



**2015
GRADUATE RESEARCH SYMPOSIUM
PROGRAM**

New Frontiers in Process Engineering and Applied Science

DEPARTMENT OF PROCESS ENGINEERING & APPLIED SCIENCE

DALHOUSIE UNIVERSITY

HALIFAX, NOVA SCOTIA

**Dr. Mark Gibson
Graduate Programs Coordinator**

**Paula McKenna
Graduate Secretary**

**William Judge
MAsc Materials Engineering**

April 29, 2015

**DEPARTMENT OF PROCESS ENGINEERING AND APPLIED SCIENCE
GRADUATE PROGRAMS**

Biological Engineering

Chemical Engineering

Food Science and Technology

Materials Engineering

PROGRAM
Wednesday, April 29, 2015

- 8:00 am** ***Registration & Poster Mounting (Sculpture Court, Dalhousie Arts Centre)***
Paula McKenna, Secretary
Department of Process Engineering and Applied Science.
- 8:45 am** ***Introduction and Welcome (Kenneth C. Rowe 1020)***
Chair – Dr. Mark Gibson, Graduate Coordinator
Department of Process Engineering and Applied Science
- 9:00 am** ***Poster Slide Presentations (Kenneth C. Rowe 1007, 1014, 1016)***
Chair – Will Judge
- 10:30am** ***Morning Break (Sculpture Court, Dalhousie Arts Centre)***
- 11:00 am** ***'When the going gets tough, the tough want cash flow' The historical context of current problems confronting the mining industries***

Dr. Roger Burt - *Lecturer, Professor, Academic Historian (Kenneth C. Rowe 1020)*
- 12:00 pm** ***Lunch and Poster Judging (Sculpture Court, Dalhousie Arts Centre). Lunch is provided by the Department. Poster presenters will be next to their poster for judging during the lunch break.***
- 1:00 pm** ***"Photons, phytoplankton and climate: Using ocean optical technologies to understand a changing ocean"***

Dr. Susanne Craig – *Sr. Research Scientist, Professor (Kenneth C. Rowe 1020)*
- 2:00 pm** ***Oral Presentations (Kenneth C. Rowe 1007, 1014, 1016)***
- 4:00 pm** ***Award Presentation and closing remarks (Kenneth C. Row 1020)***

KEYNOTE SPEAKERS

Dr. Roger Burt - Lecturer, Professor, Academic Historian



Born 1942 and educated at Wandsworth Comprehensive School and the London School of Economics, BSc(Econ) PhD. Lecturer/Senior Lecturer/Professor at the University of Exeter 1966 to 2006. Entire career spent researching the history of non-ferrous metals in Britain and other world mining districts, together with a later interest in fraternal history. Academic historian and consultant to industry, government and environmental/heritage groups. Visiting

lecturer at Lund University, Sweden: Keio University, Tokyo, Japan: The University of Alberta, Canada. Elected Fellow of the Royal Historical Society, the Geological Society, and the Institution of Mining and Metallurgy

A sample of some recent articles include:

1. **'Diamond Core Drills: Their Invention, Early Development and Consequences for Mining and Quarrying' Published in the *Mining History Journal* Vol. 21 (2014)**
2. **'Diamond Core Drills' - Illustrations**
3. **'Strategic Technological Change in the Metallurgical and Mining Industries during the Eighteenth and Nineteenth Centuries: The Cases of Copper, Zinc, and Manganese' Published in *Revista de Historia Internacional* ISTAR Vol XIV No.56 (2014)**

All of these and more can be found on Dr. Burt's website:

<http://rburt7.wix.com/rogerburt>



Dr. Susanne Craig

Senior Research Scientist
Professor

Dr. Susanne Craig is a Senior Research Scientist in the CERC.OCEAN Unit, Oceanography Department and an Adjunct Professor in Process Engineering and Applied Science at Dalhousie University. Trained as a physicist, her research focuses on the use of optical measurements to understand fundamental ecological processes in the ocean.

Originally from Scotland, Dr. Craig has conducted her research in a number of ocean science institutes including the University of Strathclyde, UK, University of Southern Mississippi at the NASA Stennis Space Center, Bedford Institute of Oceanography, and Dalhousie University. Her current and past research includes studies of harmful algal blooms, the role of phytoplankton in the uptake of atmospheric CO₂, the production of climate-relevant trace reactive gases by phytoplankton, and the development of satellite ocean colour algorithms for optically complex coastal and inland waters.

Most recently, Dr. Craig was selected as the only non-US member of the Science Team for the new NASA PACE satellite mission, which will measure global ocean colour to investigate the response of the ocean to a changing climate

2015 Poster – Short Slide Presentations:

Room 1007

Development of Monitoring & Control Systems of Amine Neutralization in Potash Processing

Mohammad Hussein, MAsC Chemical Engineering

A Conductivity-Based Measurement Device To Determine The Volume Fraction, and Gas Slip Velocity for Different Fluids

Mazin Saied, MAsC Chemical Engineering

Crystallization of Paraffin Wax Under Shear Flow

Yijin Su, MAsC Chemical Engineering

Simultaneous Product Extraction Of High Value Products From Tetraselmis Suecica

Zoë Grabowski, MAsC Chemical Engineering

Northern New Brunswick Air Quality Health Index Evaluation Study

Alan Wilson, MAsC Biological Engineering

The Source Apportionment of Biogenic Marine Emissions of Reactive Trace Gases to the Lower Troposphere Over the Scotian Shelf, Sable Island

Haya Qadoumi, MAsC Biological Engineering

Room 1014

Application of the Root Zone Water Quality Model (RZWQM) to Stimulate Fate and Transport of Emerging Substances of Concern in Soils Receiving Long-term Biosolids Application

Weixi Shu, PhD Biological Engineering

Evaluation of Microalgae Harvesting Methods for Industrial Production of Biodiesel

Mariam Al Hattab, PhD Biological Engineering

Crystallization of Tristearin From a Dodecane Solution Under Shear Flow

Tianguang Jia, MSc Food Science and Technology

Characterizing Sources of Fecal Pollution and Human Health Risk at Urban Public Beaches in the Halifax Regional Municipality

Michael McDonald, MSc Food Science and Technology

Role of Osomolytes in the Desiccation Survival of Listeria Monocytogenes

Amit Ross, MSc Food Science and Technology

Room 1016

Powder Metallurgy Processing of Aerospace Grade Aluminum 7055

Neal Kraus, MASc Materials Engineering

Preliminary Investigations of Liquid Phase Sintering of MAR-M247 Superalloy Using DSC and Dilatometry

Addison Rayner, MASc Materials Engineering

Asymmetric Rolling of Aluminum Alloy 6061

Mark Yao Amegdazie, PhD Materials Engineering

Construction of Erosion Mechanism Map

Tahrim Alam, MASc Materials Engineering

Spark Plasma Sintering of Aluminum 2219

Joseph McNeil, MASc Materials Engineering

Development of a Boron Free Brazing System Using a Ni-Cu-Mn Filler Metal

Taylor McLellan, MASc Materials Engineering

2:00 p.m. *Oral Presentation – Session I (Room 1007)*

Introduction

2:00 p.m. *An Experimental Study of the Influence of Porous Media on the Rate of Hydrate Formation*

Najlla Ali, MASc Chemical Engineering

2:20 p.m. *Development of a High-Rate Microbubble-Aerated Bioreactor*

Albahlool Omar Idhbeaa, PhD Chemical Engineering

2:40 p.m. *Numerical Investigation of Underwater Sour Gas Well Blowouts*

Devin O'Malley, PhD Chemical Engineering

3:00 p.m. *Lithium-Rich Core-Shell Cathodes with Low-Irreversible Capacity and Mitigated Voltage Fade for Lithium Ion Batteries*

Jing Li, PhD Chemical Engineering

3:20 p.m. *Use of Antimicrobial Compounds for the Removal of Biofilms Formed by *Listeria Monocytogenes*, *Staphylococcus Aureus*, *Salmonella Enterica Serovar**

Celine d'Entremont, MSc Food Science and Technology

2:00 p.m. Oral Presentation – Session II (Room 1014)

Introduction

- 2:00 p.m.** *Value-Added Processing of Food Wastes in Canada*
Jonathan Rolin, MSc Food Science and Technology
- 2:20 p.m.** *Textural Softening of Artic Surf Clams (*Macruomeris Polymyna*)*
David Bent, MSc Food Science and Technology
- 2:40 p.m.** *A ¹H NMR-Based Technique to Determine Epoxide Yield in Oxidized Oil*
Wei Xia, PhD Food Science and Technology
- 3:00 p.m.** *3-Oh Oxylipins in the SMA Strain of *Saccharomyces Pastorianus**
Greg Potter, PhD Food Science and Technology
- 3:20 p.m.** *Influence of Blended Elemental and Prealloyed Aluminum Additions of the Sintering Behaviour of Titanium Alloys*
Joannie Lapointe, MASc Materials Engineering

2:00 p.m. Oral Presentation – Session III (Room 1016)

Introduction

2:00 p.m. *Regional Challenges and Opportunities for Agricultural Biomass in Nova Scotia*

Allan Thomson, PhD Biological Engineering

2:20 p.m. *Optimization of the Microencapsulation of Anthocyanins from Haskap Berries (Lonicera Caerulea L.) In Ca-Alginate Beads for Oral Delivery*

Giovana B. Celli, PhD Biological Engineering

2:40 p.m. *In-Situ Thermal Diffusivity Analysis During Powder Metallurgy Processing of Titanium and Titanium Alloys*

Eric Moreau, PhD Materials Engineering

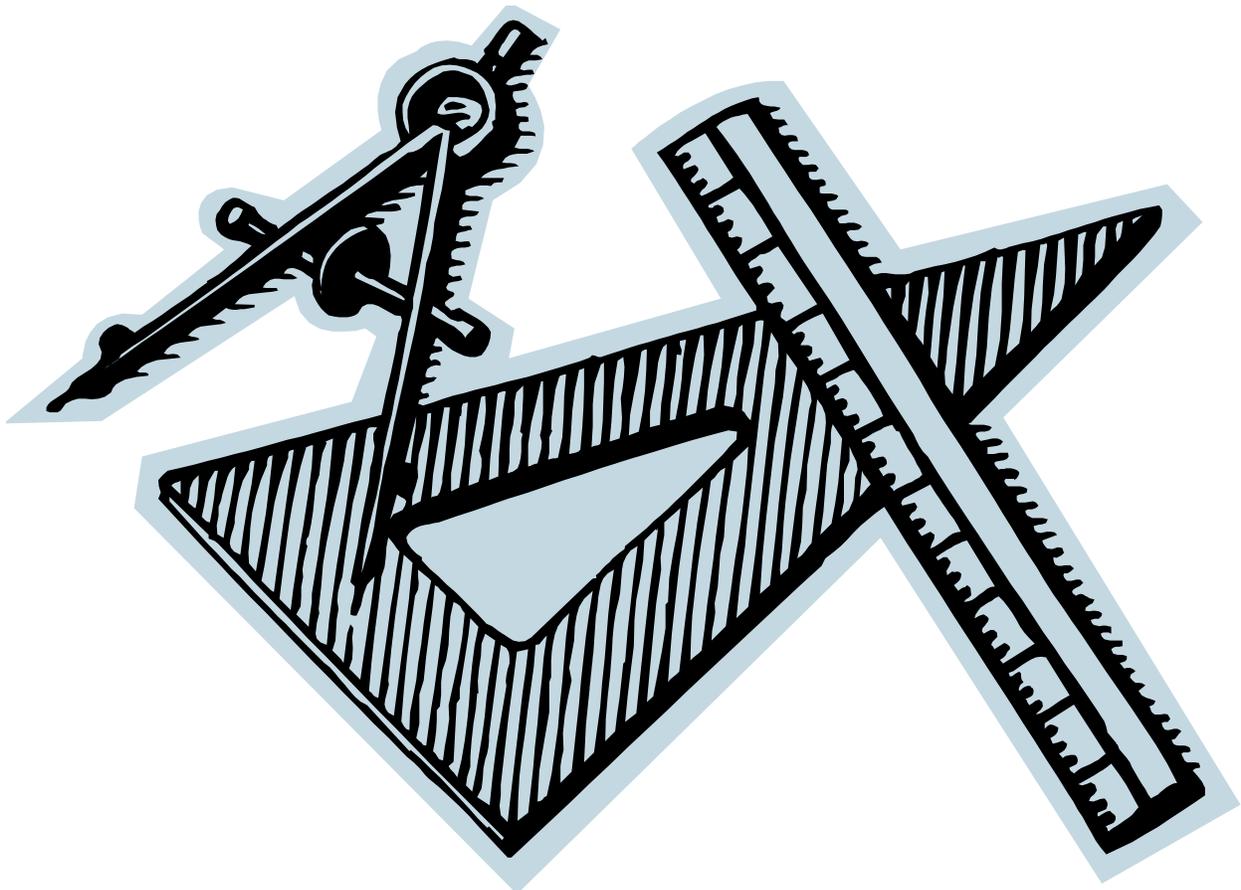
3:00 p.m. *Titanium Brazing and Filler Metal Selection*

Colin Taddell, PhD Materials Engineering

3:20 p.m. *Aluminum Metal-Matrix-Composites Produced Using a Powdered Metal Approach*

Greg Sweet, PhD Materials Engineering

**2015 Abstract Submissions of Biological,
Chemical, Materials Engineering and
Food Science & Technology
Graduate Students**



Development of Monitoring & Control Systems of Amine Neutralization in Potash Processing

Mohammad Hussein
Dr. Adam Donaldson
Chemical Engineering
Masters in Applied Science

ABSTRACT

Fatty amines have been used as binding molecules to remove KCl from slurry feeds as part of a flotation process. The amines are used as binding agents that bind to KCl molecules and remove them from the solution. The amine molecules are initially activated, and turned into cationic molecules, through a neutralization reaction with HCl. The amine initially is heated up and melted to the solutions' temperature, 50-70° C. The amine is then added to the solution, while HCl is added soon afterwards. Several issues arise due to the titration-based monitoring technique employed in lab settings. This technique employs pH as a way to determine the degree of neutralization. However, the amine molecule acts as a buffering agent that mitigates the pH response as well as it provides a poor correlation between the pH and degree of neutralization. Therefore, the purpose of this project is to design a continuous control system of the neutralization process between the fatty amines and HCl. The control system will involve spectrophotometric instruments such as UV/Vis or FT-NIR. These instruments will be utilized to measure the absorbance and the wavelengths of certain active ingredients.

The proposed continuous process involves a heated water vessel that is connected to two syringe pumps. The two syringe pumps are equipped with heated syringes that are used to inject the fatty amines followed by HCl. The product is then passed to a flow-through cell that is connected to either UV/vis or FT-NIR in order to measure the absorbance and the corresponding wavelength of the active sites within the molecules. Previous studies confirmed the use of UV/Vis and FT-NIR to monitor both the amine content and the degree of neutralization.

A CONDUCTIVITY-BASED MEASUREMENT DEVICE TO DETERMINE THE VOLUME FRACTION AND GAS SLIP VELOCITY FOR DIFFERENT FLUIDS

Mazin Saied
Supervisor: Adam Donaldson
Chemical Engineering
MASc

ABSTRACT

Multiphase flow metering is needed in the oil and gas industry for well monitoring gas Fraction, oil cut, water cut and tracking of solid content. In addition, multiphase flow metering has been extended farther to deal with some science studies and applications such as nuclear reactors. This project is involving with the performance and measurement uncertainty of wire-mesh sensors in different air-water flow regimes in horizontal pipes. It also presents measurements of volume fraction and calculates both an interfacial velocity and pressure drop of two phase's gas-liquid flows. Moreover, the model setup is similar to traditional wire-mesh sensors for larger multiphase flow cross sections with parallel wires. These wires are working as electrodes extended across the flow channel in two adjacent planes and with perpendicular wire orientation between planes. Conductivity measurement is performed by special electronics which consecutively applies bipolar voltage pulse excitation to the transmitter wires and measures electrical current flow in the wire crossings at the receiver wire. High speed photographic camera is used to measure the velocity of two-phase flow which then can be compared the data with wire-mesh sensor data calculation.

CRYSTALLIZATION OF PARAFFIN WAX UNDER SHEAR FLOW

Yijin Su
Gianfranco Mazzanti
Chemical Engineering
M.Sc

ABSTRACT

Crystallization of paraffin wax due to cooling increases the pressure drop along pipes in hydrocarbon transport lines.

In this work, an optical shear cell (CSS 450) and a polarized light microscope (Olympus-BX50) are used to observe the crystallization under shear flow of paraffin wax from a dodecane model solution. Three kinds of paraffin wax which have different melting point are used (mp are 53-57 °C, 58-62 °C and =65 °C respectively).

The crystallization temperature and composition are related in theory by the Hildebrand equation, if the enthalpy is known. Differential Scanning Calorimetry (DSC) is used to get the wax's enthalpy.

Samples of 20% (w/w) wax are heated in the shear cell above their clear point and kept for 10 minutes at the shear rate under study (0, 8 or 800 s⁻¹). They are then cooled at 5 °C/min to the crystallization temperature under study. The images taken from microscope and the Hildebrand predictions for the wax solution can be compared with each other to evaluate the deviation from Hildebrand's predictive equation.

SIMULTANEOUS PRODUCT EXTRACTION OF HIGH VALUE PRODUCTS FROM TETRASELMIS SUECICA

Zoë Grabowski
Azadeh Kermanshahi-pour
Chemical Engineering
M.ASc.

ABSTRACT

To improve the economics of production of chemicals from microalgae, it is desirable to enhance the use of microalgal biomass via derivation of multiple products simultaneously. *Tetraselmis suecica* offers great potential for this work given that it has existing commercial applications as aquaculture feed due to its high protein quality. Additionally, the cell wall of *T. suecica* contains KDO (3-deoxy-D-manno-oct-2-ulosonic acid), a sugar of pharmaceutical value. *T. suecica* is capable of growth using various carbon sources, which offers additional benefits for production of value-added chemicals. The objective of the present research is to develop an understanding on the effect of the nitrate concentration and type of carbon source on accumulation of KDO in the cell wall, eventually leading to the development of a KDO extraction process.

NORTHERN NEW BRUNSWICK AQHI EVALUATION STUDY

Alan Wilson
Dr. Mark Gibson
Biological Engineering
M.A.Sc.

ABSTRACT

A. Wilson¹, D. Waugh¹, S. Beauchamp¹, L. Chisholm¹, M. Gibson², P. Lehr¹, R. Savoie³

The Campbellton, New Brunswick AQHI measurement site was established in September 2012 in order to evaluate the GEM-MACH AQHI forecasts in a rural area. This study is in support of the expansion of Environment Canada's air quality forecast program from its current focus on Canadian urban centres to providing regional forecasts of the AQHI and to evaluate the efficacy of model based AQHI forecasts in rural landscape setting with relatively low concentrations of pollutants. Monitoring was conducted with high-temporal resolution instrumentation for the AQHI constituents (NO₂, O₃, and PM_{2.5}), NO, NO_x, and CO, as well as meteorological conditions at the monitoring site. Data available for the period of mid-September 2012 to end February 2014 were 97% complete (N= ~10000). The GEM-MACH air quality forecast model and observed AQHI values were within ± 1 of the observed AQHI 97% of the time. The observed concentrations of AQHI constituent species are considered to be generally low ambient concentrations. However, the site is inhomogeneous with respect to local emission influences, including motor transport and local heating. Data analysis shows probable local and other effects leading to divergence of model and observed values. Major suspected causes of observed-model AQHI divergence were winter/nighttime pollutant build-up in stable PBL regimes, forest fire smoke (not in the operational model) and several springtime incidences of ozone exceeding modeled values by more than 20 ppbv of unknown cause. There was generally good agreement between modeled and observed constituent values for long-range transport (LRT) of anthropogenic emissions from the St. Lawrence and Ohio valleys.

Affiliations:

- 1. Environment Canada, MSC Atlantic Region*
- 2. Dalhousie University*
- 3. Community College of New Brunswick*

The source apportionment of biogenic marine emissions of reactive trace gases to the lower troposphere over the Scotian Shelf, Sable Island

Haya Qadoumi
Dr. Mark Gibson
MA Sc Biological Engineering

ABSTRACT

The study focuses on identifying and apportioning biogenic marine emissions of trace gases to the lower troposphere over the Scotian Shelf, Sable Island. Understanding the primary pollution sources and their impacts is necessary for pollution reduction which, otherwise, can have tremendous effects on climate forcing, ecosystems, health and the perturbation of stratospheric ozone formation and loss. The main objective is identifying biogenic marine emissions and their contribution to atmospheric chemistry using in situ air sampling techniques, and the USEPA Positive Matrix Factorization (PMF) source apportionment receptor modelling and Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) modeling. The PMF modelling will be augmented by satellite remote sensing of surface air quality data and air mass back trajectory modelling. Visual images from the Aqua and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) will be used for visual identification of upwind sources of air pollution, i.e. phytoplankton blooms on the Scotian Shelf, wild fire smoke, and continental smog outflow from the North American continent.

The thesis will be conducted using existing state of the art air pollution instruments including an on-line Thermo air server-thermal desorption-gas chromatograph-mass spectrometer (TD-GC-MS) for the determination of 100+ volatile organic compounds (VOCs), total VOC-analyzer, black carbon analyzer, two size-resolved particle counters 10 nm-20 microns particles in 32 size bins (DYLOS and UPM 3031), multi-tube sequential sampler (MTS-32), and an aerodynamic particle sizer (APS 3321). Other air metrics that will be measured include black carbon, nitrogen oxides (NO_x), sulphur dioxide (SO₂), hydrogen sulphide (H₂S), ozone (O₃), fine particulate matter with a median aerodynamic diameter that is less than 2.5 microns (PM_{2.5}), carbon dioxide (CO₂) and methane (CH₄). Fingerprints for VOC species emitted by phytoplankton will also be developed and used to help understand pollution sources and their impacts on the environment as well as allow for development of pollution reduction policies.

Application of the Root Zone Water Quality Model (RZWQM) to simulate fate and transport of emerging substances of concern in soils receiving long-term biosolids application

Weixi Shu
Gordon Price, Rob Jamieson
Biological Engineering
PhD

ABSTRACT

Biosolids contain emerging substances of concern (ESOCs) which are not removed by conventional wastewater treatment processes. Land application of biosolids can provide entry of ESOCs into the soil system. Better understanding of the fate and transport of ESOCs in biosolid-amended soils is required to assess and manage the risk of adverse effects on the environment and humans. The Root Zone Water Quality Model (RZWQM) is a comprehensive one-dimensional, numerical agricultural systems model used to predict the effects of agricultural management on crop production and environmental quality. The pesticide transport sub-model of the RZWQM is a cost-effective tool to simulate the behavior of the pesticides in the agricultural system. The purpose of the study is to test the potential to simulate the fate and transport of ESOCs by using the same sub-model. A set of field based lysimeter cells were used to collect water samples from biosolid-amended soils. The rates of ATB application included a 0, 14, and 42 Mg ATB ha⁻¹ which were applied to microplots within each cell residing over a drainage port. The concentration of two types of ESOCs, ciprofloxacin and naproxen, were analyzed by GC/MS and used to validate the model simulation.

EVALUATION OF MICROALGAE HARVESTING METHODS FOR INDUSTRIAL PRODUCTION OF BIODIESEL

Mariam Al hattab
Dr. Abdel Ghaly
Biological Engineering
PhD

ABSTRACT

The production of biodiesel from microalgae requires culturing, harvesting, lipid extraction and downstream processing. The dewatering step is one of the major obstacles for using microalgae on an industrial-scale. It accounts for 20-30% of the total associated costs. The aim of this study was to review the current methods used for harvesting and concentrating microalgae biomass and to perform a comparative analysis in order to determine the most efficient and economically viable method(s) for large scale processing. The harvesting techniques reviewed included sedimentation, vacuum, pressure and cross flow filtration, disc stack and decanter centrifugation, dispersed and dissolved air flotation, fluidic oscillation, inorganic and organic flocculation, auto-flocculation, bio-flocculation, electrolytic coagulation, electrolytic flocculation and electrolytic floatation. Eight criteria were used for the evaluation: (a) dewatering efficiency, (b) cost, (c) toxicity (d) suitability for large scale use, (e) time, (f) species specificity, (g) reusability of media and (h) maintenance. Each criterion was assigned a score between 7 and 15 based on its degree of importance. Higher values were given to the criteria deemed most important for the development of an efficient and economic large scale dewatering method, whereas lower values were given to criteria that were deemed necessary but were considered less important. The results indicated that of the 16 methods evaluated, four (disc stack centrifugation (87), cross flow filtration (84), decanter centrifugation (82), and organic flocculation (80)) scored values of 80/100 or greater, deeming them suitable industrial scale microalgae harvesting techniques. These techniques were deemed suitable because of their effectiveness, low cost, suitability for numerous species, rapidness, minimal maintenance requirement and being environmentally friendly. Other methods were not effective in dewatering a wide array of microalgae species, not suited for large volumes, costly and require high maintenance. Although each of these harvesting techniques was deemed suitable, a combination of methods can also be used to enhance the recovery efficiency and improve the economics. The use of organic flocculation as an initial harvesting step to concentrate the algae suspension, allows for effective removal of algae from large amounts of liquid media. The costs associated with energy intensive centrifugation and filtration techniques (used individually) can be reduced by using them as secondary technique since less volumes will need to undergo secondary treatment. The use of centrifugation or filtration as a secondary dewatering step will reduce the time and costs associated with drying.

CRYSTALLIZATION OF TRISTEARIN FROM A DODECANE SOLUTION UNDER SHEAR FLOW

Tianguang,jia
Dr. Gianfranco Mazzanti
Food Science
M.Sc

ABSTRACT

The complexity of crystallization of triacylglycerols under shear flow can be tackled by breaking down the problem into several domains. The observation of crystallization from a non-crystallizing solvent will provide the opportunity to develop methodologies that will then be applied to multicomponent triacylglycerol mixtures.

In this project, the crystallization of tristearin from a dodecane solution under shear flow will be observed by polarized light microscopy. The Olympus BX51 microscope is fitted with a CSS450 optical shear cell (Linkam, UK). Additionally, Differential Scanning Calorimetry (DSC) will be used to verify the enthalpy and melting point for tristearin in beta form, pure and crystallizing from dodecane. This will allow us to use the Hildebrand equation to calculate the ideal mole fraction of tristearin in equilibrium with the crystals at different temperatures. The deviations from the ideal behavior due to shear flow or physicochemical interactions will be used to develop a predictive equation for future studies with this model material.

A solution of 10% tristearin in dodecane (w/w) will be heated to 80 °C and kept for 10 minutes under shear to ensure homogeneity. The mixture will then be cooled at 15 °C/min to different final temperatures (45 °C, 50 °C, 55 °C) and kept at that temperature during crystallization for one hour. The shear rate will be provided by the shear cell (0, 80, 800 s⁻¹) for the duration of the experiment. Polarized light images will be recorded automatically during the crystallization, and analyzed to determine the crystallized amount, and therefore the final solution concentration.

CHARACTERIZING SOURCES OF FECAL POLLUTION AND HUMAN HEALTH RISK AT URBAN PUBLIC BEACHES IN THE HALIFAX REGIONAL MUNICIPALITY

Michael McDonald
Dr. Lisbeth Truelstrup-Hansen and Dr. Rob Jamieson
Food Science and Technology
MSc.

ABSTRACT

Potential contamination and presence of human pathogens within recreational beach waters can present a public environmental health and safety problem, and must be managed. The Halifax Regional Municipality currently monitors the water quality at twenty-three public beaches, several of which have closed frequently during past beach seasons due to levels of the fecal indicator bacterium, *Escherichia coli*, surpassing the guideline for recreational waters (200 CFU/100 mL). This project will examine the water quality at four local beaches before, during, and after beach open season. On a bi-weekly basis (from May – October 2014) water samples from Springfield beach (Middle Sackville), Kinsmen Beach (Lower Sackville), Sandy Beach (Bedford), and Birch Cove Beach (Dartmouth) were enumerated for *E. coli* and coliforms. Molecular methods will be utilized to determine the presence/absence of human pathogens (*E. coli* O157:H7, *Listeria monocytogenes*, *Campylobacter jejuni/lari/coli*, *Salmonella species*, *Giardia lamblia*, and *Cryptosporidium parvum*) and identify potential sources of fecal contamination (humans, dogs, gulls, and ducks) within the beach waters. The efficacy of *E. coli* as a valid indicator of fecal contamination in Nova Scotian freshwater beaches will also be evaluated. Preliminary results show that *E. coli* and coliforms levels tended to be higher in Springfield and Kinsmen beaches in comparison to Birch Cove and Sandy beaches. Throughout the sampling season, two storms events with high winds and precipitation led to a spike in *E. coli* and coliform levels. Information obtained from this project will be provided to the Halifax Regional Municipality to aid in knowledgeable decisions about beach site management and preventative contamination mitigation programs.

ROLE OF OSMOLYTES IN THE DESICCATION SURVIVAL OF *LISTERIA MONOCYTOGENES*

Amit Ross
Lisbeth Truelstrup Hansen
Food Science, MSc

ABSTRACT

Under abiotic stress conditions such as desiccation, freezing and high salinity, bacteria can accumulate large amounts of osmolytes called compatible solutes. High intracellular levels of these compatible solutes help protect the cell from stressful conditions without interfering with essential metabolic processes. This study aims to assess the ability of various amino acid-based compounds and sugars to act as a compatible solute for *Listeria monocytogenes* during desiccation. The compounds to be tested are glycine betaine, carnitine, proline, choline, sucrose, trehalose, lactose and inositol. Three strains of *L. monocytogenes* will be used to test the effects of the osmolytes at three different concentrations.

The experiment will consist of two phases. In the first phase, *L. monocytogenes* strains will be precultured with and without osmolyte, and then desiccated with and without osmolyte. Following desiccation, the cells will be rehydrated and their absorbance will be measured regularly until stationary phase is reached. Osmolytes that result in a significant increase in bacterial desiccation survival will be selected for the next stage. In the second phase of the experiment, *L. monocytogenes* will be spotted on stainless steel (SS) coupons in order to better simulate a food-processing environment. Throughout the desiccation period, SS coupons will be sampled to monitor the number of surviving cells.

The results of this experiment will provide greater insight into whether naturally occurring osmolytes found in food soils contribute to *L. monocytogenes* persistence, and lead to the creation of an effective sanitation program.

POWDER METALLURGY PROCESSING OF AEROSPACE GRADE ALUMINUM 7055

Neal Kraus
Dr. Bishop
Masters of Applied Science
Materials Engineering

ABSTRACT

The objective of this research was to develop a powder metallurgy process suitable for the fabrication of high strength components. Wrought aluminum alloy 7055 was initially gas atomized into a powder form and then processed through a sequence of cold isostatic pressing, liquid phase sintering, and hot swaging. The effects of tin and magnesium as sintering activators along with powder size and sintering temperature were studied. Finished products attained near full theoretical density as well hardness and tensile properties that closely replicated those of the advanced aerospace alloy wrought 7055-T76.

PRELIMINARY INVESTIGATIONS OF LIQUID PHASE SINTERING OF MAR-M247 SUPERALLOY USING DSC AND DILATOMETRY

Addison Rayner

Dr. S. F. Corbin

Materials Engineering

M.A.Sc.

ABSTRACT

The sintering behavior of powder injection metallurgy (PIM) parts made with pre-alloyed MAR-M247 powder was investigated. The particle size and morphology was determined while the fundamental thermal behavior of the alloy and PIM parts was studied using differential scanning calorimetry (DSC) and dilatometry. The melting and solidification ranges of the alloy were determined. A preliminary investigation of sintering behavior was conducted using dilatometry to determine the change in density as well as microstructure. An additional phase was added to the PIM material to create a liquid phase sinter (LPS) in an attempt to increase the final sintered density of the material while enhancing microstructural features.

ASYMMETRIC ROLLING OF ALUMINUM ALLOY 6061

Mark Yao Amegadzie
Dr. Paul Bishop, P. Eng.
Materials Engineering
Ph.D.

ABSTRACT

Asymmetric rolling (ASR) involves the passage of a material between two rollers that either have different diameters or different angular velocities. Due to this imbalance between the rollers, the material is subjected to a unique combination of acute shear and compressive deformation. This scenario frequently yields products with mechanical properties that are superior to those measured for counterpart products rolled in a conventional (symmetric) manner. In the open literature, researchers have investigated the effects of ASR on metals such as iron and magnesium-based alloys in many studies. However, comparative information dedicated to the influence of ASR on the microstructure and mechanical properties of aluminum alloys is limited. In this work the response of AA6061-O to ASR was investigated. Core processing parameters of interest included roller speeds, speed ratio, and the extent of reduction. The effects of these variables on the metallurgical attributes of the rolled products were assessed and compared to symmetrically rolled counterparts.

Construction of erosion mechanism map

Tahrim Alam
Dr. Zoheir N. Farhat
Materials Engineering
M.A.Sc

ABSTRACT

Oil and gas industry spends millions of dollars every year dealing with problems caused by erosion. To the designers and engineers who have to make optimal decisions in situations where tribological considerations are significant, it is important for them to have access to information relating to the erosion process of interest. This specific set of data should be able to provide the appropriate information for materials selection and choice of suitable operating condition for a particular pair of materials. The erosion mechanism map demonstrates the change in material loss mechanisms as a function of the main process parameters. Contours of material loss rates are superimposed on these diagrams enabling the mechanistic description to be linked to a material loss rate. Such an approach makes an improvement in materials selection and process parameter optimization.

Spark Plasma Sintering of Aluminum 2219

Joseph McNeil
Dr. Paul Bishop
MAsc Materials Engineering

ABSTRACT

The fabrication of aluminum components via powder metallurgy technologies is a growing market within an array of industrial sectors. In the majority of instances, the manufacturing process is one of die compaction, liquid phase sintering, and secondary operations (sizing, heat treatment, etc.). While successful, the sintered product suffers from the presence of residual porosity that can have damaging effects on critical mechanical properties such as fatigue and tensile ductility. In an effort to eliminate this feature, numerous researchers are now investigating the spark plasma sintering (SPS) behaviour of aluminum alloy powders. SPS is an intriguing option as it can fully densify aluminum powders and simultaneously reduce the levels of impurities in the consolidated product. This investigation aimed to optimize the SPS processing of the aerospace aluminum alloy AA2219 (Al-6.3Cu-0.3Mn-0.2Zr-0.1V-0.1Ti). Particular attention was given to the effects of peak temperature, hold time, and applied pressure. The microstructures of all SPS products were assessed while the density and select mechanical properties (hardness, TRS bend strength/ductility) were quantified. Data were also acquired from specimens of wrought 2219-T6 for comparison purposes so as to highlight the principal effects of manufacturing practice.

Development of a Boron Free Brazing System Using a Ni-Cu-Mn Filler Metal

Taylor MacLellan
Dr. Stephen Corbin, Dr. Paul Bishop
Materials Engineering
Masters of Applied Science

ABSTRACT

Brazing is a bonding method used to bond two or more components together using a filler metal. During the brazing process, the filler metal melts and forms atomic bonds between the components as solidification occurs. Brazing is utilized as it can produce strong, stress free, uniform joints over large areas; furthermore, the metals being bonded can vary widely in thicknesses and composition. One drawback of brazing is that each base metal needs a specifically designed filler metal for each application, and optimal filler metals do not yet exist for many alloys. Common filler metals used when brazing nickel based super alloys contain high amounts of boron. Boron is added to the filler metal to lower the melting point and because of its fast diffusion in nickel. However, boron is detrimental to the final components properties as it forms brittle borides within the base alloys that reduce the ductility and toughness of the joint. This research tries to find a suitable substitute for the boron containing filler metals by investigating the nickel-copper- manganese system. Brazing parameters such as filler metal composition, temperature, hold time, and heating rate are investigated to optimize the braze joints properties.

An Experimental Study of the Influence of Porous Media on the Rate of Hydrate Formation

Najlla Ali

Supervisors: Michael Pegg and Jan Haelssig
Process Engineering and Applied Science
MAsc in Chemical Engineering

Abstract

An experimental system will be designed and constructed to study the factors influencing the rate of methane and carbon dioxide hydrate formation in natural gas reservoirs. Gas hydrates are a crystalline compound formed as a result of the reaction of light gas molecules such as methane, ethane and carbon dioxide with water under specific conditions of low temperature and high pressure. Formation of hydrates in natural gas reservoirs can slow down the flow and sometimes completely plug the path of the fluid to the production well. Hydrates may also form during injection of sour gas into reinjection wells. Therefore, it is necessary to determine the factors that influence the rate of hydrate formation in order to avoid these undesired consequences. The aim of the present study is to provide a better understanding of the effect of porous media properties, as well as the influence of the reservoir conditions (temperature, pressure), on the rate of hydrate formation. So far, a comprehensive literature review has been undertaken to identify experimental systems that have previously been used to study hydrate formation kinetics, and to identify previously used models. As a result of this literature review, two sets of experiments are planned. First, an instrumented core will be used in core flood experiments to study hydrate formation kinetics. Second, a rectangular flow channel packed with glass beads will be used to study hydrate formation visually. The experimental results will then be used to develop a model to predict hydrate formation dynamics.

Development of a High-Rate Microbubble-Aerated Bioreactor

Albahloul Omar Idhbeaa

Dr. A. M. Al Taweel, Dr. A. Ghanem, and Dr. M. Walsh

Chemical Engineering

PhD

ABSTRACT

Airlift bioreactors are extensively used in a wide range of chemical and biochemical processes such as biological wastewater treatment, ozonation of water or wastewater, and fermentation processes, as well as cell and algae culture, and multiphase catalytic reactors. This is driven by performance advantages like simple construction, low cost, the ability to maintain sterile conditions, the ability to achieve high mixing rates without the presence of high local shear rates, and the high inter-phase mass transfer rates that can be obtained in such units. Recently, significant performance improvement was achieved by using microbubbles for aeration causing very large interfacial area of contact between the phases.

A pilot-scale internal-loop airlift reactor (ALR) was tested, showing high performance. The unit is equipped with a dual-fluid sparger capable of generating microbubble dispersion even at a high gas holdup. This microbubble-aerated approach, combined with controlling the overall hydrodynamics of ALR (gas holdup, liquid circulation velocity and mixing time, and energy dissipation) and inter-phase mass transfer, can satisfy the requirements of ALR bio-performance. Although the performance of this approach is significant, further improvement can be achieved by adopting a more efficient bubble separator design capable of removing microbubbles without creating excessive shear and preventing them from being entrained in the downcomer stream, limiting its operational flexibility. Similar arrangements for removing solids are required by the high biomass generation capacity associated with such large gas liquid mass transfer coefficients. Also, more energy-efficient transonic spargers will be developed in order to overcome the relatively high energy consumed by the dual-fluid sparger.

This improved high-performance microbubble-aerated airlift bioreactor can be applied in biological wastewater treatment. For cell-culture processing, packing material is applied in the downcomer section to grow biofilm, which is anticipated to result in greater microbial activity and assist with the subsequent removal of the formed biomass.

NUMERICAL INVESTIGATION OF UNDERWATER SOUR GAS WELL BLOWOUTS

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Department of Process Engineering and Applied Science
Doctor of Philosophy in Chemical Engineering

ABSTRACT

During offshore natural gas production, underwater pipelines are used for production, transportation and reinjection of gas. When sour gas is sweetened, one of the common by-products is a gas containing a high fraction of toxic H₂S. To dispose of this gas, it can be re-injected into a depleted well. However, in transporting both the produced natural gas and the sour gas, there is a small chance of catastrophic failure and subsequent release of gas into the ocean. Such a gas release would pose a risk both to human safety and to the environment, and therefore it is critical to develop accurate models to predict the impact of such an event. In the event of a catastrophic failure of either the wellhead or undersea pipelines, sour gas would be released into the water column. Near the release point, the gas jet is governed by the momentum resulting from a back pressure inside the well or pipeline. Further away from the point of release, enough momentum has dissipated into the surrounding liquid so that the gas forms a buoyancy-driven plume. The specific goal of this project is to develop a comprehensive model for the near-field region. There are numerous complications to be considered, such as the rapid expansion of the gas, and the potential of heat and mass transfer that may affect the formation of the plume. Such complications are not included in currently available models.

This presentation will present an overview of the overall modeling problem, and then discuss progress that has been made so far. Results of a literature review on currently available modeling methodologies are discussed. The framework that has been adopted for developing the computational fluid dynamics (CFD) model is then presented. Specific challenges in implementing this framework are then discussed, and results from preliminary studies are presented.

Lithium-Rich Core-Shell Cathodes with Low Irreversible Capacity and Mitigated Voltage Fade for Lithium Ion Batteries

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Presenter: Jing Li

Supervisor: Jeff Dahn

Program: Chemical Engineering

Degree: Ph.D student

Lithium-rich layered Ni-Mn-Co oxide materials have been intensely studied in the last decade. Mn-rich materials have serious voltage fade issues and the Ni-rich materials have poor thermal stability and readily oxidize the organic carbonate-based electrolyte. Core-shell (CS) strategies that use Ni-rich material as the core and Mn-rich materials as the shell can balance the pros and cons of these materials in a hybrid system. The lithium-rich CS materials synthesized through co-precipitation method introduced here showed much improved overall electrochemical performance compared to the core-only (Ni-rich) and shell-only (Mn-rich) samples.

The energy dispersive spectroscopy results of the CS precursor and lithiated samples show that there was diffusion of transition metals between the core and shell phases after sintering at 900°C compared to the prepared hydroxide precursors. A Mn-rich shell was still maintained whereas the Co which was only in the shell in the precursor was approximately homogeneous throughout the particles. The CS samples with optimal lithium content showed low irreversible capacity (IRC), very stable average voltage as well as high capacity and excellent capacity retention. Sample CS2-3 had a reversible capacity of ~218 mAh/g with 12.3%

**USE OF NATURAL ANTIMICROBIAL COMPOUNDS FOR THE REMOVAL
OF BIOFILMS FORMED BY *LISTERIA MONOCYTOGENES*,
STAPHYLOCOCCUS AUREUS, *SALMONELLA ENTERICA* SEROVAR
TYPHIMURIUM AND COMMENSAL BACTERIA**

Celine d'Entremont
Dr. Lisbeth Truelstrup Hansen
Food Science
M.Sc

ABSTRACT

Pathogenic bacteria, such as *Listeria monocytogenes*, are easily transferred from biofilms on processing equipment to foods, causing many foodborne outbreaks and illnesses. Antimicrobial essential oils may satisfy the need for more natural disinfectants in the food industry. The objective of this study was to determine if thymol, carvacrol, trans-cinnamaldehyde and lemongrass essential oil inhibited the formation of *Listeria monocytogenes*, *Salmonella* Typhimurium, *Staphylococcus aureus*, *Pseudomonas fluorescens* and *Shewanella baltica* biofilms as well as eradicate preformed biofilms at various life stages. For each bacterium, the minimum inhibition concentration (MIC), minimum biofilm inhibition concentration (MBIC), and minimum biofilm eradication concentration (MBEC) were determined in a 96-well micro-titer plate assay at 15°C using crystal violet and 3-[4, 5-dimethylthiazol-2-yl]-2, 5 diphenyltetrazolium bromide (MTT) staining as measures for the formation of biofilm exopolymeric substances (EPS) and metabolic activity, respectively. All four compounds were inhibitory to the growth of planktonic cells (MIC) and biofilms (MBIC) at concentrations of 0.45-6 mM for thymol, carvacrol and trans-cinnamaldehyde and 0.03-0.25 % (v/v) for the lemongrass essential oil. However, preformed biofilm, obtained by incubation (15°C, 3 days), required higher concentrations; only carvacrol and thymol eradicated the metabolic activity in preformed biofilm of all species tested at concentrations of 1.5-12 mM and 2-8 mM, respectively. The antimicrobial efficacy of all compounds decreased with increasing biofilm maturity. The strong biofilm former, *Shewanella baltica* required higher concentrations of antimicrobials for eradication of the preformed biofilm (e.g., carvacrol, 12 mM) while trans-cinnamaldehyde at the maximum level of 24 mM had no effect. Moreover, variable MICs, MBICs and MBECs were observed among three *Listeria monocytogenes* strains (085578, 568, CP45-1), suggesting that different strains vary in susceptibility. These results support use of natural antimicrobial compounds to target biofilms formed by pathogenic and spoilage bacteria to improve the hygiene and food safety in the food processing environment.

Value-Added Processing of Food Wastes In Canada

Jonathan Rolin

Dr. Tom Gill

Food Science and Technology

Ph.D

The annual cost of food waste in Canada is estimated to exceed \$31 billion. The majority of food wastes are produced by consumers (47%) and food processors (20%), while wastes produced on-farm, during transport, and through trade represent the remainder. Value-added processing involves the conversion of foodstuff by-products into new materials or resources. Many food by-products have been shown to contain biologically active components or valuable chemical compounds, yet are discarded during processing because of consumer preference. Foods rich in antioxidants, flavonoids, phytochemicals, and valuable protein and oil are suitable candidates for value-added processing. Furthermore, both processing by-products and household organic wastes are suitable inputs for energy production by both biological and thermochemical processes. In Canada annual potato and salmon production yield approximately 4.6M tonnes and 0.1M tonnes, respectively. Salmon processing can divert up to 30% of whole-fish weight as a by-product. These by-products remain a rich source of omega-3 fatty acids shown to protect against cardiovascular disease, and a protein source currently being investigated as a nutraceutical for Type 2 Diabetes. Potato peels are the primary processing by-product and contain equivalent concentrations of bioactive compounds. Peel extracts have been shown to protect against protein and lipid oxidation, including during radiation-sterilization of meat. Homogenous food processing by-products and heterogeneous municipal food wastes have both effectively been utilized as inputs for energy production. The development of robust industrial processes, including pretreatments of the material and efficient reactor designs, represent the primary limitations for its application as a suitable form of energy production at the municipal level. An overview of value-added processing is presented, with focus on Canada's largest agricultural and aquaculture products.

TEXTURAL SOFTENING OF ARCTIC SURF CLAMS (*MACTROMERIS POLYMYNA*)

Presenter: David H. Bent
Supervisor: Dr. Tom A. Gill
Program: Process Engineering and Applied Science
Degree: Master of Science

Arctic Surf Clam (*Mactromeris polymyna*) is a minimally processed sea food sold blanched, shucked, frozen and consumed without further processing. The mouthfeel (texture) of surf clam meat is of great importance to the consumer and may be dependent on the condition of the live clam and perhaps the effects of processing and freezing. Customer complaints have been received by a surf clam processor about textural softening of their clam meat. The problem has been occasional but persistent, forcing the processor to search for the cause of the textural softening. Surf clams are known to contain high levels of proteolytic cathepsin (B and D) enzymes which are a likely cause of the textural softening. Cathepsin enzymes are normally membrane-bound, within sub-microscopic lysosome organelles, but can be freed and activated by trauma, stress or normal protein turnover within cells.

The purpose of this study is to determine the cause of textural softening of Arctic Surf Clam meat and to determine if there are any practical methods of mitigation and control. An instrumental method for texture analysis was developed using a TAXT2 texture analyzer measuring the force required to cleave samples in a guillotine-like motion. Total cathepsin activity assays are being performed on clam homogenates as well as free cathepsin activity assays on cytoplasmic juice prepared by centrifugation of intact clam tissue. In this way the study will determine whether or not there is a correlation between textural softening in surf clam meat and free active cathepsin activity. A possible cause of increased cathepsin activity is stress caused by elevated ocean temperatures observed in recent years. The effect of environmental temperature on cathepsin activity in surf clams will be measured with live clams harvested, acclimated and then cultivated at normal and elevated environmental temperatures (5, 10 and 20°C, respectively).

A ¹H NMR-BASED TECHNIQUE TO DETERMINE EPOXIDE YIELD IN OXIDIZED OIL

Wei Xia
Dr. Suzanne Budge
Food Science
Ph. D

ABSTRACT

Epoxides have been suggested as important intermediates in lipid oxidation of edible oils but they are rarely monitored. Here, we developed and validated a new method to determine epoxide concentrations in oxidized soybean oils using ¹H NMR. To investigate the chemical shifts of epoxides, trilinolein, trilinoleinin, and fresh edible oils were epoxidized by formic acid and hydrogen peroxide. Epoxides gave signals between 2.9 - 3.2 ppm, distinct from the signals of other lipid oxidation products. To calibrate, soybean oils with a range of epoxide concentrations were synthesized and quantitated by taking *sn*-1,3 glycerol protons as internal references using ¹H NMR. The ¹H NMR signals were compared to the epoxide content determined by titration with hydrogen bromide-acetic acid (HBr) solution. As expected, the signal response increased with concentration linearly ($R^2 = 99.96\%$) and the validation of the method proved that the proposed method gave reliable results. A stability study of soybean oil was performed by applying this method to monitor epoxides during thermal oxidation at 100 °C. The epoxide content increased over time and showed a different trend compared to hydroperoxides, a well-known primary product from lipid oxidation. Therefore, it was concluded that epoxides were important lipid oxidation products.

3-OH OXYLIPINS IN THE SMA STRAIN OF *SACCHAROMYCES PASTORIANUS*

Presenter: Greg Potter
Supervisors: Dr. Sue Budge
Program: Food Science and Technology
Degree: PhD

Three-hydroxy-oxylipins (3-OH oxylipins) have been previously detected in brewing yeast production strains at flocculation onset. In this work, the SMA strain of *Saccharomyces pastorianus* was characterized during growth in a miniature fermentation assay by measuring flocculation and cell surface hydrophobicity (CSH). Proportions of 3-OH oxylipins were also measured concurrently during growth in the miniature fermentation assay and a defined 3-OH oxylipin extraction protocol using ethyl acetate was developed along with a novel derivatization and gas chromatography-mass spectrometry detection approach. When the SMA strain was grown in the assay, near maximal CSH and flocculation levels were achieved by 36 hours fermentation time. Under the same culture conditions, the oxylipins 3-OH decanoic acid (3-OH 10:0) and 3-OH octanoic (3-OH 8:0) were identified. These oxylipins could not be detected early in the fermentation, but elevated relative levels were reached by 36 hours, coinciding with increased CSH levels. It was previously presumed that the formation of 3-OH oxylipins at flocculation onset might increase the CSH. However, results from this study suggest that 3-OH 8:0 and 3-OH 10:0 may not contribute to cell wall hydrophobicity. A second 3-OH oxylipin detection approach was later devised where the ethyl acetate extracted oxylipin containing fraction of the total lipid extract was separated on a TLC plate. Oxylipins present were then methylated with BCl₃-methanol and derivatized with an electro-negative heptafluorobutyrate (HFB) group. When analyzed in negative chemical ionization-mass spectrometry (NCI-MS), the HFB derivatized oxylipins, characterized by [M-40] spectra, produce a much stronger signal than during earlier electron impact analysis. Thus, the latter more sensitive NCI-MS based approach should facilitate quantitative detection of trace levels of 3-OH oxylipins in the SMA strain during lab-scale fermentations.

INFLUENCE OF BLENDED ELEMENTAL AND PREALLOYED ALUMINUM ADDITIONS ON THE SINTERING BEHAVIOUR OF TITANIUM ALLOYS

Presenter: Joannie Lapointe
Supervisors: Dr. Stephen F. Corbin and Dr. Kevin Plucknett
Program: Materials Engineering
Degree: Master of Applied Science

ABSTRACT

One of the NSERC Automotive Partnership Canada programme goals is to determine cost effective powder metallurgical based fabrication routes for the production of titanium alloy automotive parts. The production of these alloys through the addition of blended elemental (BE) or master alloy (MA) powders to commercially pure titanium (CP-Ti) powder is under consideration. This project studies the in-situ alloying of these additions during sintering.

Aluminium is the most common alloying addition in titanium alloys. For this reason, this presentation focuses on the sintering interaction between Al and Ti, using both a MA titanium aluminide and CP-Ti mixture, as well as a BE Al and CP-Ti blend. Particle size and sintering time were the primary parameters studied. Differential scanning calorimetry (DSC) evaluation has been conducted, along with sintered density evaluations, dilatometry, microstructural observations, and energy dispersive X-ray spectroscopy (EDS) to assess alloy homogenization and sintered compact densification.

DSC was used to analyze the shape of the exothermic peak caused by the β - to α -Ti transformation during cooling. This peak shape was used to describe the extent of aluminum diffusion and the phase homogeneity in the sintered compact.

Smaller BE or MA particle size was found to increase the rate of in-situ alloying. Optical microscopy and exothermic peak analysis have shown that the chemical homogenization time ranged from 15 min for the fine BE aluminum addition to over one hour for the coarse MA addition. These results were confirmed by quantitative observations of the aluminum concentration with EDS.

In compacts made either from fine or coarse BE powders, optical microscopy reveals large spherical pores, and prolonged sintering time does not increase density. However, there is a sharp increase in density for fine MA compacts. These samples have a larger density increase, but are less homogenous than compacts from BE powder.

Regional Challenges and Opportunities for Agricultural Biomass in Nova Scotia

Allan Thomson
Dr Kenny Corscadden
Biological Engineering
PhD

ABSTRACT

Nova Scotia is currently in the process of developing a biomass energy industry, with a current installed capacity of 105MW, and a further 33.75MW due to come on-line between 2015 and 2018. This new demand for resources by the biomass energy sector combined with the needs of existing biomass users which include heat production (residential and commercial), pulp and paper, lumber and wood production, has the potential to exacerbate the existing issues relating to biomass sustainability within the province. One option open to the province is the production of agricultural biomass crops including Short Rotation Coppice Willow and Poplar, which have become increasingly popular biomass sources in Europe and North America.

It is estimated that there is approximately 24,500 ha of inactive land available within the province, which offers significant opportunity for biomass production as it has the potential to alleviate some of the strain on the biomass sector, contribute towards Nova Scotia's renewable energy mix and aid in farm diversification. While, in general, expanding the use of biomass can contribute towards the reduction of Greenhouse Gas emissions and contribute towards meeting renewable energy targets, a detailed understanding of Nova Scotia's potential production capacity, capability and economic viability needs to be undertaken to determine whether the province and producers should consider agricultural biomass as an option.

This research project is using spatial multi-criteria analysis and Life Cycle Analysis approaches to determine the viability of SRC within Nova Scotia and aims to produce a decision-making tools for land-owners considering producing agricultural biomass.

**OPTIMIZATION OF THE MICROENCAPSULATION OF ANTHOCYANINS
FROM HASKAP BERRIES (*LONICERA CAERULEA* L.) IN Ca-ALGINATE
BEADS FOR ORAL DELIVERY**

Giovana B. Celli

PhD Candidate in Biological Engineering

Supervisors: Dr. Su-Ling Brooks & Dr. Amyl Ghanem

ABSTRACT

A considerable body of research has shown that fruits are a rich source of essential micronutrients (such as vitamin C and folic acid) and other bioactive compounds, including anthocyanins. However, the incorporation of these components in different food product is limited by their intrinsic characteristics, such as taste and stability. Encapsulation techniques can contribute to overcome these limitations and to develop value-added, health-related products. Anthocyanins (ACNs) can highly benefit from encapsulation techniques, as their stability is often affected by environmental conditions, such as pH and temperature. In addition, encapsulation techniques can assist in modulating the release of ACNs and increasing their retention time in sites within the body, where their absorption is favored. This project aims to develop and characterize an encapsulate of ACNs extracted from haskap berries (*Lonicera caerulea* L.) to promote their retention in absorption sites for longer periods of time. Exploratory research was conducted to evaluate a set-up for the encapsulation of ACNs in Ca-alginate beads by an extrusion/gelation approach. Optimization was conducted using Box-Behnken design with encapsulation yield, efficiency, and size as responses. Three variables were evaluated: sodium alginate (SA) and calcium chloride (CC) concentrations, and the time (T) that the beads remained in the crosslinking solution. The results demonstrated that encapsulation efficiencies of 17.97 to 63.12% could be achieved. However, the current system is limited in industrial application as it cannot be scaled-up. Therefore, it will be used as a reference for the development of new methods.

In-Situ Thermal Diffusivity Analysis during Powder Metallurgy Processing of Titanium and Titanium Alloys

Presenter: Eric Moreau
Supervisors: Dr. S. Corbin
Program: Materials Engineering
Degree: Ph.D.

ABSTRACT

Powder Metallurgy (PM) processing represents an effective alternative to conventional metallurgy as a means of reducing the high costs of manufacturing and forming Titanium components, primarily as a consequence of near net shape processing and low materials waste. The major issue retarding the development of Titanium powder metallurgy is their generally inferior mechanical properties resulting from residual porosity. Thus, the implementation of the *laser flash method* or *laser flash analysis* (LFA) has been proposed as a means of indirectly monitoring the mechanical properties of powder metallurgy Titanium alloys through the rapid measurement of thermal diffusivity. The current work involves investigating the feasibility of utilizing laser flash analysis in measuring sensitive variations in density and chemical composition, both in the “green” unsintered condition and in-situ during the sintering of Titanium and titanium alloy powders. Additional characterization included scanning electron microscopy, energy dispersive spectroscopy, x-ray diffraction, optical microscopy, physical density/dimensional measurements and dilatometry. The preliminary results confirmed a direct correlation between the thermal diffusivity with both the green and sintered density, while appreciable gains in thermal diffusivity which were unachievable through compaction alone were observed as a result of the sintering process. The outcomes of confirming the feasibility of laser flash analysis in validating the mechanical properties of Titanium powder metallurgy alloys are the development of a rapid, effective and non-destructive quality assurance technique, as well as an enhanced understanding pertaining to the dependence of thermal properties with densification and homogenization; both phenomena which transpire during sintering.

Titanium Brazing and Filler Metal Selection

Colin Taddell
Dr. Stephen Corbin
Materials Science Engineering
PhD Candidate

ABSTRACT

Titanium Brazing is an established method of reducing the weight of launch vehicles and aircraft structures by joining titanium to titanium, titanium to stainless steel, etc. Currently, over 100 brazing filler metals exist to facilitate the joining of these metals in the aerospace industry with the goal of improving strength and corrosion resistance of these joints. A smaller subset of these filler metals are capable of the high performance brazing method known as Transient Liquid Phase Bonding (TLPB). Titanium is a metallic allotrope which can exist in two distinct phases depending on the applied temperature. Filler metal selection must be specific to the allotrope and temperature in question. Another issue in brazing filler metal selection occurs due to titanium's high reactivity to many different chemical elements. Selection of a filler metal that can join titanium at elevated temperatures using the TLPB technique while maintaining its desired mechanical properties and corrosion resistance is the main goal of this investigation.

Aluminum Metal-Matrix-Composites Produced Using a Powdered Metal Approach

Greg Sweet

Dr. Paul Bishop

PhD Materials Engineering

ABSTRACT

Spark Plasma Sintering (SPS) of metal matrix composites (MMC) was performed. These materials consisted of an aluminum matrix material combined with a ceramic phase of either SiC, AlN, Si₃N₄ or BN. The effect of these ceramic additions to an aluminum matrix were investigated with a primary purpose of determining the effects of ceramic type, content and particle size. BN MMCs proved to inhibit bonding, resulting in relatively poor properties. SiC, AlN and Si₃N₄ systems proved to be considerably better performing. Coarser ceramic particle additions were densified to near-theoretical values, producing significant hardness gains. Finer ceramic particles were more problematic in densification, as clusters of these particles introduced porosity. Hardness gains were superior to the coarser ceramics. Three point bend tests proved to be a suitable method in determining the relative mechanical performance and sinter quality of MMC systems. SiC ceramics outperformed AlN in bend tests. SiC achieved excellent ductility and bend strength at low temperatures while equivalent AlN materials required more elevated temperatures to achieve comparable properties.