UNIVERSITY OF WATERLOO

Nanotechnology Engineering Symposium

Friday, March 20, 2015, 9:00am to 6:00pm, at the William G. Davis Computer Research Centre

Project Presentations

I. Nano Electronics & Photonics		*Room DC-1304*
Time	*Project Title, Design Group*	*Project No.*
9:30	**Optically Transparent Organic Photovoltaic Cell** *Geoffrey Deignan, Alan Dorssers, Jon Joel, Stephen Pynenburg*	NE_2014_01
9:50	**Temperature Sensing for Culinary Applications with Smartphone Integration** *Nick Deakin, Ian Gzegorczyk, Urvashi Pal, Ben Pries, Lawrence Yu*	NE_2014_03
10:10	**Transparent Crystalline Nanocellulose Defroster** *Apoorva Hasija, Kelvin Liew, Lyazzat Mukhangaliyeva, Prathima Sundaram*	NE_2014_05
10:30	**Colour-Changing Metasurface for Displays and Customizability** *Navid Abedzadeh, Nigel Clarke, Matt Lavrisa, Brent McCleave*	NE_2014_08
10:50	**Optics with Tunable Light Absorption and Colour: A New Paradigm in Smart Eyewear** *Sean Cormier, Noah MacCallum, Parth Patel, Derek Sun*	NE_2014_13
11:10	**Suncayr** *Derek Jouppi, Andrew Martinko, Rachel Pautler, Hayden Soboleski, Chad Sweeting*	NE_2014_20
11:30	**Printing Circuit Board Using Sintering Methods** *Joon Youp Lee, Jonathan Li Kam Wa, Taehyung Lee, Daniel Park*	NE_2014_24
II. NEMs & Nano Fluidics		*Room DC-1304*
	Project Title, Design Group	*Project No.*
12:30	**Mechanical Energy Harvesting using Piezoelectric ZnO** *S M Tadmir Bin Chisti, Divya Dhokte, Mahika Mehta, Mohammad Mehedi Rahman*	NE_2014_02
12:50	**Piezoelectric Applications of Zinc Oxide Nanowires on Fabric** *Joshua Fenning, Emily Gruber, Dongnan Huang, Tevis Jebb*	NE_2014_06
1:10	**Necho: Ionic Hydrogel Actuator for Noise Cancellation** *Rana Ahmed, Vincent Chow, Matt Ewertowski, Andrew Mendonca, Noorin Samji*	NE_2014_11
1:30	**Programmable Surface via Linear Actuator Array** *Ahmed Eltom, Aidan Gallagher, Sam Jeong, Dhruva Nathan*	NE_2014_19
1:50	**µFlow: A Reconfigurable Microfluidic Device by Electrowetting**	NE_2014_21

	Fred Fu, Yunjo Kim, Dan Panaite, Alex Saagi	
2:10	**Microfabricating an Electrospray Ion Thruster for use on Microsatellites** *Kristopher Bicanic, Richard Garner, Matthew Mulvale, Adam Svatos*	NE_2014_22

III. Nanobiotechnology & Biomedical Systems — *Room DC-1331*

Time	*Project Title, Design Group*	*Project No.*
12:30	**Novel Sensor for Gluten Detection** *Aaminah Ahmad, Nishi Bhatt, Zachary Jacobi, Natascha van Lieshout*	NE_2014_04
12:50	**Biomedical Applications of CNC-Thermoplastics for Improved Osteogensis** *Shahab Akmal, Gregg Hamm, Tigor Mihaljevic, Daniel Osorio*	NE_2014_09
1:10	**Evergrow** *Pawel Jaworski, Aleksandar Pesic, Leslie Snelgrove, Sonya Wach, Anthony Wang*	NE_2014_14
1:30	**Rapid Vitamin D Detection** *Youssef Helwa, Lucas Lim, James MacLean, Nirushan Udayakumar*	NE_2014_15
1:50	**ExoSkeleton – 3D Printable Nanocomposite Orthopaedics** *Jeff Carette, Matthew Carlucci, Ben Dippelsman, Calvin Xu*	NE_2014_18
2:10	**Detecting a Post-operative Anastomotic Leakage** *Jinu Kurian, Dany Younan, Shadman Zaman*	NE_2014_23

IV. Nano Functional Materials — *Room DC-1304*

Time	*Project Title, Design Group*	*Project No.*
3:00	**Water Conditioning by Carboxylated Cellulose Nanocrystals Facilitated Ion Exchange** *Moutaz Al-Huneidi, Jining Huang, Seungwon (Sean) Oh, Nathaniel Zavitz*	NE_2014_07
3:20	**MilleMisceo: Enhanced Coatings** *Jared Lenos, Anand Lopez, Francis Nguyen, Adam Pollit*	NE_2014_10
3:40	**Flowable Electrode Capacitive Desalination System With Energy Recovery** *Mason Kolbeck, Rachelle McKeown, Jacob Terry, Zac Young*	NE_2014_12
4:00	**Spill-o-Pill** *Laura Corner, Andrea Erakovic,, Ryan Neufeld, Orysia Soroka,*	NE_2014_16
4:20	**Grapht** *Devavrat Badami, Raymond Fung, Ricardo Guerrero, Thomas Kennedy*	NE_2014_17

Project Abstracts

I. Nano Electronics & Photonics

Project No.

NE_2015_01 **Optically Transparent Organic Photovoltaic Cell**

Geoffrey Deignan, Alan Dorssers, Jon Joel, Stephen Pynenburg

Although silicon solar panels are popping up on rooftops of large buildings, a vast amount of light comes into contact with their glass windows and curtain walls. Our device provides an optically clear solar panel which can be mounted on such surfaces to turn some of the sun's invisible light into power, while maintaining the architectural and visual qualities of the glass underneath. This is a perfect way to create cash flow for building owners and to provide engineers and architects with a new option for on-site renewable power generation, contributing to LEED credits.

NE_2015_03 **Temperature Sensing for Culinary Applications with Smartphone Integration**

Nick Deakin, Ian Gzegorczyk, Urvashi Pal, Ben Pries, Lawrence Yu

Cooking a delicious meal is a precise art that requires preparing food according to a specific set of instructions. Similar to following a laboratory procedure, it is important to make sure that all variables are controlled precisely to a recipe's requirements. The proposed product aims to solve the problem of a home chef being unaware of a pan's surface temperature. Being able to monitor a pan's surface temperature allows a chef to cook food at a precise temperature that will result in the best tasting meal.

NE_2015_05 **Transparent Crystalline Nanocellulose Defroster**

Apoorva Hasija, Kelvin Liew, Lyazzat Mukhangaliyeva, Prathima Sundaram

Canadian winters can be beautiful, cold, and icy. This usually means getting out early to scrape ice off the car windshields or waiting for our car defroster to melt the ice to ensure visibility. Currently technologies are opaque and time consuming. Our solution is a transparent, conductive thin film composed of biodegradable crystalline nano-cellulose (CNC) surface modified with conductive polymers that can defrost windshields while maintaining greater visibility than current technologies.

NE_2015_08 **Colour-Changing Metasurface for Displays and Customizability**

Navid Abedzadeh, Nigel Clarke, Matt Lavrisa, Brent McCleave

Using a phenomenon known as surface plasmon resonance, we have developed an active metasurface that can completely change its appearance by selecting which colours of ambient light are reflected and which are absorbed in real-time, all with near-zero power consumption. As a display technology platform, this metasurface is versatile in its possible applications, which include instantaneously colour-changing cars, displays which remain crisp and bright in direct sunlight, and mobile devices can last for days between charges.

NE_2015_13 **Optics with Tunable Light Absorption and Colour: A New Paradigm in Smart Eyewear**

Sean Cormier, Noah MacCallum, Parth Patel, Derek Sun

Modern eyewear has made substantial progress in optical quality, protective capacity and cost; however, lenses lack the ability to adapt to changing external conditions. Herein we present a novel tunable optics technology that rapidly adjusts colour and light absorption in response to changing environments. We use a high precision microfluidic system to fill a thin optical cavity with dyes behind existing lenses. Our technology can be easily integrated into all eye apparel to meet any outdoor needs.

NE_2015_20 **Suncayr**

Derek Jouppi, Andrew Martinko, Rachel Pautler, Hayden Soboleski, Chad Sweeting

We have developed a colour changing ink that tells you exactly when to reapply sunscreen. This is drawn on as a marker or pen and then sunscreen is applied as normal. When your sunscreen wears off, the picture that you drew is exposed to UV light and changes colour, instantly telling you when to reapply. The ink forms a thin film that is non-toxic, waterproof, and stays on the skin all day.

NE_2015_24 **Printing Circuit Board Using Sintering Methods**

Joon Youp Lee, Taehyung Lee, Jonathan Li Kam Wa, Daniel Park

All electronics have one thing in common, they all use printed circuit boards. However, manufacturers know how hard it is to design circuit boards because of their complicated schematics or because there are no efficient ways of testing the boards before manufacturing and assembly. That's why we are proposing a printer which uses laser sintering methods as an easy and quick way to print circuit boards for testing the schematics.

II. NEMs & Nano Fluidics

Project No.

NE_2015_02 **Mechanical Energy Harvesting using Piezoelectric ZnO**

S M Tadmir Bin Chisti, Divya Dhokte, Mahika Mehta, Mohammad Mehedi Rahman

Wish you had just 1% more of charge to complete that call? Tired of your phone running out of charge at a crucial moment? The intent of this design project is to fabricate a flexible and robust device for mechanical energy harvesting for easy integration in different areas of application, such as in shoe soles or knee pads. You can now charge your devices on the go using your body movements instead of having to look for an electrical outlet every time! So don't forget to check out our booth at the symposium to find out more!

NE_2015_06 **Piezoelectric Applications of Zinc Oxide Nanowires on Fabric**

Joshua Fenning, Emily Gruber, Dongnan Huang, Tevis Jebb

A wearable textile that produces power using the movement of the human body through the natural bending and stretching of clothing has been developed. The mechanism of power generation in this wearable textile relies on the electromechanical effect of zinc oxide nanowires. The textile is a simple power source that can be added onto existing clothing and potentially power a small scale electrical device.

NE_2015_11 **Necho: Ionic Hydrogel Actuator for Noise Cancellation**

Rana Ahmed, Vincent Chow, Matt Ewertowski, Andrew Mendonca, Noorin Samji

Noise is often an irritation in everyday life that isn't easy to get rid of. Our aim is to create a thin, transparent speaker that could be used as a noise cancelling device. Incoming noise is collected through a microphone, the sound waves inverted and then projected through the speaker to cancel the noise. Due to its transparency, the device would be visually discrete, allowing for noise cancellation in the office environment without blocking your view out the window.

NE_2015_19 **Programmable Surface via Linear Actuator Array**

Ahmed Eltom, Aidan Gallagher, Sam Jeong, Dhruva Nathan

Our product is a programmable surface, consisting of an array of magnetic linear actuators. The device has a variety of applications including injection molding and interactive displays. The highlight of the device is that there are no moving parts (apart from the actuator itself), so it has strong potential for scaling down to the micron level and beyond. This will allow the user to create arbitrary surfaces with high resolution. The device is being developed in conjunction with Maieutic Enterprises, a start-up company consisting of our own Nanotechnology Engineering graduates.

NE_2015_21 **µFlow: A Reconfigurable Microfluidic Device by Electrowetting**

Fred Fu, Yunjo Kim, Dan Panaite, Alex Saagi

Lab-on-a-chip devices are an emerging technology that is capable of consolidating laboratory techniques onto small chips. The proposed device would allow one to create these chips by accurately manipulating water droplets using an electric field through a pre-polymer material. Users will be able to design their own unique chip structures through a software interface. Our goal is to provide a simple, reusable alternative to traditional fabrication methods.

NE_2015_22 **Microfabricating an Electrospray Ion Thruster for use on Microsatellites**

Kristopher Bicanic, Richard Garner, Matthew Mulvale, Adam Svatos,

Microsatellites with a mass of one to ten kilograms have become popular in recent years due to their rapid development cycles and their low cost of launch. However, most microsatellites have unpredictable lifetimes since they cannot control their position or velocity after launch. This arises from the fact that the propulsion technology currently available for microsatellites is too heavy or voluminous to be applied without compromising the original mission. As a solution, our group has further developed and tested a microfabricated ion thruster design invented at MIT's Space Propulsion Laboratory. Our ion thruster is being integrated into WATSAT-2, the microsatellite developed by the University of Waterloo Satellite Team, for Canadian Satellite Design Challenge - a competition where the winning team has their satellite launched into orbit.

III. Nanobiotechnology & Biomedical Systems

Project No.

NE_2015_04 **Novel Sensor for Gluten Detection**

Aaminah Ahmad, Nishi Bhatt, Zachary Jacobi, Natascha van Lieshout

Celiac Disease is an autoimmune disorder that affects approximately 350 000 Canadians and can only be treated by a strict gluten free diet. Treatment is complicated by the difficulty of determining which foods do and do not contain gluten. We have developed an inexpensive test strip that can detect minute amounts of gluten. This strip can be marketed directly to consumers to allow them to effectively manage their disease.

NE_2015_09 **Biomedical Applications of CNC-Thermoplastics for Improved Osteogensis**

Shahab Akmal, Gregg Hamm, Tigor Mihaljevic, Daniel Osorio

Our project focuses on creating an economically viable, nano-filler-infused polymer nanocomposite for use in 3D printing. This is done with the intent of creating innovative surgical screws for bone repair. Our objective is to create these screws with enhanced mechanical strength, bio-compatibility and rapid biodegradability. Our design also enables us to create a product with full customizability through the use of 3D modelling. Different surgical screws can be specifically modelled allowing for more flexibility since not all fractures or breaks, not to mention patients, are the same.

NE_2015_14 **Evergrow**

Pawel Jaworski, Aleksandar Pesic, Leslie Snelgrove, Sonya Wach, Anthony Wang

We are introducing a novel, all-green fertilizer that maintains a slow release of nutrients while retaining water. The fertilizer is composed of nano-silicon and loaded into a biocompatible, FDA-approved food-safe additive—it is as safe, if not safer than most fertilizers currently sold. The benefit of this slow release of fertilizer is that a single dose is comparable to several weeks of daily commercial fertilizer application. The water-retention layer is capable of absorbing upwards of 100 times its own weight, allowing for a prolonged release of water. Formulated with a nanotechnological approach, this fertilizer delivers revolutionary improvements to current fertilizers.

NE_2015_15 **Rapid Vitamin D Detection**

Youssef Helwa, Lucas Lim, James MacLean, Nirushan Udayakumar

Vitameter is developing a product to quickly determine your vitamin levels; first we have concentrated on vitamin D detection. Vitamin D deficiency is a major issue in North America, which has been linked to numerous diseases, and up to a third of the population is deficient. We design a test that is simple to use by the everyday person and can be completed within a few minutes in the comfort of his or her home. This device allows users to determine if they need to take supplement pills, and how many in order to manage their micronutrients.

NE_2015_18 **ExoSkeleton – 3D Printable Nanocomposite Orthopaedics**

Jeff Carette, Matthew Carlucci, Ben Dippelsman, Calvin Xu

The ExoSkeleton is an orthopaedic wrist brace constructed of a nanocomposite material via 3D printing. Utilizing the strength of cellulose nanocrystals paired with the adaptability of the 3D printing platform, the ExoSkeleton offers a highly customizable, economical alternative to conventional custom orthopaedics.

NE_2015_23 **Detecting a Post-operative Anastomotic Leakage**

Jinu Kurian, Dany Younan, Shadman Zaman

Post-surgical internal bleeding is among the leading complications associated with surgery. This capstone project explores the design of an electrolytic sensor which can detect the presence of gastric fluids and/or blood within the abdominal cavity. Detected signals are then relayed to a host device (ie. a computer, tablet, or phone) via wireless transmission alerting the nurse/doctor to any internal leaks.

IV. Nano Functional Materials

Project No.

NE_2015_07 **Water Conditioning by Carboxylated Cellulose Nanocrystals Facilitated Ion Exchange**

Moutaz Al-Huneidi, Jining Huang, Seungwon (Sean) Oh, Nathaniel Zavitz

Hard water is an issue that plagues many natural water sources; the high concentration of alkaline salts causes massive infrastructure damage every year. Modern water softeners are resource inefficient and ineffective in the long run. The current technology still has potential to grow, and by taking advantage of current nanomaterials, some shortcomings may be addressed. The product introduces a nanomaterial with a high specific surface area, allowing an increase in the ion exchange process, which facilitate water softening.

NE_2015_10 **MilleMisceo: Enhanced Coatings**

Jared Lenos, Anand Lopez, Francis Nguyen, Adam Pollit

Scented walls, improved durability, increased lifespan and absence of spiders. Now, all of these features are simultaneously possible by mixing our nano-material additive, MilleMisceo, into water-based paints. Balanced formulations containing widely used insecticides and fragrances create a bug-killing, fragrance-laden, or even mould-busting paint without any harm to the environment. MilleMisceo improves additive effectiveness and longevity, ensuring performance lasts as long as your paint sticks.

NE_2015_12 **Flowable Electrode Capacitive Desalination System With Energy Recovery**

Mason Kolbeck, Rachelle McKeown, Jacob Terry, Zac Young

The UN predicts that by 2025, 1.8 billion people will be living in areas of absolute fresh water scarcity. One option is to tap into our saline water sources, but current desalination methods are not sustainable. We are developing an energy efficient, environmentally-friendly, and cost-effective solution using a flowable electrode capacitive deionization (CDI) system. By employing activated carbon suspension electrodes and a continuous energy recovery system, our device will be sustainable and attractive.

NE_2015_16 **Spill-o-Pill**

Laura Corner, Andrea Erakovic, Ryan Neufeld, Orysia Soroka

Oil spills at sea cause huge environmental damage and cost millions to clean up. The solution? Spill-o-Pill. The exclusive product designed to mitigate the costs and risks of oil spill cleanup. Spill-o-Pill is unique in that it soaks up subsurface oil, that's usually missed by the competition. By using a nanostructured material, oil is absorbed and water is kept out, turning an environmental pollutant into a ready-to-burn fuel source. Spill-o-Pill: a clean ocean is not just a good cause, it's good business.

NE_2015_17 **Grapht**

Devavrat Badami, Raymond Fung, Ricardo Guerrero, Thomas Kennedy

Grapht is an additive for polymeric composites which provides improved thermal and electrical conductivity and mechanical properties, resulting in products with lower costs and longer product life times. Grapht achieves the benefits by overcoming poor graphene dispersion by having the graphene bond directly into the polymer matrix. Grapht will provide a simple and effective solution to produce substitute graphene/polymer composites with the requisite mechanical, thermal, and electrical properties for applications across many fields.