Fall 2005

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The Catalyst

University at Buffalo The State University of New York

Department of Chemical & Biological Engineering News

Message from the Chair

Carl R. F. Lund

David Kofke is one of the most thoughtful guys I know. By that I don't mean that he always remembers my birthday and sends me a card if I'm ill. No, what I mean is that he thoroughly thinks things through before acting on them. (Well, most of the time; ask him about vacuuming wallboard dust off his living room couch.) In addition, Dave is forthright and highly respected here at U.B. and throughout the chemical engineering community. As such, I know that my successor as the Chair of CBE is the right person for the job, and I am also confident that if he is supported by the faculty, students, staff, alumni and administration in the same way that I was, the department will flourish.

It's not my style to get all sappy and weepy as I pass the torch, so I won't. However, I don't want to move on without saying "thank you." There isn't sufficient time or space to mention all the ways I've been helped and supported by the faculty and staff of the department during the past eight and a half years. I'd particularly like to thank Darlene for all the help and assistance she's provided.

I'll be spending part of my time in the future as the Associate Dean for Research. As such, I'd like to ask you to keep U.B. in mind whenever your company is looking for collaboration or to outsource research. The School of Engineering has a tremendous breadth of expertise and capabilities, and our graduate students are talented and motivated. In addition to solving technical challenges, collaborative research programs often prove to be an excellent means of hiring. Collaborative projects can supply new employees who can step in and have immediate impact because they are already up to speed in an area of importance to the sponsoring company.

As long as I'm in a "what can the alumni do for us" mode, I'll also point out that U.B. produces some truly outstanding undergraduates. It is my impression that these excellent students are under-recruited. Recruiting has changed considerably since I was an undergraduate, with fewer corporations going to a smaller number of campuses to recruit. If your company is interested in identifying highly competent, entry-level chemical engineers, I'd encourage you to contact the U.B. Placement Office, participate in the U.B. career fair, or contact the students directly through AIChE, Tau Beta Pi or other student organizations.

Seems I've developed a theme and I'm on a roll now: there's yet another thing you can do for us. Elsewhere in this issue of *The Catalyst*, you'll read about a re-structuring of the undergraduate curriculum. The department sincerely wants to hear your feedback related to the changes. Please take a few moments to consider the revisions and send us your comments and thoughts. Would the modified curriculum have served you better or worse in your career? Will it serve a 2010 U.B. Chemical Engineering graduate better or worse than the old curriculum, and why?

Finally, as always, drop us a line and let us know what's new in your life. The AIChE Meeting in Cincinnati provided an opportunity for getting re-acquainted with a few of our alumni. Personally, it was great to re-connect with a few of you who were graduate students when I first came to U.B., seeing you for the first time in almost 20 years. Similarly, a few of you dropped in here on campus when you were back in the Buffalo area. I truly enjoy spending a little time catching up and reminiscing.▪

*The CBE Faculty, Staff and Students would like to express our heartfelt thanks and appreciation to **Carl Lund** for his selfless years of service as our Department Chair!*

Tzanakakis Receives NYSTAR James D. Watson Award to Support Stem Cell Research

For diabetes patients, who can't produce their own insulin, human stem cell-based transplants that produce insulin would be a major breakthrough.

But current laboratory methods of culturing human stem cells result in very limited quantities, far short of the quantities necessary for therapeutic applications.

For that reason, Dr. Emmanouhl (Manolis) Tzanakakis, CBE Assistant Professor, is striving to boost the numbers of stem cells produced in the laboratory, expanding the pool of cells that eventually can be differentiated into insulin-producing cells.

Dr. Tzanakakis has received a $200,000 James D. Watson Investigator Grant award to support his studies from the New York State Office of Science, Technology and Academic Research (NYSTAR). He is one of six researchers throughout the state to receive the award this year.

His ultimate goal is to conduct research to develop methods that will allow sufficient quantities of differentiated cells that secrete insulin to be produced from the stem cells. Such cells could be used for diabetes therapies, including transplantation into patients, freeing them from the lifelong necessity of daily insulin injections.

"One of the main obstacles to using stem cells as any kind of human treatment is that you need many more cells than now can be produced in the laboratory systems," said Tzanakakis. "The key questions are, 'How do you generate large quantities of cells for patients?' and then 'How do you get them to differentiate to a specific cell type?'"

Working with adult and embryonic stem cells derived from both mice and humans, Tzanakakis and other groups use bioreactor systems, vessels containing growth media and stem cells, that have the potential to produce high densities of undifferentiated cells.

He noted that success will require enhanced understanding of the molecular mechanisms that regulate self-renewal, or regeneration, of stem cells. "With sound engineering and the application of biological principles, I believe we can achieve large-scale expansion of stem cell production," he said.

He also is exploring ways of inducing larger numbers of stem cells to differentiate into those that produce insulin, based on an understanding of how the pancreas develops in the embryo.

"Although we are a long way from generating cells identical to native beta cells, using stem cells, we are trying to coax stem cells into becoming insulin-producing cells," he said. "To achieve this, cells are treated with growth factors, which are important to the development of the embryonic pancreas effectively mimicking that developmental process, to some extent."

Before coming to the CBE Department in 2004, Dr. Tzanakakis held post-doctoral positions at the Diabetes Center in the Department of Medicine at the University of California, San Francisco, and at the Stem Cell Institute in the Department of Medicine at the University of Minnesota.

He has also received funding for this research from the Juvenile Diabetes Research Foundation.▪

(We would like to thank Ellen Goldbaum and UB News Services for contributions to this issue.)

New Department Web Site

In our previous newsletter we reported that the Department's web site had been given a makeover. The new site went live a few weeks after the newsletter was mailed, so if you visited too soon, you didn't get to see it. Have a visit there sometime (the address is ***www.cbe.buffalo.edu***), and if you have comments or suggestions about it, please let us know. We'll write about the site again as we introduce more features that may be of interest to you. ▪

Nanomaterials Engineering in the Swihart Group

By Mark T. Swihart, Associate Professor

Over the past decade, there has been tremendous scientific and technological interest in nanotechnology, broadly defined as the manipulation of matter on length scales of one to a few hundred nanometers (billionths of a meter). This is a size range in which many materials exhibit properties that are size dependent and that are different from those of the corresponding bulk material. In the context of preparing materials for electronic, magnetic, photonic, and biological applications, this provides an additional degree of design freedom, along with the composition, phase, etc. of the material in question. One component of nanotechnology consists of the preparation of *nanomaterials*. These can be defined as human-made substances with useful properties that are imparted by chemical and structural features at the nanometer length scale.

In the Swihart group, we are studying the formation, modification, and applications of a variety of nanomaterials. This is a field where chemical engineers have a tremendous opportunity to contribute, not only in the discovery of new materials and synthesis routes but, more importantly, in the quantitative understanding of nanomaterials synthesis and processing, and in the transformation of laboratory-scale discoveries to commercial-scale realities.

Over the past several years, we have been studying the formation, surface modification, and applications of silicon nanoparticles. In the world of silicon microelectronics, silicon nanoparticles are generally considered a bad thing. There are a number of steps in integrated circuit manufacture where thin silicon films are deposited by chemical vapor deposition. In such a process, a gas phase precursor molecule like silane (SiH_4) reacts to produce a silicon film on the wafer surface. The same reactions that lead to film deposition can also result in the nucleation of silicon nanoparticles. If these deposit on the wafer surface, they can lead to failure of the integrated circuit. Particulate contamination is a leading cause of yield loss in the semiconductor industry. Thus, our initial studies of the gas-phase nucleation of silicon nanoparticles were primarily aimed at preventing their formation, and this remains a significant motivation of our work in modeling particle formation.

On the other hand, silicon nanoparticles are unique materials with tremendous technological potential in several applications. Unlike some other semiconductors, silicon is a very poor emitter of light. That is why the lasers in your DVD player, laser pointer, etc. are made from a relatively expensive compound semiconductor like gallium arsenide. However, silicon nanoparticles, in the size range of 1 to 5 nm in diameter (tens of atoms to a few thousand atoms) can emit light quite efficiently. Furthermore, these silicon 'quantum dots' absorb and emit light at wavelengths that depend on their size, ranging from blue emission for ~1 nm diameter particles to infrared emission for ~5 nm particles. This makes them potentially useful in a variety of applications from fluorescent imaging in biology and medicine, to solid-state lighting and displays, to printable solar cells.

> One of the first Ph.D. students to graduate from our group, Dr. Xuegeng Li, joined a small venture-capital-funded company focused on the applications of silicon nanoparticles in light emitters and photovoltaics. This company, Innovalight, Inc. (see www.innovalight.com) was recently featured in Time Magazine. They are using technologies from our group and from The University of Texas and The University of Minnesota to develop silicon nanoparticle based devices.

In the Swihart group, we have developed a unique, scalable process for making luminescent (light-emitting) silicon nanoparticles in relatively large quantities. In our approach, we first generate the particles in the gas phase, by thermal decomposition of silane. This is just like the unwanted particle formation that sometimes occurs in silicon wafer processing, except that instead of heating the whole reactor, we use an infrared laser to rapidly heat only the gas (but not any surfaces) which induces particle nucleation without film deposition. The resulting particles are still a little too big to be luminescent, so we etch them, in solution, to reduce their size until they emit light of the desired color. Finally, we carry out reactions to attach organic molecules to the particle surface, which stabilizes their luminescence properties and allows us to control their surface reactivity

(Continued on page 4 - Swihart Group)

(Continued from page 3 - Swihart Group)

for further applications. In addition to our experimental work in this area, we have been working for several years on the development of detailed chemical kinetic models of silicon nanoparticle nucleation, and the linking of these models to descriptions of nanoparticle transport, growth by surface reactions, coagulation, and sintering. These modeling efforts extend from quantum chemical studies of individual silicon-hydrogen clusters and their reactions, to 3-dimensional computational fluid dynamics models of particle synthesis reactors. Another of the first Ph.D. graduates from our group, Dr. Suddha Talukdar, went from UB to Intel, where he is a Senior Engineer in their Computer Aided Design group, doing a variety of computational projects.

In addition to our work on silicon nanoparticles, we have prepared and studied nanoparticles of a variety of other materials. We have used the same laser-driven aerosol synthesis approach to produce nanoparticles of iron, nickel, and their alloys. We have produced tellurium dioxide, a material with interesting optical properties, using spray pyrolysis. In this method, tiny droplets of telluric acid in water are heated to evaporate them, decompose the telluric acid, and nucleate small particles of TeO_2. In collaboration with researchers in UB's Department of Chemistry and Institute for Lasers, Photonics, and Biophotonics, we are exploring solution-phase synthesis of a variety of multi-component nanoparticles. These include polystyrene microspheres with a thin shell of gold or silver on their surface. By varying the core diameter and shell thickness, we can tune the optical properties of these structures so that they absorb light of different wavelengths across the visible spectrum. We are also making hybrid nanoparticles that combine a magnetic component such as Fe_3O_4, a noble metal component such as gold, and a semiconductor component, such as cadmium selenide or lead sulfide. Combinations of two or three of these components, each with individually controlled nanometer-scale size and shape, can allow us to achieve combinations of electronic, magnetic, and optical properties not attainable in a homogeneous material.

We have had a number of fruitful interactions with industry over the past few years, in the context of several nanoparticle related projects. In addition to interactions with Innovalight mentioned above, we have carried out projects aimed at understanding and preventing particle formation (with Advanced Silicon Materials of Butte, Montana) and projects aimed at intentional synthesis of nanoparticles (with INCO of Toronto, Canada). This is certainly something that we hope to do more of, as opportunities arise.

For further details of the work described above, other projects not described here, lists of publications and awards, pictures of my kids, etc. please see *http://www.cbe.buffalo.edu/swihart*, or *http://www.eng.buffalo.edu/~swihart*. You can also reach me by phone (716-645-2911 x2205) or e-mail (*swihart@eng.buffalo.edu*). Comments and questions from alumni and friends are always welcome!▪

Moving?

Don't forget to give us your new address so you won't miss an issue.

Name: ____
Degree(s)/Year(s) Graduated: ______________________________
New Address: ____
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Mail your address change to: The Catalyst
Department of Chemical & Biological Engineering
State University of New York at Buffalo
307 Furnas Hall
Buffalo, NY 14260-4200

New Undergraduate Curriculum Approved

Chemical engineering is a profession undergoing change. There are many exciting new areas where it is being applied, and many old ones where it remains very important. We have been working actively for more than a year to revise our undergraduate curriculum to reflect these realities. To inform this process we have met with industry focus groups, participated in national discussions on chemical engineering curricula, and solicited input from students and from you, our friends and alumni. We received some great feedback from all of these sources. We have also conducted a careful review of what is taught in each course, and removed material that is outdated or that duplicates without adding depth.

Even we are surprised at some of the changes we have made as a result of this process. Highlights include:

- We redesigned the thermodynamics sequence. Much of the same material is there, but it is distributed in ways that put theory closer to the applications. As a consequence we have removed *EAS 204 Thermodynamics* as a required course.
- We performed a similar redesign of the fundamental and applied transport sequence, with a consequence that *CE 311 Unit Operations I* is removed from the curriculum (don't worry; we think the material taught there is important, and have moved it into the other transport courses)
- We removed *EAS 207 Statics* as a required course.
- We removed *CE 307 Design* from the curriculum.

With the removal of these courses we have room to make some additions:

- We added a required course in biology.
- We added a required CE course on the topic of product design.
- We added a required CE course on process control.
- All CE labs are increased by 1 credit each, allowing space to introduce instruction in applied statistics, design of experiments, data analysis, and related topics.
- We permit biochemistry to be taken in lieu of the second course in organic chemistry.

We have also added three tracks of suggested electives for students to follow if they have an interest in particular specialties. These tracks are in Biological Engineering, Materials Engineering, and Process Engineering, respectively.

We could say a lot more about these changes, and we probably will in future newsletters. But in the interest of space, we'll leave you with those highlights, and show you the new suggested course sequence here. You'll notice that all of the basic science is completed by the end of the sophomore year, and all of the engineering science is done in the junior year (including kinetics and materials). The senior year can then be devoted to systems and design.

The program of study is of course just the framework for the curriculum. The important stuff is the content of the courses and how it is delivered. As the new curriculum is phased in, we will be working hard to adjust these aspects, so that we prepare our graduates them in the best way possible for their chemical engineering careers. To this end we always want your input to inform our efforts at continuous improvement. In future letters we'll describe this process some more and show you how you can help.▪

Fall		Spring	
Freshman			
CHE 107	General Chemistry I	CHE 108	General Chemistry II
EAS 140	Engineering Solutions	PHY 107	General Physics I
MTH 141	Calculus I	MTH 142	Calculus II
	Gen Ed	EAS 230	Higher-level Language
	Gen Ed		Gen Ed
Sophomore			
CE 212	Fund. Principles of CE	CE 304	CE Thermodynamics
MTH 241	Calculus III	MTH 306	Differential Equations
CHE 201	Organic Chemistry I	CHE 204 or	Organic II, or
PHY 108	General Physics II	BIO 205	Fund. of Biological Chemistry
PHY 158	Physics II Lab	BIO 201	Cell Biology
			Gen Ed
Junior			
CE 317	Transport Processes I	CE 318	Transport Processes II
CE 327	CE Lab I	CE 328	CE Lab II
CE 334	Physical Chemistry for CEs	CE 433	Materials Science & Engng.
CE 329	Chem. Reaction Engng.	CE 407	Separations
200+	Technical Elective	300+	Technical Elective
Senior			
CE 404	CE Product Design	CE 408	CE Plant Design
CE 427	CE Lab III	CE 428	CE Lab IV
CE 434	Chemical Systems & Control	CE 000	CBE Technical Elective
CE 000	CBE Technical Elective		Gen Ed
	Gen Ed		Gen Ed

Chem-E-Car Team Places Fourth in National Competition

"Mr. Freeze," the Chem-E-Car designed by CBE students at UB finished fourth in the seventh annual Chem-E-Car competition held at the annual meeting of the American Institute of Chemical Engineers in Cincinnati this past October.

Students from over 30 universities from across the country competed. Each of those universities had placed first, second or third in their regional competitions to qualify for the national competition. UB's team placed second at the regional conference in Easton, PA last April.

The competition requires students to power shoebox-sized cars via a chemical reaction and carry a specified payload for a given distance. Students are not given the payload or distance until one hour before the competition.

The CBE team met regularly from the start of the semester, said Lindsay Mroz, president of UB's AIChE student chapter and a member of the Chem-E-Car team.

"The team collectively came up with the design we used in the competition," she said. "The car was powered by a sodium borohydride electrolyte fuel cell and was stopped by dissolving magnesium ribbon in hydrochloric acid. As the magnesium was connected in series with the fuel cells, the car stopped when the ribbon broke, due to an incomplete circuit."

"Other reactions for the propulsion mechanism include aluminum air cells and the water-gas shift reactor," Mroz added.

In this year's event, students were challenged to transport 300 milliliters of water 79 feet. The teams got two chances to run their cars, with their final score being their best attempt at exactly meeting the specified distance.

While each team has a faculty advisor to offer guidance, the final products are conceptualized and developed by the students.

"The Chem-E-Car team did an excellent job in preparing for this competition," said Manolis Tzanakakis, assistant professor and advisor to the team. "Besides teamwork, the students had the opportunity to experience in practice some of the difficulties associated with applying what they are taught in class. Such an experience will be a valuable asset as they are preparing for their professional careers."

In addition to Lindsay Mroz, members of the UB team include Alex Buffone, Abhijeet Kohli, Robert Forbes, William Frank, Rachel Frydrychowski, Michelle Halvarson, Nicole Hartley, Jeffery Kraska, Andrew Waterman, Sarah O-Hara, Stacy Pustulka and Wei Seang Ooi.▪

(We would like to thank UB News Services for contributions to this issue.)

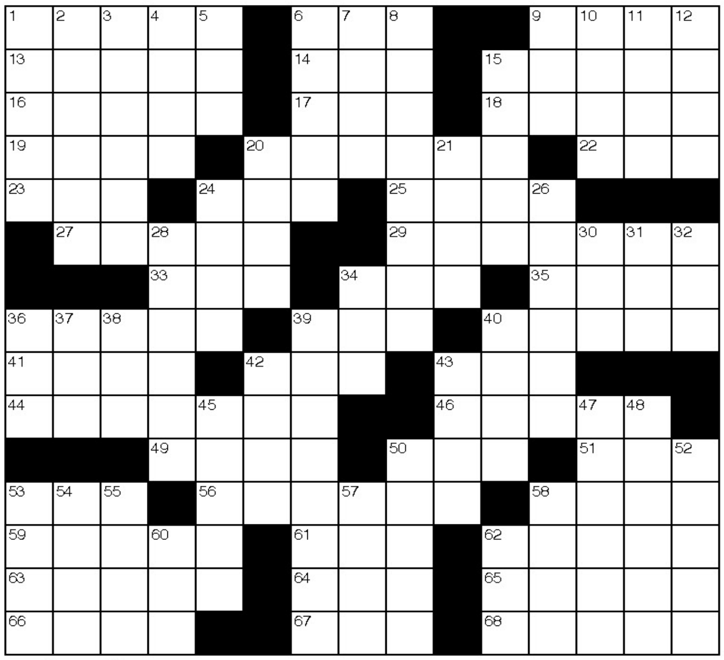
Obituary

Sgt. 1st Class Robert V. Derenda (BS '97) was killed on August 5, 2005 while on duty in Iraq when a civilian fuel tanker slammed into the military vehicle he was riding in.

Derenda, a native of Cheektowaga, was working as a drill sergeant at a base in Al Kasik, in the northwestern part of the country training raw recruits for Iraq's military. He was due to arrive home in September and return to his job as a chemical engineer in Paducah, KY.

Before attending the University at Buffalo, Derenda attended The Citadel, the South Carolina military academy. He is survived by his parents and a sister. He was 42.▪

Crossword Puzzle.



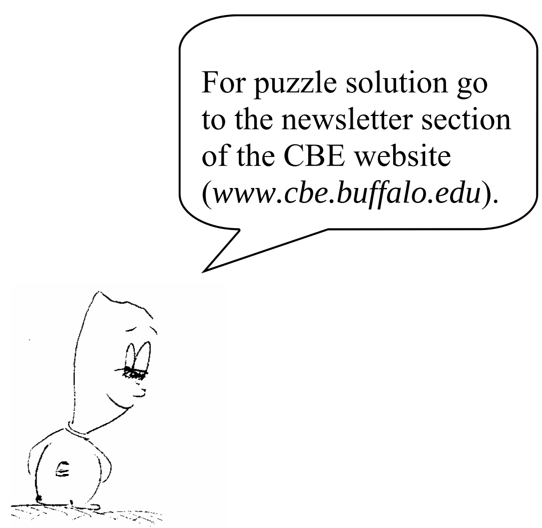
www.CrosswordWeaver.com

ACROSS

1 For goodness __!
6 Baby fox
9 ***Conserved quantity***
13 Ancient Greek marketplace
14 ***Differential eqn with one independent variable (abbrev.)***
15 "To __ Mockingbird" (2 wds.)
16 Maimed
17 Bog
18 ***Gas obeying PV=nRT***
19 Restaurant
20 Glides across the ice
22 Compass point
23 Greek letter 'h'
24 Non-tuition cost to attend university
25 Imitated
27 Sugar-free brand
29 ***Inorganic material formed using heat, e.g., porcelain***
33 Opposite of him
34 ***Vapor-liquid equilibrium (abbrev)***
35 Secure
36 Whip
39 Compete
40 Brownish-orange color
41 ***IF, THEN, ____, END IF***
42 Clip
43 ***Low-density fluid phase***
44 Town crier
46 ***Alcohol + acid-anhydride polyester***
49 Loosen
50 Bullfight cheer
51 ***Source of petrochemicals***
53 ***Venue for experiments***
56 Heathens
58 Tactic
59 Accustomed
61 Ornament
62 Religious offering
63 Mettle
64 ___ de Janeiro
65 The one left
66 Challenge
67 Talk
68 Untidy

DOWN

1 Gravy
2 Male relation on father's side
3 ***A current cbe@buffalo Asst. Prof.***
4 ***Buffalo lake***
5 ***College entrance exam***
6 ***Incoming Chair of cbe@buffalo***
7 Product of creative thought
8 Octopus part
9 Middle
10 Brews
11 Slice
12 Sold at a discount
15 ***cheme@buffalo Prof from 1964 to 1997***
20 Dreamer
21 Fencing sword
24 Touch
26 Cloth
28 ***McCabe's partner in distillation***
30 Cut grass
31 ***A charged molecule/atom***
32 Wail
34 Dignitary
36 Second month (abbr.)
37 ***Liquid-liquid equilibrium (abbrev)***
38 Sign language
39 ***Acetic-acidy***
40 Yarn
42 Space ship builders
43 Opposite of guys
45 ***Symbolic math software***
47 Juveniles
48 Plates
50 Upon (2 wds.)
52 Distrustful
53 ***Outgoing Chair of cbe@buffalo***
54 At sea
55 Hiker's nemesis
57 Opera solo
58 Ritual
60 Street abbr.
62 ***Prof. Weber's first name***



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We would like to hear from you to know what you've been up to since graduation! Please take a few minutes to fill out the form below and mail it to us, or reply via the web at: ***www.cbe.buffalo.edu/alumni***. We'll put your news in future issues of our newsletter, unless you indicate otherwise. (Please check one of the boxes below to indicate your preference).

Name: ______________________________

Address: ______________________________

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UB CE degree(s) and years: ______________________________

Spouse's Name and Children: ______________________________

News/Comments: ______________________________

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