Upcoming Events

For information on upcoming events visit chem-eng.utoronto.ca

Join us on LinkedIn

The Department of Chemical Engineering & Applied Chemistry is now on LinkedIn. We encourage you to keep us updated on your professional news, post discussions and share job opportunities. Joining our group is easy. Visit linkedin.com, create an account (if you don't already have one) and simply search out our group—U of T Chemical Engineering Alumni.

Publications Mail
Agreement No 40780631

interfaces

Alumni & Industry Magazine
Chemical Engineering & Applied Chemistry
University of Toronto

Volume 10, Spring 2013

Biofuels

Chemical Engineering & Applied Chemistry
UNIVERSITY OF TORONTO

Volume 10, Spring 2013
Biofuels

Contents

About This Issue
Printed in Canada by Somerset Graphics using VOC Free UV Inks on Mohawk Options PC100 paper. PC100 is made from 100% Post Consumer Waste using wind generated electricity and is FSC® Certified.

Publisher
Grant Allen
(ChemE 8T1, MASc 8T3)

Editor
Jennifer Hsu

Art Direction & Design
Mark Neil Balson R.G.D.

Thanks
This issue of *Interfaces* was made possible through the contributions of Joan Chen, Brenda Cromb, Cecilia Konney, Megan Murphy, Jane Park, Kathy Weishar and all story participants.

Chemical Engineering & Applied Chemistry
University of Toronto
200 College Street
Toronto, ON
Canada M5S 3E5
T 416.978.8770
F 416.978.8605
external.chemeng@utoronto.ca
www.chem-eng.utoronto.ca

Biofuels — A Way Forward

"…educated workforce that can innovate and solve 'the next' problem while taking a leadership role in its implementation."

There is broad consensus the world has to take significant steps to find more renewable sources of energy, chemicals and materials, as well as reduce our carbon footprint. Though it's not clear what the future state will look like, it will undoubtedly entail a multitude of approaches involving chemical and biochemical systems and a well educated workforce that can innovate and solve 'the next' problem through leadership in its implementation. Biofuels — and more broadly chemicals derived from biomass — are surely going to play a key role in this future, as a replacement for transportation fuels and a source of commodity chemicals.

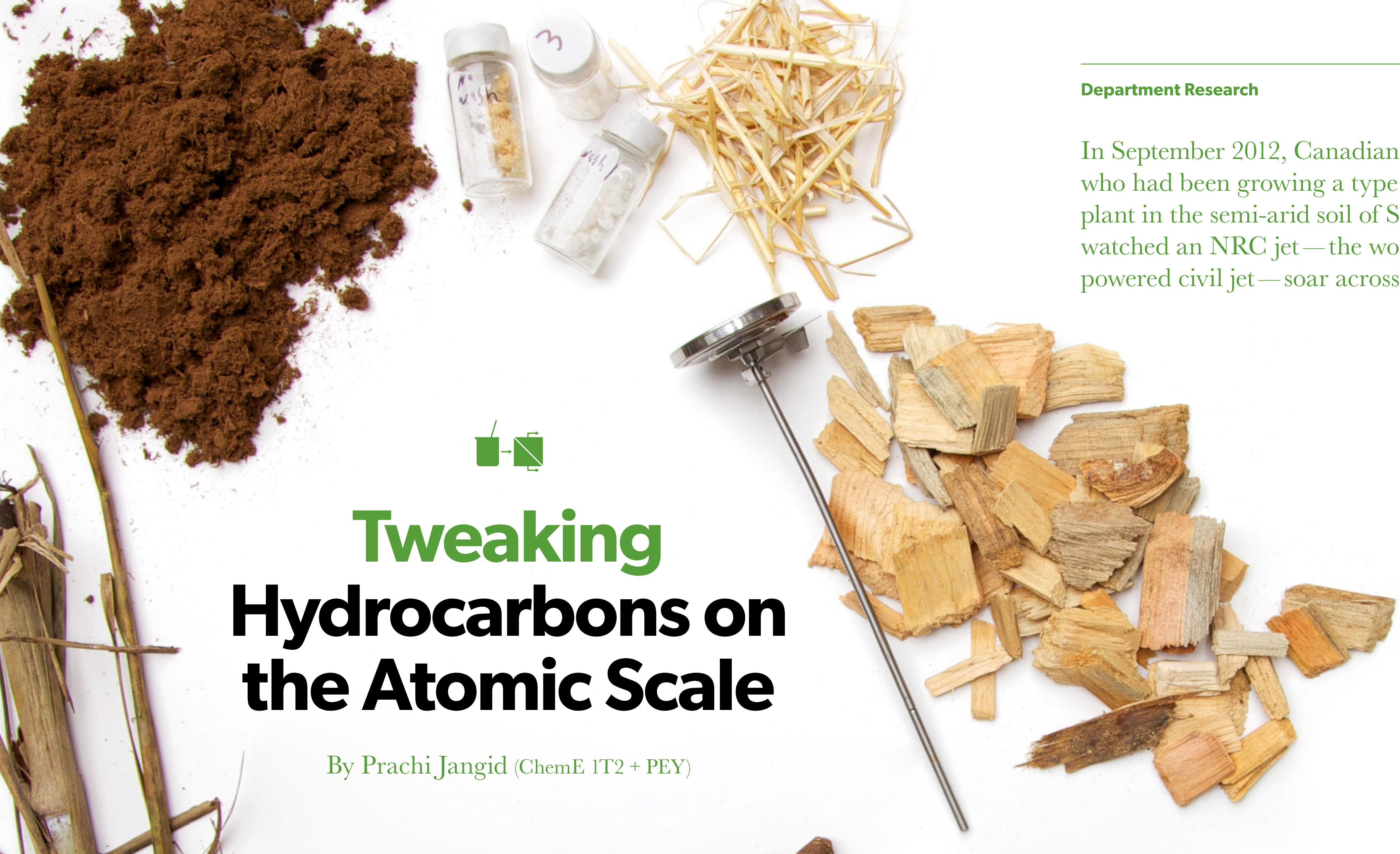
The University of Toronto's Department of Chemical Engineering & Applied Chemistry has a proud history and bright future in the area of biofuels and, more generally, biomass derived materials and chemicals. One of our more recent commercial success stories began in 1994 when Professor Emeritus David Boocock discovered a new, more efficient and significantly less expensive method of converting cooking grease, waste animal fats, recycled vegetable oils and agricultural seed oils into biodiesel. Biox Corporation was created in September 2000 and in 2007 it completed construction of a commercial-scale facility. Many other examples come from alumni such as Frank Dottori (ChemE 6T3), who was part of a great Canadian success story. He led Tembec into a thriving international forest products company that manufactures a wide range of products including the conversion of waste into ethanol and natural gas.

As you'll learn in this issue of *Interfaces*, our students, faculty and alumni are actively engaged in sustainable energy, particularly recovering energy, chemicals and materials from biological sources. Twelve of our faculty and their students work in the conversion of biomass to fuels and chemicals in partnership with more than 20 companies and several colleagues across the Faculty, University, Canada and around the world. The topics are wide ranging. They include biochemical, catalytic and thermochemical conversion processes that occur all the way from the molecular to the process scale. Our efforts go well beyond the process and consider the impact of the process on society and the environment.

The stories you will read not only demonstrate leadership but also partnership. Collaboration of ideas and integration of techniques and knowledge are what has and will continue to drive us to deliver high quality education and research with impact.

I hope you enjoy this issue of *Interfaces* and when you are done please share our magazine with others, join us on Facebook and Twitter, and email us your feedback to let us know how we are doing so far.

Professor **Grant Allen**
(ChemE 8T1, MASc 8T3)



Tweaking Hydrocarbons on the Atomic Scale

By Prachi Jangid (ChemE 1T2 + PEY)

In September 2012, Canadian farmers and researchers who had been growing a type of Ethiopian mustard plant in the semi-arid soil of Saskatchewan, eagerly watched an NRC jet—the world's first 100% biofuel-powered civil jet—soar across the Ottawa sky.

The jet-fuel being tested was the crushed, dried and processed output of an industrially developed variety of *Brassica carinata*, an unassuming leafy crop that grows only in dry soil—the kind that is unsuitable for cultivating competing 'food' crops like canola or corn.

An expert on biofuel technology pathways and platform development, Professor **Bradley Saville** of the Department of Chemical Engineering & Applied Chemistry says that the excitement in the research community about creating chemical analogs of diesel, gasoline and jet fuel is—tangible. Yet even as two of Professor Saville's graduate students (**Pei Lin Chu** and **Katherine Rispoli**) evaluate opportunities in early renewable aviation fuel technology, challenges abound. As Professor **Grant Allen** (ChemE 8T1, MASc 8T3), the Department Chair puts it, "Biomass derived fuel is a sustainable source of liquid energy that can potentially serve our transportation infrastructure." But to replace the petroleum-based fuel in our existing commercial aircrafts and automobiles with clean-burning substitutes, of comparable energy density, storage and thermal properties, which can be produced sustainably without hurting food production, is no slight feat.

The ultimate goal is to reconstruct the biomass into structures similar to fossil fuel to increase its heating values. As always, complex problems demand innovative ways of thinking. "Our idea is to find ways to trick the biomass

derived compounds to break and form the right chemical bonds using the right catalysts to promote the reactions. To solve the big challenge we face, we have to think deeply about the chemistry on the atomic scale," says Professor **Cathy Chin** who leads novel biofuel catalytic research in the Department. Her group applies material synthesis, kinetics, spectroscopy techniques and reaction engineering to deliver renewable fuel. The big hope for biofuels lies in developing the best way to extract energy from the tough, fibrous stuff of plants that is cellulose, or *cellulosic biomass*.

Approximately 75% of all plant material is made of cellulose, so a new chemical analog of gasoline could be produced from a myriad of sources. Like the arid-soil oilseed crop, cellulosic biomass-derived fuel is the atypical alternative that sidesteps the food vs. fuel debate. Even better, processing of cellulosic biomass (like crude oil processing) can deliver valuable co-products that find applications in the plastics, pharmaceutical and healthcare industries. The exciting news is that the Department of Chemical Engineering & Applied Chemistry at U of T has been actively exploring different sources and applications of cellulosic biomass, and is collaborating with researchers and industry partners to find faster, cheaper and more efficient ways of transforming cellulose to biofuel.

In a third floor lab of the Wallberg building, Professor Allen and his research team grow algae. "Algae as a source of biofuels is promising because it grows fast, has high oil content and doesn't compete with food." Professors Allen, **Edgar Acosta**, Stewart Aitchison (ECE), **Levente Diosady** (ChemE 6T6, PhD 7T2) and George Espie (UTM) have an NSERC Strategic Grant involving partner companies Biox, DSM and Pond Biofuels. Through collaborative efforts between engineers, biologists and experts in photonics from the Department of Electrical & Computer Engineering, and the Department of Cell & Systems Biology at UTM, Professor Allen and team are developing an algal biofilm system to grow algae at a low cost and large scale in a non-sterile environment. The hypothesis is that growing algae as a film will greatly reduce the costs and energy associated with removing water in conventional systems. The team is also developing cutting-edge technologies to describe the hundreds of species that are part of the microbial algal community to accurately analyze and optimize the biofilm.

In another lab on the third floor, Professor Saville's team has identified that co-product development can make a critical economic and environmental difference for the biofuel industry. "We can use the co-products to displace high carbon intensity products currently in the marketplace and get a phenomenal GHG reduction. But, in some cases with low GHG impact, the co-products can have other benefits. Take for instance, xylitol, a low-calorie sugar alcohol with health benefits." Professor Saville is working with Xylitol Canada in collaboration with researchers at the University of Guelph on implementing xylitol technology.

Society's need and consumption for fuel is not something that is going to disappear, and our world supply of petrochemicals is not something that will increase. The departmental projects described play a major role in addressing the global energy challenge while considering issues surrounding our food supply. Although there is still much that needs to be done to make biofuels economic and practical, the creative ideas being developed in our Department bring us one step closer to a sustainable future where our reliance on petrochemicals and our carbon footprint will decrease substantially. i

Alumni Profile

Branching Out

By Prachi Jangid (ChemE 1T2 + PEY)

How to be? That *is* the question. At least it is a question that the Canadian forest industry has been tackling with, on and off, for the past decade.

Faced with a global economic recession, the strengthening CAD dollar, rising competitors and the increasingly unanimous move to a paperless existence, the 57 billion dollar Canadian forest industry that employs 230,000 people directly and 600,000 indirectly is rapidly adapting itself to defend and develop its status as the world's largest exporter of forest products. **Catherine Cobden** (ChemE 8T9), Executive Vice President at Forest Products Association of Canada (FPAC), credits technology and innovation as game changers that have enabled the industry to reposition itself competitively and revise its fundamental business model. "From biofuels, biomaterials, biochemicals to biotextiles—technological development, creativity and innovation have led us to do so much more with the Canadian fibre base than what was possible when I started in the industry 22 years ago," she says. A passionate and strategic voice for the Canadian forest sector, Cobden has been facilitating the Canadian Forest Sector Transformation

"We are pushing for higher value-added products, and trying to ensure that we do this in a way that makes us the environmental and business leaders of choice globally."

Strategy at FPAC and the Vision2020 project for the entire industry. An articulation of what the forest industry is capable of, the two projects together will help enable the Canadian forest sector to reduce its environmental footprint by 35%, add 20 billion dollars of economic activity and recruit at least 60,000 new hires by 2020.

From curious undergrad to chemical engineer to environmental manager, and onto fully formed lobbyist and a leading advocate of the Canadian forest sector, Cobden has been on a fascinating career trajectory. As a Chemical Engineering undergrad at U of T's Pulp & Paper Centre (PPC), Cobden may not have predicted that in 22 years she would become one of the Canadian forest industry's foremost voices. But for the past two decades, Cobden's work has been enabling pulp mill operations to become cleaner and more competitive.

Cobden first became aware of the immense potential of the forest industry through her undergraduate thesis work at the PPC. "My overall experience as an undergrad in the PPC set me up for the forest industry. It helped me to understand that the forest industry had everything a chemical engineer could dream of—different types of processes, unit operations and environmental challenges."

In the mid- and late-80s, Canadian pulp mills faced intense environmental scrutiny to control the release of aquatically persistent toxic compounds in effluents out of bleach plants, among other facilities. In 1988, a 21-year old Cobden was introduced, and in a way initiated into the Canadian forest sector by Professor **Doug Reeve** (MASc 6T9, PhD 7T1) who founded U of T's PPC as an educational institute and industry partner to help tackle such challenges through collaborative research. Around the time Cobden presented her thesis on AOX effluent control to the Faculty, a supertanker accidentally released 11 million gallons of crude oil into pristine waters fueling a further restructuring of environmental policy across all industries in North America. Three years later, the Canadian federal government revised and passed strict environmental regulations governing pulp mill operations and effluent release. At 22 years, Cobden realized through her research that the forest sector was under severe environmental and economic pressure. The industry could offer her a vast range of opportunities to think creatively and grow as a chemical engineer. She began her career as a process engineer for a small pulp mill in Northern Ontario, and at one point managed North American operations at Bowater as the company's Director of Environment. Then Cobden joined the public sector as a lobbyist at Fleishman Hilliard before finally taking on the role of Strategic Leader at FPAC, where she has led key forest industry initiatives for both the pulp and paper and lumber sectors over the past 10 years.

At FPAC, Cobden has guided the landmark Bio-Pathways study, a pre-cursor of Vision2020. In late 2008, a cross-functional research team of economists, bankers, engineers and researchers began to evaluate 36 different technology pathways and platforms to deeply understand feasible growth opportunities available to the Canadian forest industry. "One of the most interesting conclusions of the study was that economically, without a doubt, you are much better off building and integrating new production facilities with existing pulp and paper mills and existing saw mills than building standalone biofuel plants," she says. "Now pulp mills are transforming into bio-refineries. We are pushing for higher value-added products, and trying to ensure that we do this in a way that makes us the environmental and business leaders of choice globally."

Over the past decade, the Canadian forest industry has been trying to figure out how to be and it now appears that like Cobden, the industry has a bright future ahead. i

Sustainability is the Common Thread

By Mark Witten

Sustainability is also the underlying meaning that has driven the graduate engineering studies and career of **Sabina Di Risio** (MASc 0T5, PhD 0T9) in the emerging bioeconomy.

As a lab manager and technical assistant to the director of a large pulp and paper mill in her native Argentina in 2002, Di Risio became very interested in new bleaching technologies that could reduce dioxin emissions and make the pulping process more environmentally friendly. "Enzymatic bleaching caught my eye. There are things you can accomplish with enyzymes that you can't through chemical means. That was the seed of my interest in sustainability," she says.

After reading the bible in the area, *Pulp Bleaching: Principles and Practice*, co-authored by Professor **Douglas Reeve** (MASc 6T9, PhD 7T1), Di Risio delved into the research activities of U of T's Pulp & Paper Centre (PPC). "I dreamt that one day I could study those topics and do some research in the PPC," she says. Di Risio contacted several professors and was accepted to do her MASc with Professor **Ning Yan** (PhD 9T7), whose Bark Biorefinery project aims to replace petroleum-based materials with green value-added products developed by converting bark.

Inspired by her grandfather, who had emigrated to Argentina from Italy with only a primary school education, Di Risio decided to go for it. "My grandfather was a very hard worker who took the risk to make a big change. He inspired me. The university environment in Canada is an open space where you can develop your potential," she says.

Di Risio's dream of doing research in the PPC was richly realized: first, through her award-winning master's work developing a method to visualize and quantify the distribution of paper coating components such as pigments, binders and pores at the nanometer scale. Then, she took on the technically challenging and meaningful PhD project of developing bioactive paper products for use in low-resource settings.

"Being born in Latin America, I have direct experience of the impact of poverty and resource limitations on people's lives. Access to health, education, pure water and clean air is not a right but a privilege. The field of bioactive papers was exciting because of its potential implications in developing cheap, disposable, paper-based devices for rapid detection of substances potentially harmful to people or the environment," she says.

Di Risio earned the PPC's Howard Rapson Prize, recognizing academic excellence and student leadership in graduate studies, and the Louis Georgevits Memorial Prize for an article on paper coating structure, co-authored with Professor Yan. She also received several Henry Bolker Awards in the Best Student Oral Presentation category for her MASc research and PhD work on using inkjet technology to deliver an enzyme-based bioink to paper.

To develop an effective enzyme-based bioink formulation, Di Risio consulted regularly with Professor **Bradley Saville**, the enzymes expert on her PhD committee. After she graduated in 2009, this led to an opportunity to work on a major collaborative research program for SunOpta Bioprocess, a Brampton-based second-generation biofuels company, under his supervision.

"What attracted me to this was the possibility of developing technologies that will reduce our dependence on fossil fuels," says Di Risio, who started as a part-time research assistant and was then offered a job managing the pilot plant and lab. "I gained tremendous experience scaling up from lab to pilot plant, analyzing process data, supervising a group of very talented technicians and engineering graduates, and interacting with experts in the field like Professor Saville."

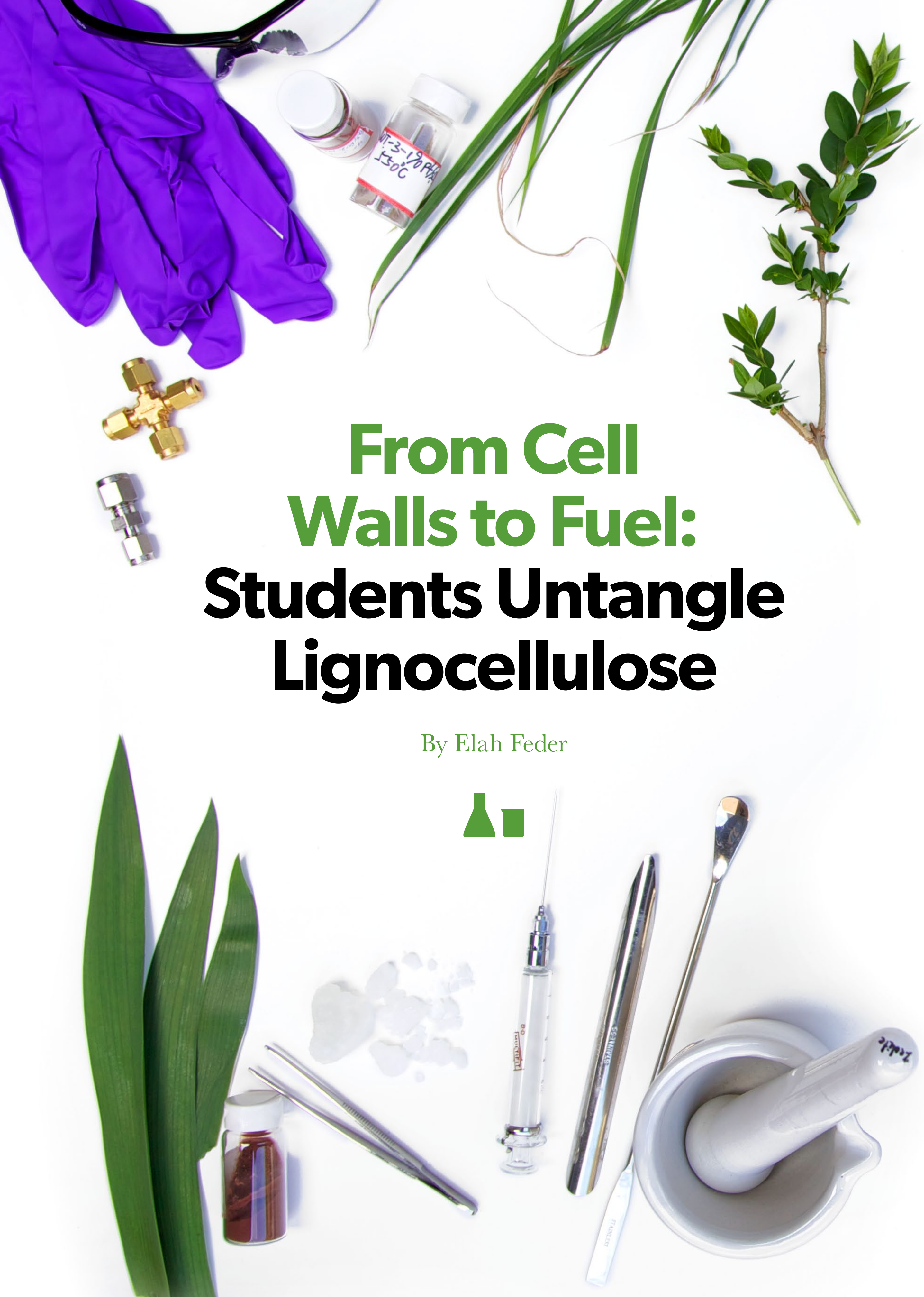
"What attracted me to this was the possibility of developing technologies that will reduce our dependence on fossil fuels"

Second-generation biofuels companies are developing technologies to convert biomass from non-food materials, such as wood, switchgrass and crop residues, into biofuels in a low-cost, sustainable way. Di Risio helped plan and run more than 6,000 hours of lab to pilot plant trials to test and validate strategies for converting cellulose from poplar trees into cellulosic ethanol. The validation trial demonstrated that certain process engineering strategies resulted in much higher sugar yields, lower enzyme costs and higher solids content, allowing for the use of smaller, less capital-intensive bioreactors. "It worked very well and exceeded the objectives," says Di Risio, noting that such advances can help to make second-generation biofuels technically and commercially viable in the future.

After SunOpta BioProcess merged with Mascoma Corp. in 2010, Di Risio worked on strategic R&D projects for Mascoma Canada, such as modeling and analyzing different processes to produce second-generation cane ethanol from *bagasse*, the residue of sugar cane. Having grown up in an area of Argentina where bagasse was burned to produce energy, Di Risio was eager to investigate its potential as part of a research group that included Mascoma co-founder Dr. Lee Lynd. "We were able to show it's economically viable to produce cellulose ethanol from bagasse in a sugar cane mill," she says. These promising findings were presented at a 2011 ethanol summit in Brazil, the world's largest producer of sugar cane ethanol.

When giving talks to Chemical Engineering students at U of T, Di Risio compares the structure of her career to the structure of a protein. Like in proteins, the twists and turns in a career are part of the structure. The most recent career turn came in the spring of 2012 when she was hired as Manager of Lab and Analytical Services for the Centre of Innovation at EcoSynthetix in Burlington, a fast-growing biomaterials company and winner of the 2012 Ontario Ernst & Young Entrepreneur award in the Cleantech category. "Working for a company that applies green chemistry to transform renewable resources into high performance biomaterials that replace petroleum-based materials is motivating and meaningful," says Di Risio, who first met the founders of EcoSynthetix, John van Leeuwen (CEO) and Steven Bloembergen (EVP Research), as an MASc student attending presentations at conferences.

The twists and turns of Di Risio's education and career have unfolded in unexpected and amazing ways. "As I mature, I have found some glimpses of the final structure of the protein, the purpose, the essence, the why. I see a certain type of protein, an enzyme. I seek for my career to be a catalyst for positive change that can bring progress in a sustainable way," she says. i



From Cell Walls to Fuel: Students Untangle Lignocellulose

By Elah Feder

Student Profile

In many ways, lignocellulose is the ideal feedstock for biofuels. This bundle of cellulose strings, woody lignin and hemicellulose bridges that make up a plant's cell wall is cheap, abundant and far more sustainable than edible alternatives like corn.

Unfortunately, the complex is also exceptionally difficult to untangle, so rather than dissect out the constituent polymers, one approach would be to first deconstruct the biomass by pyrolysis, essentially blasting it with high heat and pressure until all that remains is a soup of molecules.

A major question for researchers, then, is how we might effectively exploit the untapped potential of this unwieldy biomass. Among those tackling the problem are **Fan Lin** and **Alex Tsai**, Chemical Engineering grad students taking two entirely different approaches to making lignocellulose a viable fuel source.

Lin, a PhD student with Professor **Cathy Chin**, is attacking the post-pyrolysis end of the problem, investigating how to efficiently upgrade common pyrolytic products, like aldehydes and ketones, into fuel grade hydrocarbons. By removing oxygen and lengthening carbon chains, Lin hopes to create liquid phase, energy-rich molecules, and he's started off by experimenting with zeolite, a porous crystalline catalyst with nanometer sized structure that's been widely used in the petrochemical industry.

"It's not a new material, but the application of this catalyst in biofuel synthesis is new," Lin explains. His experiments to date have focused on aldehydes, and so far he's been able to convert them into various hydrocarbons, like olefins and aromatics without using any additional hydrogen. Now his goal is to manipulate the reactions to build larger, liquid phase molecules that mimic the fossil fuels.

But what if we didn't decompose lignocellulose into such small, low-utility molecules in the first place? What if plants could be made such that their cell wall components are easily separated into lignin, cellulose and hemicellulose, which are useful polymers in their own right? Tsai, a PhD student with Professor **Emma Master**, is working to create plants that do just this. If successful, the polymers that make

up lignocellulose will be more easily extracted, not just for biofuels, but for a broad range of industrial applications.

In a recent experiment published in *Plant Biotechnology*, Tsai inserted a white rot-derived gene encoding a carbohydrate esterase into *Arabidopsis thaliana*. The strategy was simple in concept: take enzymes normally used by fungi to attack plants, and have the plants themselves deploy those enzymes against their own cell walls. The technique conjures a somewhat unsettling image of a plant digesting itself as it grows, but Tsai assures that the reality is far less dramatic. A better way to conceive of it, he explains, is a gentle loosening of the lignocellulosic complex through targeted enzyme cuts. And Tsai has confirmed that it's working. Using Fourier-transformed infrared spectroscopy, he's shown that his transgenic lines have reduced cross-linkages in the lignin. Notably, this analysis also verified the importance of these linkages in *Arabidopsis*.

"It was at a conference," Tsai recalls, "Someone was telling me, 'Your work is really amazing. You're working on a linkage that no one has proven to exist before!'" While it might have been a frightening thought, Tsai is now able to laugh. After all, the gamble seems to have paid off.

At this stage, there's a lot more work to be done to dismantle the cell wall complex, but already Tsai has been able to show that hemicellulose is much more easily extracted from his transgenic plants, relative to the wild-type. Specifically, the same amount of sodium hydroxide extracts a higher fraction of xylan (a type of hemicellulose) from the majority of transgenic lines compared to wild-type plants. "It's not consistent in all lines," Tsai admits, "but at least it gives a glimmer of hope that it might be doing something that you are expecting it to do."

Lin is at a much earlier stage with his research, having just recently converted to the doctoral program. He's enjoying the challenge of designing new catalyst materials and understanding their functions. Having completed his experiments with zeolite, he's getting ready to explore other catalyst structures, such as sulfated zirconia, and introduce new functions into the catalyst to enable new reactions to see whether he can manipulate the reactions to build a specific group of molecules that can readily be used as commodity chemicals or liquid fuels.

Still, at this stage, Lin has more questions than answers, and Tsai, though further along in his program, knows the feeling. Although he succeeded in loosening the lignocellulosic complex, his plants exhibited a number of unintended changes as well, including a reduction in xylose and glucose content and some leaf yellowing. Both effects have been observed in other transgenic lines, but remain unexplained nonetheless. Tsai is undaunted.

"You ask one question. You solve it. You have ten more questions to answer," Tsai muses. "That's where science gets interesting." i

Honours & Awards

Members of the Department of Chemical Engineering & Applied Chemistry at U of T are what helps set us apart from the rest.

We are extremely proud of the number of awards and acknowledgements received by our alumni, faculty, staff and students over the last academic year. Congratulations to each of them on their major achievements.

Alumni

Arbor Awards
Scott MacKendrick (ChemE 8T2)

Ontario Professional Engineers Awards: Gold Medal
Bert Wasmund (PhD 6T6)

Ontario Professional Engineers Awards: Management Medal
John Bianchini (ChemE 8T5)

Professor Bill Burgess Teacher of the Year Award
2011
Chris Ambidge
2012
Yuri Lawryshyn (PhD 9T7)

Professor Diran Basmadjian Teacher of the Year Award
2011
Donald Kirk (PhD 7T5)
2012
Alison McGuigan (PhD 0T5)

The Small Young Innovator Awards
Ali Khademhosseini (ChemE 9T9, MASc 0T1)

Society for Chemical Industry: International Award
John Bianchini (ChemE 8T5)

Faculty

The Bill & Melinda Gates Foundation Grant
Yu-Ling Cheng
Levente Diosady (ChemE 6T6, PhD 7T2)
Elizabeth Edwards
Mark Kortschot (MASc 8T5)
Yuri Lawryshyn (PhD 9T7)

Canadian Academy of Engineering: Fellow
Grant Allen (ChemE 8T1, MASc 8T3)
Molly Shoichet

Canadian Academy of Health Sciences: Fellow
Molly Shoichet

Canadian Foundation for Innovation Leading Edge Fund
Charles Mims

Canada Research Chairs: Renewed
Molly Shoichet

The Canadian Society for Chemical Engineering: R.S. Jane Memorial Award
Michael Sefton (ChemE 7T1)

The Canadian Society for Chemical Engineering: Syncrude Canada Innovation Award
Edgar Acosta

Honours & Awards

Faculty

Engineers Canada: Young Engineer Achievement Medal
Milica Radisic

Governor General of Canada: Queen Elizabeth II Diamond Jubilee Medal
Levente Diosady (ChemE 6T6, PhD 7T2)
Milica Radisic
Molly Shoichet

International Academy of Food Science and Techonolgy: Fellow
Levente Diosady (ChemE 6T6, PhD 7T2)

International Fellows of Tissue Engineering and Regenerative Medicine: Fellow
Molly Shoichet

McLean Award
Milica Radisic

New Jersey Center for Biomaterials: Biomaterials Achievement Award
Michael Sefton (ChemE 7T1)

North American Mixing Forum Early Career Excellence Award
Arun Ramchandran

Northrop Frye Award
Greg Evans
(ChemE 8T2, MASc 8T4, PhD 8T9)

NSERC CREATE Program in Environmentally Sustainable Aviation
Emma Master

NSERC Discovery Accelerator Supplements
Miriam Diamond (PhD 9T0)
Ning Yan (PhD 9T7)

NSERC Strategic Project Grants
Elizabeth Edwards

Ontario Research Fund: Research Infrastructure
Cathy Chin

NSERC Collaborative Research and Development Grant
Honghi Tran (PhD 8T2)

NSERC Research Tools and Instruments Grants
Cathy Chin
Molly Shoichet

Research Leader Award
Elizabeth Edwards
Radhakrishnan Mahadevan
Emma Master

Royal Society of Canada: Fellow
Elizabeth Edwards

Society for Industrial Microbiology and Biotechnology Young Investigator Award
Radhakrishnan Mahadevan

Vivek Goel Faculty Citizenship Award
Michael Charles

Staff

Quality of Student Experience Award
Deborah Peart

Students

Canadian Institute of Food Science and Technology Scholarships 2013
Praneet Bagga (ChemE 1T4)
Joanna Ropero (ChemE 1T3 + PEY)
Neha Mithia (ChemE 1T3)
Solmaz Tabtabaei (PhD Cand.)
Elisa McGee
(ChemE 1T0, MASc 1T2, PhD Cand.)

Chemical Engineering Plant Design Award
2011
Janice Cheng (ChemE 1T1 + PEY)
Priscilla Kwan (ChemE 1T2)
Khazaneh Tahvildar (ChemE 1T2)
Fiona Neill (ChemE 1T1 + PEY)
Warda Hoque
(ChemE 1T1 + PEY, MEng Cand.)
Yi-Chen Tsai (ChemE 1T2)
2012
Arjang Tajbakhsh (ChemE 1T2 + PEY)
David Castelino (ChemE 1T3)
Mina Kong (ChemE 1T3)
Ali Soeherman (ChemE 1T2 + PEY)
Angell Yang (ChemE 1T3)
Jordan Yusufali (ChemE 1T3)

Class of 5T9 Leaders of Tomorrow Award
2012
Tameka Deare (ChemE 1T3 + PEY)
Ajay Kochhar (ChemE 1T3)
Larissa Rodo (ChemE 1T3 + PEY)
2013
Lobna El Gammal (ChemE 1T4)
Patrick Polvorosa (ChemE 1T4)

The Canadian Society for Chemical Engineering: Reg Friesen Student Competition 2012
ChemE Education: 1st Place
Lobna El Gammal (ChemE 1T4)
ChemE Education: 2nd Place
Amit Unadkat (ChemE 1T3)

The Canadian Society for Chemical Engineering: Robert G. Auld Student Competition 2012
ChemE Technical Research: 2nd Place
Alex Koven (ChemE 1T3)
ChemE Technical Research: 3rd Place
Kathak Vachhani (ChemE 1T4)

The Canadian Society for Chemical Engineering: Student Chapter Merit Award 2012: 2nd Place
U of T CSChE Student Chapter

Environmental Engineering Plant Design Award
2011
Adam Dwyer (ChemE 1T1 + PEY)
(Ian) Yin Liu (ChemE 1T1 + PEY)
Melissa Battiston (ChemE 1T1 + PEY)
Jozef Maka (ChemE 1T1 + PEY)
Nirupa Balendran (ChemE 1T3)
Tasmia Tabassum (ChemE 1T3)
2012
Adriano Arnini (ChemE 1T3)
Anika Mohammed (ChemE 1T2 + PEY)
Amir Mohamed (ChemE 1T3)
Sonia Liscio (ChemE 1T3)
Xiaobo Pan (ChemE 1T3)

Eco-Tec Founder's Fellowship
2012
Pooya Azadi Mansour
(MASc 0T7, PhD 1T2)
Thomas Wood
(ChemE 0T7, MASc 1T1, PhD Cand.)
2013
Hamideh Hajija
(ChemE 0T7, MASc 0T9, PhD Cand.)
Olivia Molenda (PhD Cand.)

Edward Jarvis Tyrrell Fellowship
2012
Umme Salma Akhtar (PhD Cand.)
Adrian Vega (PhD Cand.)
2013
Umme Akhtar (PhD Cand.)
Jeremy Dang (PhD Cand.)

ERCO Worldwide Leaders of Tomorrow Award
2012
Laura Burget (ChemE 1T5)
2013
Albert Huynh (ChemE 1T2 + PEY)

Gordon Cressy Student Leadership Awards
2012
Janice Cheng (ChemE 1T1 + PEY)
Sami Khan (ChemE 1T1 + PEY)
Graham Morse (PhD 1T2)
2013
Albert Huynh (ChemE 1T2 + PEY)
Ajay Kochhar (ChemE 1T3)
Arjang Tajbakhsh (ChemE 1T2 + PEY)

Honours & Awards

Students

Graduate Student Life Catalyst Award 2012
Rhiad Gajraj (ChemE 1T0, MASc 1T2)
Jine Jine Li (MASc 1T2)
Angela Tran Kingyens (ChemE 0T5, MASc 0T7, PhD 1T2)

Helen L. Cross Memorial Award
2012
Karyn Susana Ho (PhD 1T2)
Alex LaPlante (MASc 1T2, PhD Cand.)
2013
Rosanna Kronfli (ChemE 1T1, MASc Cand.)

Howard Rapson Prize
2012
Azadeh Bagherzadeh Namazi (PhD Cand.)
Rosanna Kronfli (ChemE 1T1, MASc Cand.)
2013
Faraz Azadi Manzour (MASc 0T7, PhD 1T2)
Xiaoxing Jin (ChemE 1T1, MASc Cand.)

Irving O. Shoichet Graduate Scholarship
2012
Elizabeth Csaszar (PhD Cand.)
Sahar Javaherian (PhD Cand.)
2013
Miles Montgomery (MASc Cand.)
Boyang Zhang (PhD Cand.)

Ontario Food Protection Association Scholarships
2012
Yousuf Ali (ChemE 1T2)
Wael Charanek (ChemE 1T2)
Warda Hoque (ChemE 1T1 + PEY, MEng Cand.)
Juwairia Obaid (ChemE 1T1 + PEY)
Fan Zhang (ChemE 1T1 + PEY, MEng Cand.)
2013
Sonia Liscio (ChemE 1T3)
Neha Mithia (ChemE 1T3)
Nicole DiMonte (ChemE 1T3)
Satita Vidayakorn (ChemE 1T3)
Ajay Kochhar (ChemE 1T3)

Professor Douglas Reeve Leaders of Tomorrow Award
2012
Maygan McGuire (PhD Cand.)
Angela Tran Kingyens (ChemE 0T5, MASc 0T7, PhD 1T2)
2013
Alex LaPlante (MASc 1T2, PhD Cand.)
Peter Schnurr (PhD Cand.)

Professor James W. Smith Leaders of Tomorrow Award
2012
Praneet Bagga (ChemE 1T3)
2013
Stephanie Fata (ChemE 1T5)

Sustainable Engineering Plant Design Award
2011
Serene Sow Mun Lock (ChemE 1T2)
Jia Yi Guan (ChemE 1T1 + PEY, MEng Cand.)
Mizuka Kobayashi (ChemE 1T1 + PEY)
Kenneth Zhi Jian Tan (ChemE 1T2)
Nikhita Sathish (ChemE 1T2)
2012
Ajay Kochhar (ChemE 1T3)
Anderson Chin (ChemE 1T3)
Malvinder Singh (ChemE 1T2 + PEY)
Noosheen Walji (ChemE 1T3)
Tsai-Hsin Yeh (ChemE 1T2 + PEY)

Trinity College Dublin Undergraduate Awards 2012
Sami Khan (ChemE 1T1 + PEY)

Troost Family Leaders of Tomorrow Award
2012
Abby Eldib (ChemE 1T2)
Schnelle Gopalan (ChemE 1T2)
Jessica Ng (ChemE 1T1 + PEY)
2013
Kelly-Marie Melville (ChemE 1T3)

Undergraduate Student Life Catalyst Award 2012
Sami Khan (ChemE 1T1 + PEY)
Kelly Bryck (ChemE 1T1 + PEY)
Sean Salonga (ChemE 1T1 + PEY)
Jessica Ng (ChemE 1T1 + PEY)
Schnelle Gopalan (ChemE 1T2)

William J. Dowkes Graduate Bursary
2012
Mohammad Ahsanul Islam (PhD Cand.)
2013
Nikolaos Anesiadis (MAsC 0T7, PhD Cand.)

Inaugural Weston Fellowship
Julie-Anne Gandier (PhD Cand.)

In Memoriam

It is with regret that we have learned of the passing of the following ChemE graduates since the last issue of *Interfaces*

Thomas Calvin (ChemE 5T6)
February 21, 1933 – June 15, 2012

Lorne Russell Farquhar (ChemE 4T7)
March 4, 1925 – May 2, 2013

John Clinton Fisher (ChemE 5T0)
March 20, 1925 – July 24, 2012

Rodney Victor Klassen (ChemE 5T0)
September 30, 1927 – July 12, 2012

Arthur Roy Love (ChemE 5T0)
September 17, 1926 – March 3, 2013

Paul Denis Oliver (ChemE 5T4)
August 21, 1932 – September 22, 2012

Richard C. Quittenton (ChemE 4T3, MASc 4T8, PhD 5T3)
July 7, 1921 – June 18, 2012

R. James Raycroft (ChemE 6T0)
December 9, 1923 – March 10, 2013

Alexandar Murray Reid (ChemE 4T1)
November 11, 1919 – July 25, 2012

Robert Arnott Richardson (ChemE 6T0)
June 10, 1937 – February 10, 2013

George Webster (ChemE 5T3)
December 27, 1927 – February 26, 2012