consistent experimental results. Further studies for code compliance needs to be done.

Poster Number: 16

Current Progress in the Design of Novel Multifunctional Materials for Sustainable Applications

Presented by: Mikaila Kringstad
MSc Candidate at the University of North Dakota, Mechanical Engineering

Advisor(s): Dr. Surojit Gupta

Co-Author(s): Margaret Ahmann, Makayla Platt, Annie Miles, Surojit Gupta

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

National Academy of Engineering (NAE) has come up with 14 Grand Challenges. Different schools are developing Global Challenge Scholar's Program (GCSP) to incorporate some of the key elements of grand challenge in the educational program. Some of the important elements of the GCSP program are: "(a) A creative learning experience connected to the Grand Challenges such as research or design projects, (b) Authentic experiential learning with clients and mentors that includes interdisciplinary experience in fields such as public policy, business, law, medicine, ethics, and communications, (c) Entrepreneurship and innovation, (d) Global and cross-cultural perspectives, and (e) Development of social consciousness through service-learning" [1]. This poster is about the current progress we have made in our lab regarding design of novel materials which can performed the objectives of Carbon Sequestration Methods, Water purification/harvesting, and Engineering tools for scientific discovery by developing collaboration with scientists.

Reference:

1. http://www.engineeringchallenges.org/File.aspx?id=15680&v=c29105cb

Poster Number: 17

Immobilization of nuclear waste outlaws $[MoO_4]^{2-}$ and $[SO_4]^{2-}$ in B_2O_3-Al_2O_3-P_2O_5-SiO_2 glasses

Presented by: Arun Krishnamurthy
PhD Candidate at the University of Manitoba, Chemistry

Advisor(s): S. Kroeker

Co-Author(s): Scott Kroeker

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Low solubility (> 1mol%) of fission products like molybdenum (Mo) in the glass which is used as an immobilization host is a serious drawback and a concern. Low solubility of Mo leads to phase separation of water soluble molybdates which sequester radioactive 137Cs and 90Sr. Sulfate also has low solubility in borosilicate glasses (0.4 to 0.5 wt%) and has phase separation characteristics similar to the Mo. Similar cationic field strengths of Mo^{6+}, S^{6+} and P^{5+} ions have resembling ordering effects on surrounding oxygens thereby end up sharing the oxygens. Hence phosphate glasses can immobilize higher volumes of Mo and SO_4^{2-}. Although phosphate glasses are being explored as possible nuclear waste immobilization hosts, their low chemical durability is a concern. In this work a Na_2O-B_2O_3-SiO_2 glass with a basic composition similar to SON68 glass is considered and SiO_2 is gradually replaced with P_2O_5. The effect of this substitution on the solubility of Mo and SO_4^{2-} and corresponding changes in the glass structure are studied using multi-nuclear NMR and X-ray diffraction studies

Poster Number: 18

Paramagnetic NMR of crystalline solids: challenges and the promises

Presented by: Kirill Levin
PhD Candidate at the University of Manitoba, Chemistry

Advisor(s): S. Kroeker

Co-Author(s): Scott Kroeker

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Solid-state NMR with fast magic angle spinning (MAS) is a valuable technique for structural elucidation of local atomic environments. The presence of an unquenched magnetic moment in the system introduces a significant paramagnetic interaction which can dominate the observed signal. This contribution is often deemed undesirable as it lowers the signal resolution and generates non-intuitive shifts of the resonance signal. This work will focus on how to understand paramagnetic shifts, and will emphasize aspects of the paramagnetic coupling that can be beneficial to spectral interpretation in relation to the local environment around the source of unpaired electrons. As an illustration of these concepts, 13C and 1H MAS NMR spectra of metal acetylacetonates will be presented. Fast MAS rates of up to 60 kHz, together with computational methods aid in the spectral assignment. These techniques together with the outlined principles are emerging tools to provide NMR spectroscopists the means to successfully interpret structural information in paramagnetic solids.

Poster Number: 19

Spectroscopic optical coherence tomography for ageing assessment of high voltage transformer insulation

Presented by: Biniyam Kahsay Mezgebo
PhD Candidate at the University of Manitoba, Electrical and Computer Engineering

Advisor(s): Dr. Sherif, Dr. Kordi

Co-Author(s): Namal Fernando, Behzad Kordi, Sherif Sherif

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

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

The deterioration of the insulation paper produces actual changes in its morphology and structure. In this work, we will develop an algorithm that uses subsurface structural images and localized near infrared absorption profiles, obtained by spectroscopic optical coherence tomography (OCT), to estimate the remaining lifetime of high voltage transformer insulation paper. OCT methods for aging assessment of transformer paper are desirable, as they could be performed in situ.

A quadrature swept source OCT was built to acquire subsurface structural images and localized near infrared absorption profiles from both synthetically and in-field aged transformer insulation paper samples. We will describe a corrected OCT image reconstruction from non-uniformly spaced interferogram samples that we developed using Frame theory. We will also describe a sparsity-based basis pursuit algorithm using the least angle regression (LARs) technique to extract spectroscopic information from OCT images.

Poster Number: 20

Performance of additions in concrete with EAFS and protection of reinforcing steel

Presented by: Yasmin Perez
PhD Candidate at the Universidad Pedagógica y Tecnológica de Colombia, PhD. Engineering and Cience of Materials

Advisor(s): E. Vera

Co-Author(s): E. Vera

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

The present research contains the advances in the development of the doctoral thesis denominated" Performance of additions in concrete with EAFS and protection of reinforcing steel", which tries to demonstrate the feasibility of the use of industrial residues in the construction of rigid pavements. The waste to be used is the Electric Arc Furnace Slag (EAFS) as a substitute for the coarse aggregate and the Recycled Ground Glass (RGG) as a substitute for the fine aggregate. The data and observations recorded in this document are limited to the characterization of the new materials to be incorporated into the mixtures of the hydraulic concrete, especially to the characteristics related with RGG, which have not been easily obtained within the current literature, especially geographically demarcated for the department of Boyacá (Colombia). In addition, it presents an updated bibliographic revision of the use of EAFS and RG Gas substitutes in the mixtures of hydraulic concrete, without being used simultaneously, as is the fundamental of this research, being a novel advance of great impact when implementing its use in the construction of the road infrastructure. The research is experimental and seeks to evaluate the behavior of reinforced hydraulic concrete, useful in the construction of infrastructure works. The properties to be evaluated are the simple compression strength, corrosion resistance of reinforcing steel, density, voids and absorption. Electronic scanning (SEM/EDX) and X-ray diffraction (XRD) have been employed.

Poster Number: 21

Dynamic Impact Response and Constitutive Modeling of Haynes 282 Superalloy at Elevated Temperatures

Presented by: Nnaemeka Ugodilinwa
MSc Candidate at the University of Manitoba, Mechanical Engineering

Advisor(s): M. R. Khoshdarregi, O. A. Ojo

Co-Author(s): M. R. Khoshdarregi, O. A. Ojo

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Haynes 282 is a newly developed γ'-strengthened Nickel-base superalloy with excellent combination of high-temperature mechanical properties, ease of fabricability, and oxidation resistance. It is used in static and rotating components for jet turbine engines and engine blade containment structures, and recently a candidate material for advanced ultra-supercritical steam boilers. Several studies have been reported in the literature on the mechanical properties of Haynes 282, however, limited information is available on its dynamic impact behavior. The impact behaviour of a material is assessed through conditions that predisposes it to shear localization. An understanding of the susceptibility of Haynes 282 to shear band formation is critical in defining its resistance to damage under high strain rate applications such as machining and ballistic impact. This study investigates the impact energy absorbing properties of Haynes 282 at strain rates from 2×10^3 to 9×10^3 s^{-1} and temperatures from 25 to 800°C using the direct Hopkinson compression bar. Experimental results shows that Haynes 282 has a near-constant to negative strain rate dependence with flow stress, a testament to its ease of machinability. This is in contrast to Inconel 718, the most widely used Ni-based superalloy, with positive strain rate sensitivity. Moreover, the new alloy is less susceptible to adiabatic shear band than Inconel 718, which enhances its resistance to ballistic damage. Furthermore, it is shown that the coupled effects of strain hardening, strain rate softening and temperature on the dynamic behavior of Haynes 282 can be modeled using Arrhenius-type constitutive equation.

Poster Number: 22

Thermal Gradient Contribution to Ageing Processes within Insulation Material: Experimental Design and Implementation

Presented by: Anton Vykhodtsev
PhD Candidate at the University of Manitoba, Electrical and Computer Engineering

Advisor(s): D. Oliver, B. Kordi

Co-Author(s): D. Oliver, B. Kordi

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Solid polymer insulating materials represent a critical component of high voltage equipment in power systems. Ageing processes in these insulators are of considerable interest and the degradation of performance and ultimate failure of the insulation can result in significant power outages and/or system instability. While thermal approaches have been used to artificially age materials over an accelerated timescale, little attention has been spent considering the thermal gradients present, for example, across a transformer bushing situated at the outer shield or radially across the insulation of underground cables buried in the vicinity of the frost line. We have designed and built a test module that applies a constant thermal gradient to a sample of insulation material. The impact of ageing in this environment is compared to ageing of the same type of material in a uniform temperature environment. The characteristics of the material are determined using dielectric spectroscopy measurements over the frequency range 0.1 mHz - 10 kHz.

Poster Number: 23

Material Characterization and Defect Inspection Based on Acoustic Guided Waves – an Application of Corrosion Detection on Grounding Electrodes

Presented by: Junhui Zhao
Researcher at the University of Manitoba, Electrical and Computer Engineering

Advisor(s): Dr. Thomson

Co-Author(s): Junhui Zhao, Nicholas Durham Douglas Thomson

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

Civil structures like buildings, bridges and aircrafts built for serving our society use a large variety of elastic solid materials. The material integrity is critical for the structural performances and functions. The structures often fail due to the existence of physical defects and the deterioration of physical properties. Therefore, material characterization and defect inspection are very important for inspecting the structure health. The elastic mechanical waves forming and propagating in the boundary-confined solid materials such as plates, tubes and rods are termed as the acoustic guided waves (AGW), which velocity is directly associated with material density and elasticity. This property is thus utilized to characterize material properties and defects.

In this work the AGW based pulse-echo method was investigated for corrosion detection of electrical grounding steel rods in electrical power substations. Three guided wave modes, longitudinal, flexural and torsional modes, were studied in simulation and experiment. The generation and propagation of the guided waves using different types of acoustic wave emitters and sensors were investigated. The experimentally obtained group velocities versus frequency are consistent with numerical simulations. The principal longitudinal mode at low frequencies has been identified as the best candidate for defect detection on the grounding rods. The pulse-echo signals from the simulated corrosion pits are well correlated with the positions and cross-sectional areas of the pits. The research work demonstrates the potential technological application in detecting corrosion damage of grounding electrodes so that expensive and time consuming excavation based methods can be augmented.

Poster Number: 24

Introduction to the size measurement of nano particles

Presented by: Yi Zheng
Researcher at the Central Iron and Steel Research Institute, X ray lab of Powder Metallury Institute

Advisor(s):

Co-Author(s):

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable

Abstract:

When we focusing on the target, usually, we should know 3 elements, what, where and what happened. In nano research, we should know what kind of nano, where is it and what happened. On nano particles research, we should know what material(including shell or core), size (including morphology of particles), and what happened in the process. How to measure the size of nano particles is the topic of this lecture. TEM, Laser, X ray and the other method will be compared. Meanwhile, the advanced and shortcoming will also be shown. Meanwhile, some kind of advanced research related nano will be discussed as extend introduction.

Poster Number: 25

Broadband ultrasonic study of Asian noodle dough: bubbles and matrix properties

Presented by: Reine-Marie Guillermic
Postdoctoral Research Associate at the University of Manitoba, Physics and Astronomy

Advisor(s): J.H. Page, M.G. Scanlon

Co-Author(s): Reine-Marie Guillermic, Mia Wang, Sébastien Kerhervé, Anatoliy Strybulevych, John H. Page, Martin G. Scanlon

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable, Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Characterization of the mechanical properties of soft food materials is crucial in the food industry, both for process design and for quality enhancement purposes. Ultrasonic techniques are well suited to meet this need, as they are a very convenient non-destructive tool for assessing the mechanical properties of food products. In the case of Asian noodle dough, these properties are influenced strongly by the ingredients (flour, salt, water content) and the processing conditions (work input), but also by the bubbles trapped during the manufacturing process. A better understanding of the effects of bubbles and dough matrix properties on the acoustic signatures (phase velocity and attenuation) is crucial for an optimum development of online acoustical quality control tools in noodle processing industry. We present here the results of ultrasonic contact measurements on noodle dough over a wide frequency range. Both longitudinal transmission experiments (100 kHz – 13 MHz) and shear reflection experiments (200 kHz – 1.5 MHz) have been performed, giving access to longitudinal and shear moduli respectively. This study is completed by X-Ray microtomography experimental data, providing bubble size distributions in noodle dough samples. The effect of noodle dough aging is also being investigated. By putting all this information together, we can unravel the role of matrix and bubbles in the ultrasonic signatures of noodle dough.

Poster Number: 26

Dose of oxygen in sputtered Indium Tin Oxide (ITO) thin film based H_2 & CO_2 gas sensors on changes to properties and sensitivity

Presented by: Sadna Isik
MSc Candidate at the University of Manitoba, Electrical and Computer Engineering

Advisor(s): C. Shafai

Co-Author(s): Omer Coban, Emre Gur, Cyrus Shafai

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable, Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Indium Tin Oxide (ITO) is widely known as a highly degenerate wide-gap semiconductor (band gap ~3.7eV) and well-known transparent conducting oxide. In this study we investigated physical deposited (RF magnetron sputter deposition) ITO thin film samples with varying oxygen partial pressure. These thin films were characterized by using X-ray diffraction spectroscopy (XRD), Scanning electron microscopy (SEM), Energy Dispersive Spectroscopy (EDX) and optical absorption techniques. Characterized samples were deposited on aluminum interdigitated electrode (IDE) to fabricate H_2 and CO_2 gas sensors and to measure sensitivity. We studied band gap variation, transmittance, figure of merit, crystal orientation, growth rate with respect to oxygen contents of ITO thin film. We found that added oxygen content affected on properties and sensing performance of ITO thin film.

Poster Number: 27

Broadband Coherent Perfect Absorption of Acoustic Waves with Bubble Meta-Screens

Presented by: Maxime Lanoy
Postdoctoral Fellow at the University of Manitoba, Physics and Astronomy

Advisor(s): J.H. Page

Co-Author(s): Reine-Marie Guillermic, Anatoliy Strybulevych, J. H. Page

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable, Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Air bubbles placed in a yield-stress fluid or soft solid are excellent candidates for creating acoustic metamaterials, as they exhibit a strong low-frequency resonance, which can lead to interesting effective acoustic properties at wavelengths that can be hundreds of times larger than the radius of the bubbles. In this poster, we show how a bubble layer can be optimized to create a coherent perfect absorber for acoustic waves. Since the concept of a coherent perfect absorber, or “anti-laser”, was first proposed in optics, there has been growing interest in developing coherent perfect absorbers for acoustic waves. Perfect absorption can be achieved by coherently illuminating a metamaterial (or metalayer of bubbles in our case) using two oppositely propagating incident beams. The first step is to design a soft matrix, into which the bubbles can be embedded. The second step consists in optimizing the structure of the bubble layer in order to maximize the absorption over a broad range of frequencies. The optimization occurs when the viscous dissipation balances the radiative damping (corresponding to the critical coupling condition), giving an optimum relation between the bubble radius and separation. Model predictions, experimental observations and the results of simulations will be presented.

Poster Number: 28

Spin-wave chirality and its manifestations in antiferromagnets

Presented by: Igor Proskurin
Visiting Researcher at the University of Manitoba, Physics and Astronomy

Advisor(s):

Co-Author(s): R. L. Stamps, A.S. Ovchinnikov, J. Kishine

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable, Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Optical chirality (or Lipkin's zilch) and its applications attracted recently certain attention in optics and plasmonics. As it was first demonstrated by Tang and Cohen [Phys. Rev. Lett. 104, 163901 (2010)], in chiral metamaterials its density determines the asymmetry in the rate of electromagnetic energy absorption between left and right enantiomers. In our recent work [Phys. Rev. Lett 119, 177202 (2017)], we demonstrate that this effect is not limited by optical applications and can exist in magnetic spin systems. By constructing a formal analogy with electrodynamics, we show that in antiferromagnets with broken chiral symmetry, the asymmetry in local spin-wave energy absorption is proportional to the spin-wave chirality density, which is a direct counterpart of optical zilch. We propose that injection of a pure spin current into an antiferromagnet may serve as a chiral symmetry breaking mechanism, since its effect in the spin-wave approximation can be expressed in terms of additional Lifshitz invariants in the spin-wave energy density. We use linear response theory to show that the spin current induces a nonequilibrium spin-wave chirality density. Future generalization and proposals are also discussed.

Poster Number: 29

Crystal Planes, Magnetism and Catalysis of Co_3O_4: How They are All Connected

Presented by: Michael Shepit
MSc Candidate at the University of Manitoba, Physics and Astronomy

Advisor(s): J. van Lierop

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

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable, Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Cobalt oxide (Co_3O_4) is used widely in a variety of different fields, from magnetism to catalysis. Bulk Co_3O_4 is an antiferromagnet with a normal spinel structure, and a magnetic ordering temperature of 40 K. We were able to synthesize three different morphologies of nano-Co_3O_4; cubes, spheres, and plates. Cubes have side lengths of 17 nm, spheres are roughly 8 nm in diameter, and the hexagonal plates have a width of 76 nm and a thickness of 7 nm. High temperature nitric oxide (NO) reactions were used to characterize the catalytic properties of the samples. The crystal and magnetic structures were characterized by techniques including x-ray diffraction, electron microscopy, SQUID magnetometry, x-ray absorption spectroscopy, and x-ray magnetic circular dichroism. The cubes display very unusual magnetic behaviour around 8-30 K where the hysteresis loops are upside down! The magnetic anisotropy of the samples are set mostly by the shape of the particles, with the plates so thin the surface anisotropy is high and this results in the largest coercivity for Co_3O_4 nanoshapes. Catalytically, the plates show a much higher activity then the cubes. This is due to the reactivity of the different exposed crystal planes. For cubes the (100) plane is exposed and has a much lower reactivity than the exposed (111) plane of the plates. However, the plates show a higher conversion of NO and a slower deactivation. We used magnetometry and XAS to identify the ratio of Co^{2+}/Co^{3+} and their impact on the catalysis, and surface activation provides new insights into the unusual magnetism.

Poster Number: 30

Resonant multiple scattering of ultrasonic waves in a model disordered material

Presented by: Benoit Tallon
PhD Candidate at the University of Manitoba, Physics and Astronomy

Advisor(s): J. H. Page

Co-Author(s): T. Brunet, J. H. Page

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable, Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Progress in the study of complex physical phenomena, such as resonant multiple scattering of waves, requires well controlled model systems. In this work, we show that resonant emulsions (made by micro-fluidic techniques) fulfill this role for studying ultrasonic wave transport in strongly resonant disordered materials. The emulsion components (fluorinated oil droplets randomly suspended in a water-based gel) were selected for both their weak absorption and large sound-speed contrast, which enhance the strong Mie-type resonances of the droplets. Furthermore, the fluid nature of these components allows in situ acoustic field probing.

For diluted emulsions, our experimental observations of both the ballistic propagation of the average wave field and diffusive transport of the average intensity are well described by models based on the independent scattering approximation. We show that the group velocity is large near sharp scattering resonances, whereas the energy velocity (as well as the diffusion coefficient) is significantly slowed down by resonant scattering delay, allowing a link to be established between earlier pioneering work in optics and acoustics.

When the scatterers' concentration increases, the independent scatterer and diffusion approximations fail, and we observe more complex wave phenomena. Multiple scattering interference effects lead to sub-diffusive transport of the average intensity, suggesting that this type of model system, in which resonant scattering is further enhanced, could be an attractive prospect for studying the Anderson localization of acoustic waves.

Poster Number: 31

Mechanical and Thermal Properties of Hempcrete

Presented by: Asif Khan
PhD Candidate at the University of Manitoba, Civil Engineering

Advisor(s): M. Kavgic

Co-Author(s): Miroslava Kavgic

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable; Energy Harnessing and Storage

Abstract:

Buildings account for around 30% of total global final energy use and 20% of energy-related greenhouse gas emissions. Advanced, high-performance building envelopes are often characterised by materials of high embodied energy that result in significant carbon emissions in their production. Hempcrete is a carbon-negative build material which through photosynthesis locks much more atmospheric carbon dioxide than emits during building construction. In addition, hempcrete is a recyclable material that can be ground up and spread on farmers' fields as well as used to make new hempcrete. However, since hempcrete properties significantly depend on various factors, commercial application of hempcrete in the construction industry and development of codes and standards requires comprehensive experimental tests and analysis in order to obtain reliable information about thermo-physical properties of different hempcrete formulas. This study investigated compressive strength and thermal conductivity of hempcrete of several mix designs. The compressive strength was deduced by cylinder testing in accordance to ASTM D 4832, while the thermal conductivity of hempcrete mixes were obtained using KD2 Pro ‘transient hot wire’ testing system. Results extrapolated from the tests demonstrated the effectiveness of lime and metakaolin mix compared to cement binder used in the production of hempcrete. Lime and metakaolin used in production of hempcrete provided superior compressive strength (0.47MPa) and thermal conductivity (0.0795 W/mK) compared to cement binder with similar compaction during preparation. The loss of excess moisture for lime and metakaolin mix being more porous, provided curing to the inner core of the specimen rather than only the outer section.

Poster Number: 32

Sc_2VO_5-In_2VO_5 Phase Diagram

Presented by: Dmitry Vrublevskiy
PhD Candidate at the University of Manitoba, Chemistry

Advisor(s): M. Bieringer

Co-Author(s): A. Miller, J.A. Lussier, M. Bieringer

Research Area(s): Composite Materials: Metallurgical, Non-metallic, Structural, and Sustainable; Energy Harnessing and Storage

Abstract:

Disorder-order transition has a profound impact on the performance on the solid-state electrolyte in solid-state oxide fuel cells (SOFCs). The parent disordered oxide defect fluorite structures for solid-state electrolyte applications can undergo a phase transition to cation and/or anion ordered superstructures. ABO_3.3..[]_0.7 (e.g. Ln_2VO_5 [1]) has an oxygen defect concentration of approximately 17%, which is slightly larger than in typical oxide conducting yttrium stabilized zirconia phases. The structural diversity of Ln_2VO_5 phases suggests a rich phase diagram that needs to be understood in detail in order to prevent the ordering of cations and in particular the ordering of oxide defects. Here we present the synthesis of the Sc_2VO_5 – In_2VO_5 system, the structural characterization, and the reactivity of some of the structures. Powder neutron and X-ray diffraction data illustrate the competition between the ordered variants and the parent disordered defect fluorite structures.

[1] M.M. Kimani, C.D. McMillen, J.W. Kolis, Inorg. Chem. 2012, 51, 3588-3596

Poster Number: 33

Synthesis, single crystal growth and magnetism in s = ½ garnet $Ca_3Cu_2GeV_2O_{12}$

Presented by: Brooke Richtik
Undergraduate Student at the University of Winnipeg, Chemistry

Advisor(s): Chris Wiebe

Co-Author(s): Kelsey Duncan, Cole Mauws, Megan Rutherford, Daniel Applin, Ed Cloutis, Chris Wiebe

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

The garnet $Ca_3Cu_2GeV_2O_{12}$ was prepared by solid-phase synthesis in air at 900°C and a single crystal was grown with a floating zone image furnace. The Cu^{2+} spins (s=1/2) form a body centred cubic lattice. The magnetism in this structure was explored by analyzing the heat capacity at varying magnetic fields and by performing Raman Spectroscopy at low temperature. A possible structural magnetic transition appears at low temperatures due to Jahn-Teller distortions. However, the material fails to order magnetically down to 1.8 K. This places our compound as a new spin liquid candidate.

Poster Number: 34

Exploring the Non-Linear Dynamics of Cavity Magnon-Polariton Systems

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

Advisor(s): C. M. Hu

Co-Author(s): Yong Sheng Gui, Ying Yang, Jinwei Rao, Can-Ming Hu

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

At low oscillation amplitudes, the damping of many harmonic systems can be approximated as being linearly dependent on resonance frequency. However, at high amplitudes non-linear damping effects can no longer be ignored and act to distort the dynamics of the system near resonance. As these non-linear effects increase they will eventually produce a 'fold-over' effect, where multiple stable modes exist for certain states of the system. In our experiment we investigate the fold-over effect induced by non-linear dynamics in a cavity-magnon-polariton (CMP) system, where the magnons in an yttrium iron garnet (YIG) sphere strongly interact with the photons in a microwave cavity. In this system we observe non-linear bi-stabilities at high input powers, and show that these bi-stable states can be accessed by sweeping either the external field or the input power applied to the system. The dynamics of these states can be described by a theoretical model which accounts for the effects of strong CMP coupling as well as non-linear magnon damping. These observations show that strongly coupled CMP systems are able to provide a new platform to study non-linear light-matter interactions and may be useful for future technologies, such as information storage/transfer and magnetic switching applications.

Poster Number: 35

Propagation of Elastic Waves in a 2D Disordered Waveguide

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

Advisor(s): J. H. Page

Co-Author(s): S. O. Kerhervé, J. H. Page

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

The propagation of elastic waves in heterogeneous media can be strongly influenced by multiple scattering, leading to a long time coda, which follows the first direct signal to arrive in pulsed transmission experiments. Using a laser interferometer, we measure directly the displacement field of these "coda waves" in a sample composed of a single layer of brazed aluminum beads. Because of the two-dimensional nature of this sample, we are able to measure the evolution of these coda waves inside the sample, and investigate their wave properties.

In the multiple scattered regime, after many scattering events, it is predicted in general that the energy of elastic waves is partitioned equally among all the modes of the system, so that the ratio of shear to compressional energies becomes a constant, irrespective of the polarization of the source. We find unexpected values of this energy ratio, which we show to be frequency dependent due to the resonant nature of the scatterers and its impact on the wave transport.

At some frequencies in a range where the average transmission is low, we show the existence of transmission channels that partially open a narrow pathway for the waves. These open channels are observed only a very specific frequencies, and involve an unusual spatial redistribution of wave energy: the energy becomes concentrated in some of the scatterers while their neighbours appear to have no energy at all. This property could be used to create precise filters for elastic waves that have both position and frequency selectivity.

Poster Number: 36

Impact of charge Disorder on Ising Pyrochlores

Presented by: Cole Mauws
PhD Candidate at the University of Manitoba, Chemsitry

Advisor(s): C. Wiebe

Co-Author(s): C. Wiebe

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

The rare earth pyrochlore frustrated magnets of the form $Ln_2B_2O_7$ have been well studied for their exotic magnetic properties. However their penchants for defects can make it hard to resolve magnetic features arising due to intrinsic magnetic coupling as opposed to localized defects. Using the Ln_2ScNbO_7 series of charge disordered pyrochlores we induce large localized distortions to exacerbate this issue and hopefully distinguish between features of geometric frustration as opposed to disorder induced frustration.

Poster Number: 37

Manipulating the Verwey temperature: A story of strain

Presented by: Rachel Nickel
PhD Candidate at the University of Manitoba, Physics and Astronomy

Advisor(s): J. van Lierop

Co-Author(s): Johan van Lierop

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Despite countless studies in the nearly eighty years since Verwey's original work, the full nature of the Verwey transition in magnetite (Fe_3O_4) is still not fully understood. This transition, occurring at ~120 K in bulk Fe_3O_4, is characterized by a structural change from monoclinic to cubic phases coupled with changes in magnetic and electric properties. In recent years, the structure of the low temperature (monoclinic) phase has been resolved and quasiparticles known as trimerons have gained traction as an explanation for charge ordering. While many reports speak to factors decreasing the Verwey temperature, previous studies of strained thin films and single crystals reveal that anisotropic strain can increase the temperature. We have synthesized high aspect ratio Fe_3O_4 nanorods using a two step procedure and confirmed the phase using x-ray diffraction, Mössbauer spectroscopy and x-ray absorption spectroscopy. Using these highly strained nanorods we observe the first evidence of trimerons in nanoscale Fe_3O_4 as well as significant distortion in the low temperature monoclinic phase. Upon warming, the majority of trimerons dissolve at 150 K, while the recovery of the cubic phase occurs between 225 and 240 K —the highest Verwey temperature observed. We propose that the dramatic increase in the Verwey temperature is caused by uniaxial strain within the sample, suggesting that we can modify the Verwey transition in Fe_3O_4 by adjusting intrinsic strain.

Poster Number: 38

A puzzle solved: Finding the magnetism in nanoceria without magnetic cations

Presented by: Vinod Paidi
PhD Candidate at the Univeristy of Manitoba, Department of Physics and Astronomy

Advisor(s): J. van Lierop

Co-Author(s): D. L. Brewe, J. W. Freeland, C. A. Roberts, J. van Lierop

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

The origins of magnetism in nanoscale semiconductor oxide materials with no magnetic cations is an open question. Advances in revealing the physical mechanisms of this unusual magnetism will enable the integration of electron spin and current for spintronic devices in real world applications. Rare earth oxide CeO_2 (ceria) is a prototypical example of a bulk nonmagnetic to nanoscale magnetic system. How nanoceria is ferromagnetic is a challenging question to answer due to the change in local structure and electronic properties at the surface from finite size effects, and the complexities of decoupling the contributions from charge carriers to the magnetism.

We have finally answered the question of how nanoceria is magnetic and the mechanisms that affect its magnetism (via surface decoration with iron ions). X-ray diffraction and structure refinement, inductively coupled plasma mass spectroscopy, Brunauer–Emmett–Teller surface analysis, transmission electron microscopy and tomography identify phase pure nanoceria and its iron ion decoration. Atomic scale sensitive techniques such as x-ray absorption fine structure studies and Mössbauer spectroscopy distinguish the oxidation states and populations of the $Ce^{3+/4+}$ and $Fe^{3+/2+}$ions, and reveal that they are mediated through Ce-O-Fe pathways. Element specific (x-ray magnetic circular dichorism) and bulk magnetization measurements unambiguously identify the origin of magnetism in nanoceria to be from strongly hybridized (covalent) Ce 4f and O 2p valence bands. Additionally, foreign ion decoration of the nanoceria enhances the ferromagnetism at the Ce 4f sites by modulating the Ce 4f to Fe 2p orbital interactions through the O 2p bands, providing insights into how to control the nanoscale magnetism for application.

Poster Number: 39

Strong interaction of Electromagnetic waves and Spins in a feedback coupled cavity

Presented by: Jinwei Rao
MSc Candidate at the University of Manitoba, Physics and Astronomy

Advisor(s): C. M. Hu

Co-Author(s): B.M. Vao, V.S. Gui, S. Kaur, C.-M. Hu

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

The interaction of electromagnetic waves and matter is one of the most intriguing subjects in physics. It is present in so many applications, such as X-ray diffraction, stimulated emission of radiation from atoms, and spin excitation in magnetic materials. The information extracted by electromagnetic waves in these interactions provides a powerful perspective to study the material world, and hence, reveal the physical laws hidden behind the dazzling phenomena. Recently, a thriving field has been emerging, based on the discovery of the cavity mag non polariton (CMP) which is a new kind of quasi-particles arising from the strong interaction between the electromagnetic waves and the spins. Due to its promising applications in quantum information processing and spintronic technologies, this field is attracting increasing attention. In this work, we have designed a novel cavity structure which contains a feedback loop to compensate the energy loss of system, Based on this feedback coupled cavity, we have studied the interaction of electromagnetic waves and spins in a ferromagnetic insulator. From the strong interaction, magnon quintuplet modes were produced, and a concise quantum model has been put forward to describe the experimental observations. Following this work, a DC voltage-controlled feedback cavity has also been fabricated, which allows us to manipulate the magnon quintuplet modes electrically. This well integrated and highly tunable cavity offers us a platform for studying the strong interaction between electromagnetic waves and spins. Therefore, it may open up new avenues for coherent information processing and microwave applications.

Poster Number: 40

Dy_2ScNbO_7: an unconventional spin ice?

Presented by: Megan Rutherford
Undergraduate Student at the University of Winnipeg, Chemistry

Advisor(s): C. Wiebe

Co-Author(s): Megan Rutherford, Cole Mauws, Sarah Haravifard, Casey Marjerrison, Graeme Luke, James Beare, Dave Herbert, Jamie Ritch, Chris Wiebe

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors

Abstract:

Using standard solid state methods, Dy_2ScNbO_7, a member of a new series of pyrochlore oxides was synthesized. While the A-site is occupied by the magnetic Dy^{3+} cation, the B site is split into a mixture of disordered Sc^{3+} and Nb^{5+} cations. It appears that Dy_2ScNbO_7 has low temperature spin ice state that is similar to the titanate analogue, $Dy_2Ti_2O_7$. Despite its similarities, Dy_2ScNbO_7 exhibits much faster spin dynamics than any other dysprosium spin ice candidate. Attempts to grow single crystals of Dy_2ScNbO_7 have been successful using the floating zone image furnace. Recent characterization results will be presented.

Poster Number: 41

Charging surfaces: using electroacoustics to quantify nanoparticle surface potentials

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

Advisor(s): J. van Lierop, J. H. Page, F. Lin

Co-Author(s): J. H. Page, J. van Lierop

Research Area(s): Quantum and Extreme Materials: Discovery Science and Sensors, Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Rational design of nanoparticle system properties (e.g. size, shape, composition) has lead to the realization of biomedical applications. While the efficacy of nanoparticle systems designed for a particular application can often be surmised by a measurement of their desired action (such as bacteria kill rates), these experiments provide only an inference of the design attributes to be optimized. Furthermore, nanoparticle properties are characterized typically under ideal conditions that are not reflected in applications. It is necessary to consider the dynamic charge equilibriation that occurs when nano-surfaces are introduced into complex media containing ions and proteins. This equilibriated charge distribution around a nanoparticle is known as the "protein corona"; the compostion of which is hysteretic - depending on what environments the nanoparticles were exposed to before reaching their final destination.

To understand more completely the dynamics of protein corona formation requires a probe of nanoparticle properties in real-world conditions. Charged particles in suspension will move coherently in an electric field, producing pressure oscillations that depend directly on the nanoparticle surface properties. I have developed a new electroacoustic technique that removes the restrictions on suspending media and allows direct measurements of surface properties in application conditions. Electroacoustic results are presented for various nanoparticle systems in different media conditions, providing new insights into the physical mechanisms behind surface charge distribution in complex media.

Poster Number: 42

A critical review of pressure variation at different anatomical sites for the burn patients using pressure garments

Presented by: Hrishekesh Banik
MSc Candidate at the University of Manitoba, Biosystems Engineering

Advisor(s): M. Rahman

Co-Author(s): Mashiur Rahman

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

In the United States, approximately 1250000 people are injured by burn annually where most of the patients have a common problem of hypertrophic scars in their body. These hypertrophic scars are minimized by using the pressure garments. The patients with the burn injury have uneven body surface due to the structural variation of bony prominence and joints. Due to this anatomical variation, pressure garments which provide only static pressure on the burn-injured area are unable to provide the full range of motion (ROM) of joints. The bony prominence of joints and soft tissues attributed dissimilar counts dynamic pressure in terms of subcutaneous pressure. By using pressure garments the pressure is increased from 9 to 33 mmHg at the soft tissue areas that usually have lower pressure. Whereas, for bony prominence areas where the pressure is high, these pressure garments raise the pressure from 47 to 90 mmHg. Hence, Pressure produces more at bony prominence rather than soft tissue due to the contribution of body dynamic pressure that exerted by the edge of certain prominence and joints. During the review for this research, it was found that for textiles to provide better dynamic pressure the structure must be improved. These structures and variables are fabric type, yarn differentiation during transformation and differentiation in yarn/fibre linear density. Further, these hypertrophic scars may be treated by adding non-woven pressure pads within a compound textile structure, frequent change in pads and by standardizing the textile pad pressure for multiple stages of burn healing.

Poster Number: 43

Engineering Rechargeable Antimicrobial Coatings on Steel for Efficient Inactivation of Pathogenic Bacteria in the Presence of Organic Matter

Presented by: Mohammad Kazemian
MSc Candidate at the University of Manitoba, Biomedical Engineering Program

Advisor(s): S. Liu

Co-Author(s): S. Liu

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Since millions of people are affected by foodborne illnesses, food safety has become an important issue in the world. Stainless steel is widely used in the food industry so it is pivotal to endow stainless steel with potent rechargeable antibacterial function. In this study, stainless steel samples first went through silanization as a pre-coting step. UV curing was used to form poly (N-(2-methylbut-3-yn-2-yl) acrylamide) (polyMBAA) on the steel-silane samples. The resultant polymer was then engaged in click reaction with various antimicrobial agents such as N-chloramine and quaternized N-chloramine. Functionalized stainless steel samples then were tested against *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*) in phosphate-buffered saline (PBS) and in 5% tryptone soya broth (high protein medium (HPM)). Results reveal that quaternized N-chloramine is the most effective sample against bacteria in HPM and PBS. The antibacterial samples are also rechargeable. They could maintain their antibacterial activity and show even higher biocidal activity after five times of dechlorination and chlorination.

Poster Number: 44

Microwave Sensing Based Portable Insect Detection System

Presented by: Mun Kim
Undergraduate Student at the University of Manitoba, Physics and Astronomy

Advisor(s): C. M. Hu

Co-Author(s): Alex Reimer, Jinwei Rao, Yongsheng Gui, Can-Ming Hu

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Insect species may cause significant damage to stored grain products. The larvae of insect pests, live entirely within the kernel, where they feed unseen and usually unsuspected. They cannot be detected by ordinary inspection machinery and must be controlled by other means. Microwave sensing uses spectral characterization of a resonator to make high sensitivity measurements in scientific and industrial fields. This work demonstrates the feasibility of a portable insect detection device based on resonator sensor operating in microwave regime, with the assistance of a primitive statistical model to interpret resonance frequency patterns recorded by the portable device. Sensing principle is based on the change of resonance frequency in response to movements of insects(dielectric material) placed inside detection field of a resonator. The frequency contents of resonator were processed through cascaded electronic systems that perform frequency mixing, amplification and analog to digital conversion. Activity levels are then quantified regarding the difference between the maximum and minimum resonance frequencies recorded during a measurement interval. With the help of database constructed based on previously gathered measurements, the status of infection can be determined. Our portable device provides a promising approach for the application of microwave sensor in insect detection, with the potential to be used in various areas, such as smoke detection and material characterization. Further work needs to study the relation between detection efficiency for an even larger database as well as detection interval. Also its integration with complex field environment to address the practical challenges and to improve the overall performance of the device.

Poster Number: 45

Bacterial responsive release of potent biocide from core-shell PHA/PES nanofiber

Presented by: Wei Li
MSc Candidate at the University of Manitoba, Biosystems Engineering

Advisor(s): S. Liu, N Cicek, D. Levin

Co-Author(s): Nazim Cicek, David B. Levin, Song Liu

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Most people, at some stage in their life, have experienced a wound. In many cases, the microbial population at wound sites remains at a low-level, and there is no need for treatment, but as the microbial population continues to expand to the point bacterial burden outweighs host immune clearance, a clinical intervention is necessary. Functionalized wound dressings with incorporation of antimicrobial agents can play an active role in the wound healing process by treating infection. However, anti-bacterial treatment of wounds raises concerns, such as antibiotic resistance and unwanted harm to skin cells. Herein, we report a new approach to realize responsive release of antimicrobial agents to the sites of bacterial infections from core-shell consisting of polyhydroxyalkanoate/polyethylene succinate (PHA/PES) nanofibers prepared by coaxial electrospinning. The hydrophobic PHA/PES shell can effectively prevent the antimicrobial agent from undesirable payload release in physiological environments without pathogens. However, in the presence of pathogens, the PHA/PES shell could be degraded by bacterial lipase, and the encapsulated biocide could be released. The released drug subsequently could impose targeted antimicrobial effects on the bacteria. Core-shell PHA/PES nanofibers incorporated with antimicrobial agent showed superior antibacterial performance. We fabricated core-shell nanofibers which could be bacterial responsive and provide on-demand antimicrobial release. More controllable release for core-shell nanofibers than single nanofibers could provide an efficient and prolonged antimicrobial efficacy. These superior properties make PHA/PES coaxial electrospun mat potential candidate to tackle wound infections.

Poster Number: 46

Iron-oxide Nanodiscs for Targeted Drug Delivery and Antimicrobial Studies

Presented by: Palash Kumar Manna
Postdoctoral Fellow at the University of Manitoba, Physics and Astronomy

Advisor(s): J. van Lierop

Co-Author(s): R. Nickel, Y. Wroczynskyj, V. Yathindranath, J. Li, S. Liu, D. W. Miller, J. van Lierop

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Magnetite (Fe_3O_4) nanoparticles coated with a suitable biocompatible material can have various applications as in targeted drug delivery, hyperthermia, and topical biocide application and removal. The innate biocompatibility of Fe_3O_4 (also approved by the FDA) makes it the most sought-after candidate for such purposes. The morphology, aspect ratio and orientation of the nanoparticles influence their interaction with biological systems. Our previous results suggest that non-spherical nanoparticles have an improved cellar uptake profile compared to spheres. However, synthesis of non-spherical nanoparticles often involves multiple reagents, several steps and a highly controlled environment.

We have found a new way of synthesizing Fe_3O_4 nanodiscs in gram-scale quantities using just a single source of iron (iron(II) chloride) and an amine (triethylamine), and it does not involve (i) multiple steps and reagents, (iii) an elevated temperature, and (iv) a controlled environment. The amine not only transforms iron salt to Fe_3O_4, but also functionalizes the nanoparticles, making the synthesis very economical. By modifying the surface further, these nanoparticles promise to offer useful biomedical applications. For example, after biocide coating, the particles are found to be 100% effective in deactivating methicillin-resistant *Staphylococcus aureus* (MRSA) bacteria in 2 hrs. Cellular-uptake studies using biocompatible EDTA–Na_3 (N-(trimethoxysilyl-propyl)ethylenediaminetriacetate, trisodium salt)-coated nanoparticles in cancerous type human glioblastoma U-251 cells show that the majority of the particles are internalized by the cells in the presence of a small dc-magnetic field, making these particles a potential candidate as drug carriers for magnetic field-targeted delivery and hyperthermia.

Poster Number: 47

Experimentation and Analysis of Higly Flexible Pressure Dependent and Conductive Polydimethylsiloxane Hydrogels for Bio-Sensors

Presented by: Fariha Tasnim
Undergraduate Student at the University of Manitoba, Mechanical & Biosystems Engineering

Advisor(s): M. Xing

Co-Author(s): M. Xing

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Bio-sensors are wearable devices which incorporate flexibility, sensitivity and conductivity to monitor and display body signals. With the incompatibility between solid substrates and soft human features, gel-like substrates are becoming the preferred fabrication material for bio-sensors, although the field of research is narrow. One such substrate is the non-water-soluble Polydimethylsiloxane Hydrogel. The objective of this undergraduate thesis was to determine the capacity to which Polydimethylsiloxane Hydrogel can be utilized in the fabrication of bio-sensors. Rigorous synthesis and assessments to analyze the properties of the gel obtained two viable candidates, a conductive Polydimethylsiloxane Hydrogel with a 1:1 and a 1:4 salt ratio. It was shown that these gels have high conductivity, while maintaining structural integrity. The findings of this undergraduate thesis provide viable data in a lacking field of research.

Poster Number: 48

Low energy charge-transfer of Bis(4-Phenanthridinylamido) Metal Complexes

Presented by: Jason Braun
MSc Candidate at the University of Manitoba, Chemistry

Advisor(s): D. Herbert

Co-Author(s): Issiah Lozada, David Herbert, Rebecca Davis

Research Area(s): Energy Harnessing and Storage

Abstract:

$\{[5,5]\text{-NNN}\}^-$ pincer-type ligands containing phenanthridine (3,4-benzoquinoline) moieties represent π-extended analogs of bis(quinolinyl)amines, allowing for the delineation of the impact of site-specific benzannulation on the structural, electrochemical and photophysical properties of pseudo-octahedral complexes of metals (e.g Fe, Co, Ni, Zn, Ga) with multidentate, polypyridyl amido ligands. The derivatizable nature of the ligand framework enabled preparation of complexes with electron-donating or electron-withdrawing substituents that show enhanced solubility, more reversible electrochemistry, and modified photophysical properties compared to bis(quinolinyl)amine analogs. The highly reversible solution electrochemistry enabled isolation of pairs of redox-related complexes and observation of an extended series of electron transfer complexes by spectroelectrochemistry. The redox-events observed have significant ligand character resulting in a mixed-valent compound that exhibits intervalence charge transfer bands in the NIR spectra that indicate significant electronic communication across a metal bridge. The full characterization of these complexes via X-ray crystallography, DFT calculations, and NMR, EPR and absorption spectroscopy reveal that low energy charge-transfer bands arise from the combination of vacant phenanthridine-based π^* orbitals and a strong ligand field. The reversible electrochemistry may enable the use of these complexes for energy storage in the form of redox flow batteries.

Poster Number: 49

Platinum(II) complexes of -extended phenanthridine-based N^N^O ligands

Presented by: Issiah Lozadaib
MSc Candidate at the University of Manitoba, Chemistry

Advisor(s): D.E. Herbert

Co-Author(s): Huang Bin, Ravina Moirangthem, Jason Braun, David E. Herbert

Research Area(s): Energy Harnessing and Storage

Abstract:

Despite its relatively low abundance in the Earth's crust and, consequently, its high cost, emissive complexes based on platinum are still well sought after, as Pt(II) complexes can be used to form efficient materials for triplet harvesting.1 Different strategies have been employed to improved on molecular phosphorescence from Pt emitters, including attempts to improve quantum efficiencies by employing rigid chelating ligands containing strong s-donor and p-acceptor atoms, and tuning charge-transfer state energies via ancillary ligand substitution.2 As part of our investigations into the chemistry of p-extended N-heterocyclic ligands, we have prepared a series of tri-dentate, monoanionic N^N^O phenanthridine-based ligands (phenanthridine = 3,4-benzoquinoline) and their corresponding [Pt(N^N^O)X] complexes. Ancillary ligand modification was also employed to investigate its impact on the electronic structure the charge transfer states. Photophysical properties (absorption and emission) of the different ligands and complexes have been investigated, together with solvation effects. The impact of site-selective benzannulation and ancillary ligand identify on the electronic structures of these complexes were carried out with DFT and TDDFT.

Poster Number: 50

Controlling vapour-liquid-solid growth of copper-seeded silicon microwire arrays for solar fuel generation

Presented by: Sridhar Majety
MSc Candidate at the University of Manitoba, Electrical and Computer Engineering

Advisor(s): D.R. Oliver

Co-Author(s): Alex Ogaranko, D.R. Oliver

Research Area(s): Energy Harnessing and Storage

Abstract:

Silicon microwires fabricated using bottom-up vapor-liquid-solid process are critical component for solar fuels generation. The influence of $SiCl_4$ flow rate (10, 5, 3, 1 sccm) on the growth rate, doping, resistivity and morphology of microwires has been investigated. The growth rate variations were in agreement with the observations of Shepherd *et al.*, ranging from 8.14 µm/min at 10 sccm to 0.17 µm/min at 1 sccm. The growth rate, microwire resistivity and doping concentrations were also studied by changing the dopant flow rates: PH_3 (22, 15, 10, 5, 1, 0.1 sccm) and BCl_3 (22, 15, 10, 1 sccm). Electrical, two-point probe measurements, using a direct-contact technique involving tungsten probes controlled by piezo actuated micromanipulators, formed ohmic contacts with the microwires. The unintentional doping caused by the copper catalyst (.1016 cm^{-3}) limits the accessible doping range in both p-type and n-type microwires. When the effect of copper doping is negligible (doping of the orders 1018-1020 cm^{-3}), both p-type and n-type doping concentrations showed similar variation with volume fraction. Scanning electron microscopy was used to study the sidewall facet morphology of the microwires. It was verified that the sidewall morphology changes when the flow rate of $SiCl_4$ is changed during growth. The microwires had 12 facets at high flowrates of $SiCl_4$ and 6 facets at low flowrates of $SiCl_4$. The number of facets also depended on the concentration of dopant gas in the chamber. Donor atoms block sites for sidewall deposition and acceptor atoms enhance the sidewall deposition.

Poster Number: 51

Pi-Extended Phenanthridine-Containing P^N Ligands and Their Transition Metal Complexes

Presented by: Rajarshi Mondal
PhD Candidate at the University of Manitoba, Chemistry

Advisor(s): Dr. Herbert

Co-Author(s): Issiah Byen Lozada, Rebecca L. Davis, J. A. Gareth Williams and David E. Herbert

Research Area(s): Energy Harnessing and Storage

Abstract:

Our work involves inquiring into the coordination chemistry of multi-dentate, Pi-extended N-heterocycle/phosphine ligands (P^N) with transition metals such as Cu, Fe and Ru and investigating the properties of their complexes. The synthesis of different P^N ligand derivatives, along with halide bridge Cu_2X_2 dimers and bis$(P^N)_2$Cu(I) cations stabilized by hexafluorophosphate or tetraphenylborate counter ions will be presented, along with their absorption and emission properties in the solid and solution state. Having anticipated that the tricyclic fused ring system of phenanthridine (3,4-benzoquinoline) would lead to red-shifted absorption and emission, we were surprised to find that site-selective benzannulation led to an as-predicted red-shift in the lowest energy absorption, but a unexpected blue shift in the emission maximum. These findings and a theoretical framework for interpreting these "counter-intuitive" results will be presented. These complexes are highly anticipated to apply in the OLED field. Coordination properties of these P^N ligands with Fe and Ru complexes will also be discussed.

Poster Number: 52

A Green Method for the Electrohydrogenation of Benzannulated Pyridines

Presented by: Dion Nemez
MSc Candidate at the University of Manitoba, Chemistry

Advisor(s): D. Herbert

Co-Author(s): P. K. Giesbrecht, D. E. Herbert

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

Compounds that are analogous to the reducing agent NADH present interesting opportunities in organic synthesis, making the (re)generation of such biomimetic organohydrides a topic of significant study. Phenanthridine is a twice benzannulated pyridine whose reduced form, 1,2-dihyrophenanthridine (DHP), has been shown to be useful in the enantioselective hydrogenation of C=N and C=O bonds when paired with a chiral Brønsted acid.[1]

In this presentation a method for renewable electrochemical hydrogentation of phenthridine to 1,2-dihydrophenathridine using weakly acidic conditions will be discussed. [2] Additionally, I will touch on the use of electrochemically generated DHPs use in transfer hydrogenation reactions.

[1] (a) Chen, Q.-A.; Gao, K.; Duan, Y.; Ye, Z.-S.; Shi, L.; Yang, Y.; Zhou, Y.-G. J. Am. Chem. Soc. 2012, 134, 2442; (b) Lu, L.-Q.; Li, Y.; Junge, K.; Beller, M. Angew. Chem., Int. Ed. 2013, 52, 8382.

[2] [P.K. Giesbrecht, D.B. Nemez, D.E. Herbert Chem. Comm. 2018, 54, 338

Poster Number: 53

SHArK North: Investigation of Iron-Based Metal Oxides as Water Oxidation Catalysts

Presented by: Renmar Palma
Student at Daniel McIntyre Collegiate Institute, Winnipeg School Division

Advisor(s): E. Kozoriz, D. Herbert

Co-Author(s): Nicolas Pausing, Symon Kurt San Jose

Research Area(s): Materials that Mimic Biology and/or Support Natural Systems Under Environmental Stress

Abstract:

There is no denying that the global population will continue to rise, with current estimates of 9.7 billion by 2050.1 It is inevitable that the demand on energy consumption will also increase, and with a consumer-driven society, environmental and energy concerns have been raised. Cleaner alternative sources of energy must be sought after to meet these demands without adding to the problem. In this regard, hydrogen has been widely considered as a potential alternative and cleaner source of energy as the by-product of hydrogen combustion is water. Hydrogen gas can be generated through the photo-electrolytic splitting of water. The aim of this research is to find combinations of metal oxides that are photoactive and stable in an electrolyte solution. Based on the previous findings of SHArK, iron containing oxides seem to have good photocurrent results. Further examination of various metal oxides is conducted.

(1) World Population Prospects; United Nations, 2015