International Year of CHEMISTRY 2011

THE NUCLEUS

April 2011 Vol. LXXXIX, No. 8

Monthly Meeting

Esselen Award Meeting at Harvard Award Address by Dr. Arthur J. Nozik

Summer Scholar Report

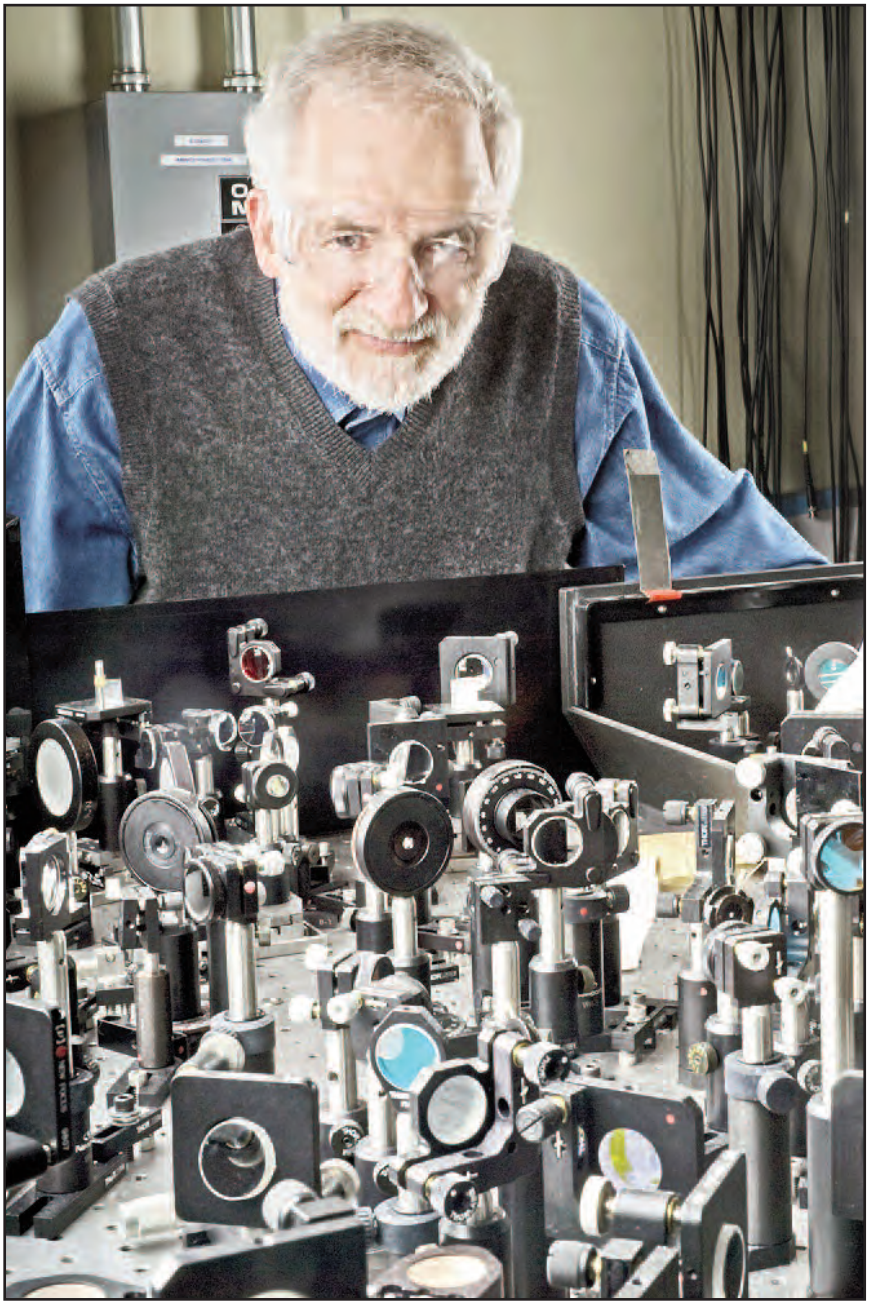
By Jiazuo (Henry) Feng and Mark W. Grinstaff
Department of Biochemical Engineering and Chemistry, Boston University

A Jack Szostak Interview

By Mindy Levine

February Meeting Report

By Michael Filosa



April Historical Events in Chemistry

by Leopold May, The Catholic University of America, Washington, DC 20064

April 2, 1953
Francis H. C. Crick and James D. Watson mailed a 900-word article on the structure of deoxyribonucleic acid (DNA) to *Nature* on this date.

April 5, 1956
Marshall Gates & G. Tschudi announced the synthesis of morphine on this date.

April 6, 1863
James Walker, a researcher on hydrolysis, ionization constants, and amphoteric electrolytes with organic compounds, was born on this date.

April 8, 1911
One hundred years ago on this date, Melvin Calvin was born. He received the Nobel Prize in Chemistry in 1961 for his research in photosynthesis.

April 10, 1863
One hundred and twenty-five years ago in 1886, Paul Louis Toussaint Héroult discovered the electrolytic aluminum process in the same year that Charles Martin Hall discovered the same process for isolating aluminum. It is called the Hall-Heroult process. He also invented the electric arc furnace for steel in 1900, which replaced giant smelters for the production of a variety of steels. He was born on this date.

April 14, 1927
Alan MacDiarmid, who was born on this date, is a researcher on the synthesis of conductive polymers. In 2000 he shared the Nobel Prize in Chemistry with Alan J. Heeger and Hideki Shirakawa for the discovery and development of conductive polymers.

April 15, 1861
One hundred and fifty years ago on this date, Ernest Solvay received his first patent, entitled "Industrial Production of Sodium Carbonate by Means of Marine Salt, Ammonia, & Carbon Dioxide.

April 15, 1961
Fifty years ago, on this date, Carol W. Greider was born. She shared the Nobel Prize in Physiology or Medicine in 2009 with Elizabeth H. Blackburn and Jack W. Szostak for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase.

April 16, 1728
Joseph Black developed the concept of latent heat and laid the foundation for modern quantitative analysis. He was born on this date.

April 18, 1838
One hundred and twenty-five years ago, in 1886, Lecoq de Boisbaudran found dysprosium in didymium that Per Teodor Cleve had concluded in 1874 had two elements, later named neodymium and praseodymium. He also discovered gallium (Ga, 31) in 1875, and samarium (Sm, 62) in 1880, using spectroscopic methods devised by Robert Bunsen and Gus-

Continued on page 13

The Northeastern Section of the American Chemical Society, Inc.
Office: Anna Singer, 12 Corcoran Road, Burlington, MA 01803
(Voice or FAX) 781-272-1966.
e-mail: secretary(at)nesacs.org
NESACS Homepage:
http://www.NESACS.org

Contents

Cover: *April Speaker and Esselen Award Winner, Dr. Arthur J. Nozik, Senior Research Fellow, National Renewable Energy Laboratory and Professor Adjunct, Department of Chemistry and Biochemistry, University of Colorado, Boulder. (Photo courtesy of Dr. Nozik)*

Deadlines: *Summer 2011 Issue: June 23, 2011*
September 2011 Issue: July 17, 2011

THE NUCLEUS

The Nucleus is published monthly, except June and August, by the Northeastern Section of the American Chemical Society, Inc. Forms close for advertising on the 1st of the month of the preceding issue. Text must be received by the editor six weeks before the date of issue.

Editor: Michael P. Filosa, Ph.D., ZINK Imaging, Inc., 16 Crosby Drive, Building 4G, Bedford, MA 01730 Email: Michael.filosa(at)zink.com; Tel: 508-843-9070
Associate Editors: Myron S. Simon, 20 Somerset Rd., W. Newton, MA 02465, Tel: 617-332-5273, Sheila E Rodman, Konarka Technologies, Inc., 116 John St. Suite 12, Lowell, MA 01852 Email: srodman(at)konarka.com tel 978-569-1414, Mindy Levine, 516-697-9688 (c), mindy.levine(at)gmail.com
Assistant Editor: Stefan G. Koenig
Board of Publications: Mary Mahaney (Chair), Mindy Levine, Vivian K. Walworth
Business Manager: Karen Piper, 19 Mill Rd., Harvard, MA 01451, Tel: 978-456-8622
Advertising Manager: Vincent J. Gale, P.O. Box 1150, Marshfield, MA 02050, Email: Manager-vincegale(at)mboservices.net; Tel: 781-837-0424
Contributing Editors: Morton Hoffman, Feature Editor; Dennis Sardella, Book Reviews
Calendar Coordinator: Sheila Rodman, email: srodman(at)konarka.com
Photographers: Morton Z. Hoffman and James Phillips
Proofreaders: Donald O. Rickter, Vivian K. Walworth, Mindy Levine
Webmaster: Roy Hagen

A Jack Szostak Interview

By Mindy Levine

When Jack Szostak was on vacation with his family in Iceland in 2006, he received a call from Dr. Joseph Goldstein, Chairman of the Lasker Awards Jury. The prestigious Lasker Prizes are awarded annually in two categories: Basic Medical Research and Clinical Medical Research. Dr. Szostak assumed that Dr. Goldstein was calling him to write a recommendation for someone who was being considered for a Lasker Prize, and "I was on vacation, so I didn't want to deal with it," said Dr. Szostak.

As Dr. Szostak later found out, he had been awarded the 2006 Lasker Prize in Basic Medical Research, together with Dr. Elizabeth Blackburn and Dr. Carol Greider. The three scientists were awarded this prize, "for the prediction and discovery of telomerase, a remarkable RNA-containing enzyme that…maintains the integrity of the genome," according to the text of the Lasker Prize. The discovery of telomerase sheds important light on how chromosome ends are maintained. In addition, the initial telomerase studies performed by these researchers have sparked discoveries that telomerase has a role in cancer and age-related degeneration.

Once the 2006 Lasker Prize was conferred, the announcement that the same three researchers won the 2009 Nobel Prize in Physiology or Medicine was not a complete surprise to Szostak. Nonetheless, one of the interesting aspects of the Nobel Prize was that it was conferred for work that Szostak performed 20 years ago, for research that has little relationship to his current research interests. "It was extremely nice to have that work recognized," Szostak said, "but I had to go read all of those papers again."

Dr. Szostak currently runs a research group at Massachusetts General Hospital comprising 10 graduate students and post-doctoral researchers who are studying questions that relate to the origin of life. Specifically, the Szostak lab is researching the design and synthesis of an artificial "protocell," that will be capable both of dividing into "daughter vesicles" and of replicating its genetic material. Researchers in the lab have already developed a reasonably good vesicle replication system.

Szostak hopes that in the next 5-10 years they will develop a good nucleic acid replication system and a functioning "artificial cell." "I think that is a feasible goal in the time I have left," Szostak said. Even if he does not reach this goal, though, Szostak is not concerned, because "there are still lots of interesting things to learn along the way."

Most of the funding for Szostak's research comes from the Howard Hughes Medical Institute (HHMI), a non-profit medical research organization that funds scientists across the USA and internationally. The Institute provides direct funding to researchers, including Szostak, allowing them the freedom to set their own research

Continued on page 12

Corporate Patrons

$2000 - or more

AstraZeneca Pharmaceuticals
Eisai Pharmaceuticals
EMD Serono
Genzyme Corp.
Novartis
Johnson Matthey
Pfizer Inc.
Schering Corp.
Strem Chemicals, Inc.
Vertex Pharmaceuticals

$1000-$1999

Boehringer Ingelheim
GlaxoSmithKline
Irix Pharmaceuticals
Lyophilization Services of NE
Sundia Meditech
Yes Bank

$300-$999

Cambridge Major Labs
Girindus
Merrimack Consultants
Organix
PCI Synthesis
Sigma Aldrich
Waters Corp.
Wilmington PharmaTech

Monthly Meeting

The 914th Meeting of the Northeastern Section of the American Chemical Society

Esselen Award Meeting

Thursday, April 14, 2011

Harvard University, Cambridge, MA

Harvard Faculty Club, 20 Quincy Street

5:30 pm Social Hour

6:30 pm Dinner

8:15 pm **Award Meeting**, Mallinckrodt Building, 12 Oxford Street
Pfizer Lecture Hall (MB23), Ground Floor
Dr. Patrick Gordon, NESACS Chair, presiding

Welcome - Dr. Arthur Obermayer, Chair, Esselen Award Committee

The Esselen Award - Dr. Myron S. Simon, Founding Member of the Esselen Award Committee

Introduction of the Award Recipient - Dr. James T. Hynes, Professor of Chemistry and Biochemistry, University of Colorado, Boulder and CNRS Director of Research Emeritus, Ecole Normale Superieure, Paris.

Presentation of the Award - Gustavus J. Esselen, IV

Award Address - *Prospects and Novel Approaches for the Low Cost Power Conversion of Solar Photons to Electricity and Solar Fuels* - Dr. Arthur J. Nozik, Senior Research Fellow, National Renewable Energy Laboratory and Professor Adjoint, Department of Chemistry and Biochemistry, University of Colorado, Boulder

Dinner reservations should be made no later than noon, Friday, April 8. Please call Anna Singer at (781)272-1966 or e-mail at secretary@nesacs.org. Reservations not cancelled at least 24 hours in advance must be paid. Members, $30.00; Non-members, $35; Retirees, $20; Students, $10.

DINNER IS BY RESERVATION ONLY.

THE LECTURE IS OPEN TO THE PUBLIC

Anyone who needs special services or transportation, please call Anna Singer a few days in advance so that suitable arrangements can be made.

Free Parking in the Broadway Street Garage (3rd level or higher), enter from Cambridge Street via Felton Street. Directions to the Harvard Faculty Club can be found at http://www.hfc.harvard.edu/ . ◇

Biography

Dr. Arthur J. Nozik is a Senior Research Fellow at the U.S. DOE National Renewable Energy Laboratory (NREL), Professor Adjoint in the Department of Chemistry and Biochemistry at the University of Colorado, Boulder, and a founding Fellow of the NREL/University of Colorado Renewable and Sustainable Energy Institute. In 2009, Nozik was selected as Associate Director of a joint Los Alamos National Lab/NREL Energy Frontier Research Center for DOE, called The Center for Advanced Solar Photophysics. During 2006-2009, he served as the Scientific Director of the Center for Revolutionary Solar Photoconversion under the Colorado Renewable Energy Collaboratory. Nozik received his BChE from Cornell University in 1959 and his Ph.D. in Physical Chemistry from Yale University in 1967. Before joining NREL in 1978, then known as the Solar Energy Research Institute (SERI), he conducted research at the Materials Research Center of the Allied Chemical Corporation (now Honeywell, Inc.). Dr. Nozik's research interests include size quantization effects in semiconductor quantum dots and quantum wells, including multiple exciton generation from a single photon; the applications of unique effects in nanostructures to advanced approaches for solar photon conversion to electricity and solar fuels; photogenerated carrier relaxation dynamics in various semiconductor structures; photoelectrochemistry of semiconductor-molecule interfaces;

continued on page 13

Abstract

One potential, long-term approach to more efficient future (3rd) generation solar cells for producing both electricity via photovoltaic (PV) cells and solar fuels via solar photoelectrochemical cells is to utilize the unique properties of semiconductor quantum dots (QDs) and unique molecular chromophores to control the relaxation pathways of excited states to produce enhanced conversion efficiency through efficient multiple electron-hole pair generation from absorbed single photons. We have observed efficient multiple exciton generation (MEG) in PbSe, PbS, PbTe, and Si QDs and efficient singlet fission (SF) in molecules that satisfy specific requirements for their excited state energy level structure. We have studied MEG in close-packed QD arrays where the QDs are electronically coupled in the films and thus exhibit good transport. We have developed simple, all-inorganic and potentially inexpensive QD PV solar cells based on QD arrays that produce large short-circuit photocurrents and initial power conversion efficiencies above 5% via nanocrystalline p-n junctions. We have observed very efficient SF in thin films of molecular crystals of 1,3 diphenylisobenzofuran with quantum yields of 200%, reflecting the creation of two excited triplet states from the first excited singlet state. Various

continued on page 12

IYC Second Quarter Science Café

Topic

Alternative Energy and Sustainability

Keynote Speaker:

Prof. Daniel Nocera

Massachusetts Institute of Technology

Additional Speakers from Suffolk University (Prof. Walter Johnson) and the Barnstable County Department of Health and Environment.

Hosted by Jennifer Maclachlan and Dr. Jack Driscoll

April 29, 2011

6:30 – 9:00 PM

Hyannis Golf Club
Route 132, Hyannis, MA

RSVP before April 24, 2011 to Jennifer Maclachlan
Email: pidgirl(at)gmail.com

Sponsored by NESACS, PID Analyzers LLC, The Cape Cod Commission and the Town of Barnstable

A Greener Nucleus

Electronic Delivery Option to be available. NESACS Members can opt out of receiving a paper copy.

The Board of Publications and the Board of Directors of NESACS have agreed that subscribers to the *Nucleus* can opt for electronic delivery only. To cancel delivery of the paper copy of the Nucleus and receive a link to download an electronic copy, please send your request as soon as possible to secretary(at)nesacs.org with your name, mailing address and email address. Alternatively, you can fill out a form on the NESACS website at www.nesacs.org. Upon implementation, if you choose to forgo a paper copy, your mailing address will be removed from the Nucleus mailing list and added to an electronic delivery mailing list. For the immediate future, you can also continue to receive a paper copy and also receive an electronic copy. If you do nothing, you will continue to receive a paper copy. We expect to implement this plan in time for the September issue.

If you have any questions please contact the editor by email: michael.filosa(at)zink.com ◇

Looking for seminars in the Boston area?

Check out the NESACS Calendar

www.nesacs.org/seminars

SURPRISE

our editor by calling and saying you appreciate the quality and content of our newsletter. Our editor works hard to maintain a publication of interest to our membership. Oh, and by the way you could also give credit to our advertisers who financially support us.

NESACS Candidates for 2011 Election

Chair-Elect (vote for 1)
Jennifer Maclachan
Liming Shao

Secretary (vote for 1)
Michael Singer

Trustee (vote for 1)
Michael Strem
John Neumeyer

Councilor/Alternate (Vote for 10)
Morton Hoffman
Doris Lewis
Michael Filosa
Christine Jaworek-Lopes
Larry Scott
Katherine Lee
Jennifer Larese
John Podobinski
Marietta Schwartz
Michaeline Chen
Raj Rajur
Sonja Strah-Pleynet
Andrew Scholte
Mary Burgess

Director-at-Large (vote for 2)
Ralph Scannell
John Burke
Jenny Li

Nominating Committee (vote for 2)
Michael Hewitt
Mindy Levine

Esselen Award Committee (vote for 2)
Steve Buchwald
Gurmit Grewal
Mukund Chorghade

Richards Medal (vote for 2)
Rosina Geoirgiadis
Sheila Hauck
Christopher Cummins

Petition candidates: *"Any group comprising 2 percent or more of the members of the Northeastern Section (136 members) may nominate candidates...."* See the NESACS website for details. ◇

NESACS and NSYCC present

NSYCC

Student Research Conference

Saturday, April 30, 2011

8:30AM-4:00 PM

Curry Student Center
Northeastern University

Keynote Lecture by Dr. Suzanne Walker, Harvard University
Oral Sessions and Poster Sessions throughout the day

All fields of chemistry are welcome!
Network with graduate and undergraduate students and explore the various fields of chemistry.

For more information and to register
visit our website at http://www.nsycc.org
or email april(at)nsycc.org

Summer Scholar Report

Synthesis and Characterization of Functional Polymeric Nanoparticles

Jiazuo (Henry) Feng and Mark W. Grinstaff*
Departments of Biomedical Engineering and Chemistry, Metcalf Center for Science and Engineering, Boston University, Boston, MA 02215.

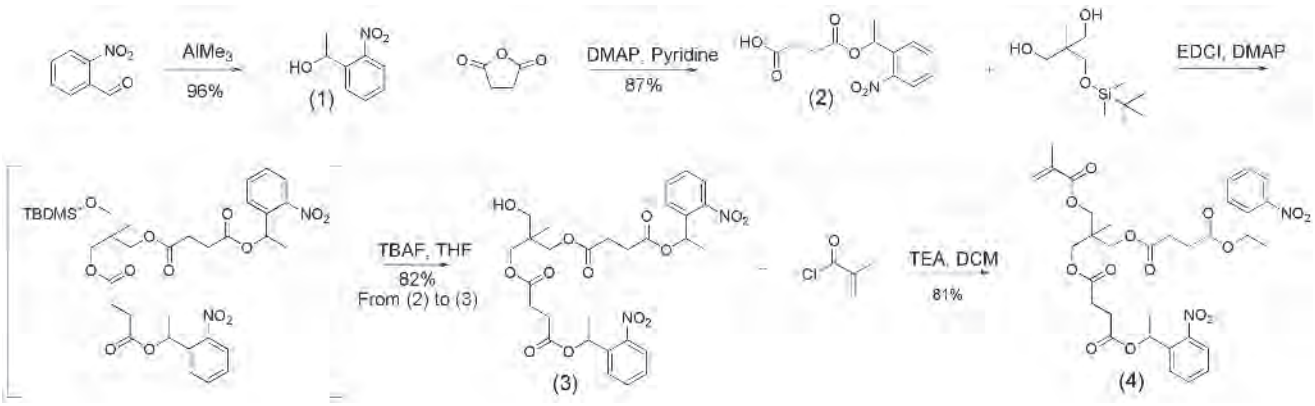
Nanoparticles are colloidal particles ranging in size from approximately 5 – 900 nm. These particles can be synthesized from a variety of materials, depending on the desired application.[1-9] In the area of drug delivery, nanoparticles are useful for addressing many of the difficulties encountered when administering therapeutic compounds. Nanoparticles can increase the solubility of hydrophobic drugs, provide a more consistent level of drug in the body through sustained release, protect sensitive drugs from low pH environments or enzymatic alteration, and, in some cases, provide local delivery or targeting of the drug to the desired tissues.[1] There are four main types of nanoparticle systems receiving considerable attention in drug delivery: drug nanocrystals, liposomes, dendrimers, and polymeric nanoparticles. To date, protein-stabilized drug suspensions, along with nanocrystals and liposomal systems, are the only nanocarriers that have received FDA approval. As our interest lies with polymeric nanoparticles, we will focus on this system.

Polymeric nanoparticles tend to be more stable than other carriers, such as liposomes, and their delivery properties can be adjusted by manipulating the structure and composition of the polymer used to prepare the particles. Thus polymeric nanoparticles may be a more favorable means to deliver chemotherapeutic agents in a post-operative setting. Although several natural and synthetic polymers have been investigated (including chitosan,[10] methacrylic acid copolymers,[11] and polycaprolactone[12]) poly(lactic acid) (PLA) and poly(lactic-co-glycolic acid) (PLGA) are the most widely studied due to availability, biocompatibility, and FDA-approved status. While PLA and PLGA systems are relatively safe, simple to synthesize, and have been explored for the delivery of many agents, including anti-cancer drugs, these particles afford relatively rapid "burst" release of the encapsulated drug (> 50% release in 10-48 hrs) regardless of nanoparticle location and thus may negate or reduce the benefit of using a drug delivery system.[8,13-15]

Therefore, functional systems in which delivery of therapeutic compounds can be tailored and even triggered by specific stimuli are being pursued in order to improve local drug delivery and anti-tumor efficacy.[16,17] Nanoparticles which respond to a wide array of stimuli are being investigated, including those that respond to pH[18-24], temperature[25-28], light[29-33], and ultrasound[34-37]. The nanoparticles described herein utilize a novel mechanism for drug release where the nanoparticle swells in response to the particle on going from a hydrophobic to a hydrophilic composition. This transition occurs in response to a lowering of physiological pH to 5, such as that found in the endosome. The first example of such expansile nanoparticles was reported by Griset *et. al.*, who used the deprotection of masked hydroxyl group at a mildly acidic pH of 5 to trigger this change in polymer structure and release of an entrapped drug.[3] Although the release is triggered by an environmental signal of low pH, there is not complete spatial and temporal control over payload release. In our attempt to solve this challenge of payload delivery, we have engineered a new polymeric expansile nanoparticle possessing carboxylic acids masked as photo-labile ester moieties. The esters can be cleaved upon irradiation with long-wave UV light ($\lambda \geq 365$ nm). The synthesis of the monomer and preparation of both polymeric core and aqueous-filled nanoparticles are discussed herein.

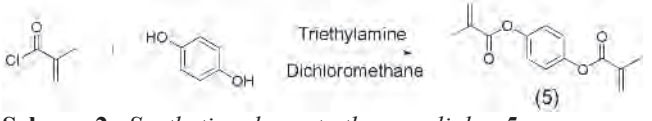
The preparation of the photo-sensitive monomer, **4**, for nanoparticle synthesis is shown in Scheme 1. Briefly, 1-(2-nitrophenyl)ethanol was added to a stirring solution of succinic anhydride to afford 4-(1-(2-nitrophenyl)ethoxy)-4-oxobutanoic acid (**2**). This was then re-suspended in dichloromethane, along with 2-((tert-butyldimethylsilyloxy)methyl)-2-methylpropane-1,3-diol and DMAP (catalytic) at 0 ºC. 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDCI) was then added to the reaction solution. After 12 hours of stirring at room temperature, the reaction solution was extracted 3 times with 0.1 M HCl and dichloromethane. The organic phases were collected, dried over sodium sulfate and concentrated. The crude product was used without further purification. The yellow viscous oil was added to a THF solution at 0 ºC, upon which it was treated with 1.0 M tetrabutylammonium fluoride (4 mmol) for 6 hours to afford '2-(hydroxymethyl)-2-methylpropane-1,3-diyl bis(1-(2-nitrophenyl)ethyl) disuccinate (**3**). Compound **3** was then treated with methacryloyl chloride and triethylamine to afford the desired photo-sensitive monomer (**4**). The composition of **4** was confirmed by ^{13}C NMR [(400 MHz, $CDCl_3$): δ17.1, 18.3, 22.0, 28.8, 29.1, 68.6, 124.5, 126.0, 127.2, 128.4, 133.6, 135.9, 137.8, 147.7, 166.9, 171.0, 171.8], ^{1}H NMR [(400 MHz, $CDCl_3$): δ 0.82 (s, 6H), 0.93 (s, 9H), 0.96 (s, 3H), 1.63 (d, 6H, J = 6.12), 1.95 (s, 3H), 2.64 (m, 8H), 3.35 (s, 2H), 3.99 (s, 4H), 5.59 (d, 1H, J = 1.2 Hz), 6.07 (d, 1H, J = 1.2 Hz), 6.38 (m, 2H), 7.42 (m, 2H), 7.67 (m, 4H), 7.85 (m, 2H)], and HR-Mass Spectrometry via a Waters QT of (hybrid quadrupolar/time-of-flight) API US System by ESI (Empircal Formula: $C_{33}H_{38}N_2O_{14}$; Exact mass: 686.23 Theoretical: 709.2221 [M+Na]; Experimental: 709.2220 [M+Na]; Error: 0.1410 ppm).

The synthesis of nanoparticles containing an aqueous core was performed in a manner adopted from Hillereau *et. al.* and these nanoparticles will be referred to as type A nanoparticles.[38] Briefly, a 14% w/w Span 80 (Aldrich) in glyceryl octanoate (Aldrich) solution was prepared (total amount of oil used was 1 gram). The oil mixture was stirred and allowed to become homogeneous, upon which 20 μL of



Scheme 1. *Synthetic scheme to monomer **4**.*

0.2 M ammonium persulfate dissolved in 80 µL of 0.1 PBS solution (Dulbecco's) was added to the oil mixture. The oil-water suspension was vortexed for 30 seconds to create a water-in-oil emulsion. Then, 40 mg of (**4**) and 1% w/w crosslinker (**5**) were dissolved in ethyl acetate was added to the mixture. The crosslinker was synthesized as shown in Scheme 2.



Scheme 2. *Synthetic scheme to the crosslinker **5**.*

Tetramethylethylenediamine (co-initiator) was also added with brief vortexing, and the emulsion was allowed to stir overnight to allow polymerization at room temperature. The emulsion was then partitioned into 350 µL portions. Each portion was re-suspended in 650 µL of 0.1 PBS buffer and centrifuged at 13000g for 40 minutes. The oil layers were aspirated. The aqueous layer and nanoparticle pellet were combined and dialyzed for 48 hours. As these photo-sensitive nanoparticles were prepared using a water-in-oil emulsion, they contain a polymeric shell and an aqueous core. By dynamic light scattering (Brookhaven Instruments, Inc. 90 Plus), there were two major populations of nanoparticles in solution one centered with a diameter of 145 nm

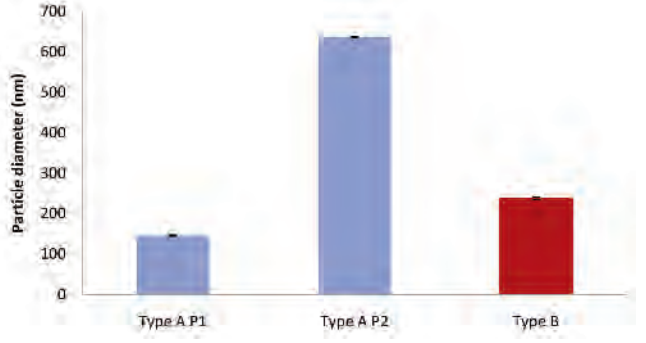


Figure 1. *Average diameter of the nanoparticles as determined by DLS. The solution of type A nanoparticles (blue) contained two populations (P1 & P2) whereas a single population was observed for type B nanoparticles (red).*

(PDI 0.19) and the other with a diameter of 637 nm (PDI 0.24) (Figure 1). As shown in Figure 2 top, scanning electron microscopy of the nanoparticles revealed spherical structures between 100 and 300 nm.

Next, we prepared nanoparticles with a solid hydrophobic polymeric core following the protocol from Griset *et. al.*[39] and these particles are referred to as Type B. Briefly, the photo-sensitive monomer, **4**, (50 mg) and crosslinker (**5**) (1% w/w) were dissolved in 0.5 mL of dichloromethane. The crosslinker was synthesized as shown in Scheme 2. This "oil" phase was suspended in 2 mL of 5 mM Tris buffer containing 10% w/w sodium dodecylsulfate. The oil-in-water suspension was subject to 10 minutes of sonication at 80 W with a 1 second pulse, 2 second delay under argon atmosphere. Upon completion of sonication, the emulsion was subject to vigorous stirring while 20 µL of 0.2 M ammonium persulfate and 4 µL of tetramethylethylenediamine were added. The system was left stirring overnight, upon which it was subject to dialysis for 24 hours in 5 mM PBS buffer to remove excess surfactants. Dynamic light scattering measurements showed nanoparticles with an average diameter of 238 nm (DPI 0.02) (Figure 1). Scanning electron microscopy showed spherical as well as elongated particle structures of approximately 250 nm in size (Figure 2-bottom).

To investigate the chemical reaction occurring with photolysis, LCMS was performed on the Type B nanoparticle solution after irradiation (Agilent LC/MSD VL system by electrospray (ESI) using a reverse-phase C18 Zorbax Eclipse 2.1 × 50 mm column (Agilent). Mobile phases were water and acetonitrile with 0.1% formic acid. Both an irradiated and non-irradiated nanoparticle suspension (40 µL of NP in 2 mL of 0.1 PBS), after filtration through a 0.02 µm syringe filter, were subject to LCMS analysis and only the irradiated sample showed the photo-degraded byproduct 1-(2-nitrosophenyl)ethanone [M_2+H]. Such mass peak was not evident in the control, non-irradiated sample. The observed photo-degradation product is consistent with that reported in the literature for this reaction.[40] Similar studies with Type A nanoparticles are ongoing.

In summary, two polymeric nanoparticles have been

Continued on page 10

Summer Scholar

Continued from page 9

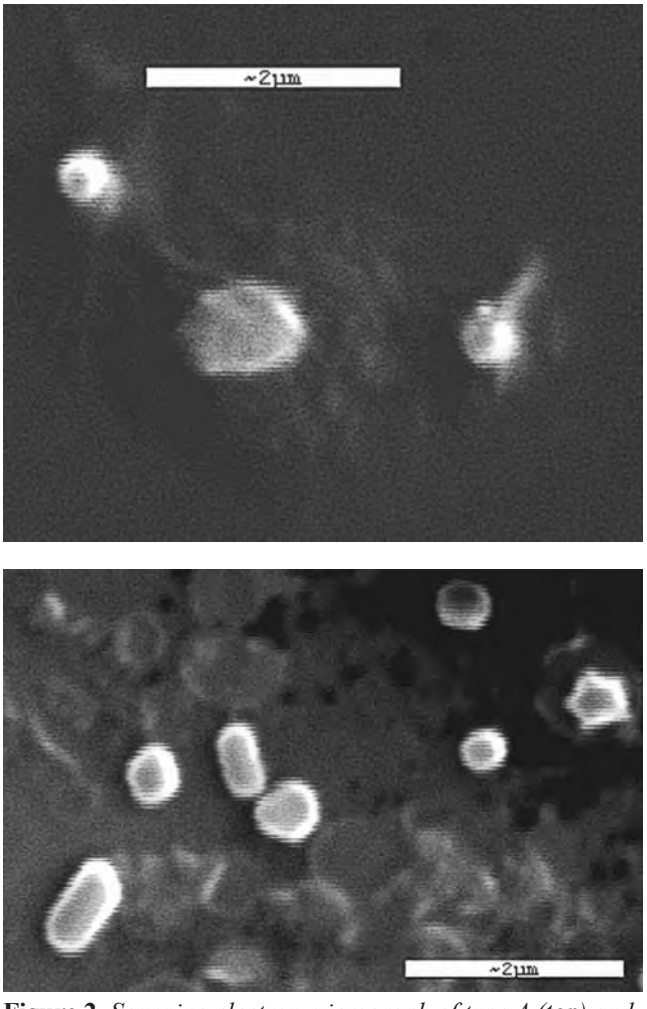


Figure 2. *Scanning electron micrograph of type A (**top**) and type B (**bottom**) nanoparticles.*

synthesized and characterized by dynamic light scattering and scanning electron microscopy. The nanoparticles were synthesized using two different emulsification/polymerization methods, with the first giving aqueous core nanoparticles (or nanocapsules) and the second giving solid polymeric core nanoparticles. The mass spectrometry studies showed the photolysis products were being formed. Further experiments are planned to characterize the nanoparticles and to examine the effects of irradiation on nanoparticle size and structure, as well as to monitor the release of an entrapped drug. Continued research on different types of nanoparticles will provide new materials for evaluation in *in vitro* and *in vivo* models of biological and clinical relevance.

Acknowledgment. JF gratefully acknowledges the ACS James Flack Norris/Theodore Williams Summer Research Scholarship for support of this work.

References

(1) Sahoo, S. K.; Labhasetwar, V. *Drug Discov. Today* **2003**, *8*, 1112-1120.
(2) Davis, M. E.; Chen, Z.; Shin, D. M. *Nature Reviews Drug Discovery* **2008**, *7*, 771-782.
(3) Peer, D.; Karp, J. M.; Hong, S.; Farokhzad, O. C.; Margalit, R.; Langer, R. *Nature Nanotechnology* **2007**, *2*, 751-760.
(4) Kabanov, A. V. *Adv. Drug Deliv. Rev.* **2006**, *58*, 1597-1621.
(5) Brannon-Peppas, L.; Blanchette, J. O. *Adv. Drug Deliv. Rev.* **2004**, *56*, 1649-1656.
(6) Moses, M. A.; Brem, H.; Langer, R. *Cancer Cell* **2003**, *4*, 337-341.
(7) Brigger, I.; Dubernet, C.; Couvreur, P. *Adv. Drug Deliver. Rev.* **2002**, *54*, 631-651.
(8) Panyam, J.; Labhasetwar, V. *Adv. Drug Deliv. Rev* **2003**, *55*, 329-347.
(9) Torchilin, V. P. *Nature Rev. Drug Discov.* **2005**, *4*.
(10) Mitra, S.; Gaur, U.; Ghosh, P. C.; Maitra, A. N. *J. Control Release* **2001**, *74*, 317-323.
(11) Nguyen, C. A.; Konan-Kouakou, Y. N.; Allemann, E.; Doelker, E.; Quintanar-Guerrero, D.; Fessi, H.; Gurny, R. *AAPS Pharm. Sci. Tech.* **2006**, *7*, 63.
(12) Shah, L. K.; Amiji, M. M. *Pharm. Res.* **2006**, *23*, 2638-2645.
(13) Sahoo, S.; Panyam, J.; Prabha, S.; Labhasetwar, V. *Journal of Controlled Release* **2002**, *82*, 105-114.
(14) Blanco, M.; Alonso, M. *European Journal of Pharmaceutics and Biopharmaceutics* **1997**, *43*, 287-294.
(15) Xu, P.; Gullotti, E.; Tong, L.; Highley, C.; Errabelli, D.; Hasan, T.; Cheng, J.; Kohane, D.; Yeo, Y. Molecular Pharmaceutics **2009**, *6*, 190-201.
(16) Roy, I.; Gupta, M. N. *Chem. Biol.* **2003**, *10*, 1161-1171.
(17) Schmaljohann, D. *Adv. Drug Deliv. Rev.* **2006**, *58*, 1655-1670.
(18) Foss, A. C.; Goto, T.; Morishita, M.; Peppas, N. A. *Eur J. Pharm. Biopharm.* **2004**, *57*, 163-169.
(19) Gillies, E. R.; Frechet, J. M. *Bioconjug. Chem.* **2005**, *16*, 361-368.
(20) Lee, E. S.; Na, K.; Bae, Y. H. *J. Control Release* **2005**, *103*, 405-418.
(21) Potineni, A.; Lynn, D. M.; Langer, R.; Amiji, M. M. *J Control Release* **2003**, *86*, 223-234.
(22) Shin, J.; Shum, P.; Thompson, D. H. *J. Control Release* **2003**, *91*, 187-200.
(23) Stayton, P. S.; El-Sayed, M. E.; Murthy, N.; Bulmus, V.; Lackey, C.; Cheung, C.; Hoffman, A. S. *Orthod. Craniofac. Res.* **2005**, *8*, 219-225.
(24) Taillefer, J.; Brasseur, N.; van Lier, J. E.; Lenaerts, V.; Le Garrec, D.; Leroux, J. C. *J. Pharm. Pharmacol.* **2001**, *53*, 155-166.
(25) Chaw, C. S.; Chooi, K. W.; Liu, X. M.; Tan, C. W.; Wang, L.; Yang, Y. Y. *Biomaterials* **2004**, *25*, 4297-4308.

Continued on page 11

Summer Scholar

Continued from page 10

(26) Chilkoti, A.; Dreher, M. R.; Meyer, D. E.; Raucher, D. *Adv Drug Deliv. Rev.* **2002**, *54*, 613-630.

(27) Choi, S. H.; Lee, S. H.; Park, T. G. *Biomacromolecules* **2006**, *7*, 1864-1870.

(28) Blanco, E.; Weinberg, B. D.; Stowe, N. T.; Anderson, J. M.; Gao, J. *J. Biomed. Mater. Res. A* **2006**, *76*, 174-182.

(29) Goodwin, A. P.; Mynar, J. L.; Ma, Y.; Fleming, G. R.; Frechet, J. M. *J. Am. Chem. Soc.* **2005**, *127*, 9952-9953.

(30) Kam, N. W.; O'Connell, M.; Wisdom, J. A.; Dai, H. *Proc. Natl. Acad. Sci. U. S. A.* **2005**, *102*, 11600-11605.

(31) Kim, H. C.; Hartner, S.; Behe, M.; Behr, T. M.; Hampp, N. A. *J. Biomed. Opt.* **2006**, *11*, 34024.

(32) Shum, P.; Kim, J. M.; Thompson, D. H. *Adv. Drug Deliv. Rev.* **2001**, *53*, 273-284.

(33) Wu, G.; Mikhailovsky, A.; Khant, H. A.; Fu, C.; Chiu, W.; Zasadzinski, J. A. *J. Am. Chem. Soc.* **2008**, *130*, 8175-8177.

(34) Huang, S. L. *Adv. Drug Deliv. Rev.* **2008**, *60*, 1167-1176.

(35) Husseini, G. A.; Pitt, W. G. *Adv. Drug Deliv. Rev.* **2008**, *60*, 1137-1152.

(36) Negishi, Y.; Endo, Y.; Fukuyama, T.; Suzuki, R.; Takizawa, T.; Omata, D.; Maruyama, K.; Aramaki, Y. *J. Control Release* **2008**, *132*, 124-130.

(37) Rapoport, N. Y.; Christensen, D. A.; Fain, H. D.; Barrows, L.; Gao, Z. *Ultrasonics* **2004**, *42*, 943-950.

(38) Hillaireau, H.; Le Doan, T.; Chacun, h.; Janin, J.; Couvreur, P. *Int. J. Pharm.* **2007**, *331*, 148-152.

(39) Griset, A. P.; Walpole, J.; Liu, R.; Gaffey, A.; Colson, Y. L.; Grinstaff, M. W. *J. Am. Chem. Soc.* **2009**, *131*, 2469-2471.

(40) Sorriso, S.; Patai, S. The Chemistry of Amino, Nitroso, Nitro and Related Groups; Wiley, 1996. ◇

February Monthly Meeting

By Michael Filosa

Nancy Jackson (ACS President), on right, with Patrick Gordon (NESACS Chair) and Ruth Tanner (NESACS Chair-Elect)

photo by Morton Z. Hoffman

The NESACS Monthly Meeting for February was held on Tuesday February 22nd at the Brookline Holiday Inn. This is a convenient and central location for a meeting with ample parking as well as excellent access via the MBTA. The guest of honor was 2011 ACS President Dr. Nancy B. Jackson of Sandia Laboratories. In addition to speaking at the meeting on the importance of chemistry in solving many of the most important global challenges, she also met regional leaders from academia, biotech, business, and the younger chemists committee over lunch at Eastern Standard in Boston. The lunch was funded by the Boston Chapter of Graduate Women in Science (GWIS) and NESACS. Dr. Jackson also met students at Department of Chemistry and Chemical Biology at Northeastern University and attended the NESACS Board Meeting.

In addition to Dr. Jackson's presence, this monthly meeting was important because the list of candidates for the upcoming election in May was read both at the Board Meeting and during the Monthly Meeting. Immediate Past Chair, John McKew has been leading the effort of the Nominating Committee to fill the slate of candidates which is published in this issue of the Nucleus. The final candidate statements will be published in the May issue.

The Meeting itself was commenced by 2011 NESACS Chair, Patrick Gordon. Mort Hoffman spoke about IYC activities and Dr. Jackson was introduced by NESACS Councilor and long-time friend of Nancy, Bob Lichter. Dr. Jackson spoke for about 40 minutes and answered questions for another 5 minutes. The audio of the proceedings had been recorded and Board of Publications is working on a process for getting these recordings as well as any slides onto the NESACS website for the benefit of NESACS members who are unable to attend a meeting.

Dr. Jackson talked about her travels around the world, "from Morocco to Malaysia," in her role as ACS President and also in her role as a chemist/chemical engineer working on international chemical security issues for the U.S. Government. The US lead in chemistry is being challenged. Visa problems after 9/11 have caused foreign students to look elsewhere, particularly Europe. In Asia research spending, both academic and industrial, is rising rapidly. Growth of publications from China is rising rapidly and the "majority of papers in ACS journals are coming from overseas."

Chemistry is a global enterprise and many of the challenges we face are global: sustainability, climate, energy. In addition, India has always been strong in science and is growing rapidly. "The rest of the world is coming up to meet us." However, in science and technology this is good because, "a rising tide raises all boats."

She worries that we do not have an adequate strategy compared to competing countries. We must support and generate the innovation needed to grow our economy. We must also find a way to reward companies that keep jobs and manufacturing here. The move of computer science jobs to India was cited as an example. Currently, it is hard to find enough skilled computer scientists in the US to meet our security needs.

Continued on page 13

Jack Szostak

Continued from page 4

directions. Even before becoming an HHMI Investigator, Szostak decided to move to MGH from the Dana-Farber Cancer Institute in 1984 to take a position in which all his research was completely funded as part of an industry-academia collaboration over a ten year period. Szostak also receives some funding from the NASA exobiology program and from the National Science Foundation.

The freedom from grant applications is particularly useful in a field like Szostak's, where other scientists may have difficulty understanding the importance of origin-of-life research. "Initially people are puzzled," Szostak said, because they want to know how Szostak's group can reach any definitive conclusions about life on prehistoric earth. However, "all we are trying to do is think about what is possible."

There has been a tremendous resurgent public interest in the study of the origin of life over the last few years, sparked in part by the discovery of extremophiles. "There is life everywhere," said Szostak, "in the deep seas, under rocks, everywhere you can imagine." At the same time, "every day there are new planets being discovered around stars. Of course you will wonder if there might be life somewhere else."

The general state of science funding in this country is "terrible," according to Szostak, in that it really "discourages innovation and doing risky things." The constant cycle of grant writing and revising is also a tremendous waste of time. One potential way to change the funding mechanism would be to "fund people and not projects," said Szostak. "Take someone who has been productive, and let's give them money to do what they think is important."

The idea of funding people and not projects is the primary mechanism by which HHMI works, in that funding is provided for researchers to pursue any project of interest. "It [funding people] would be just as competitive," said Szostak, "and we would actually get something interesting done."

Dr. Szostak is particularly frustrated by people who are interested in science only for the potential "useful" applications. Szostak's Nobel Prize winning telomerase research had virtually no applications at the time that it was discovered. "It was just a puzzle that we wanted to solve," said Szostak. "It was pure curiosity about how something works." Now, twenty years after this discovery, researchers have found a whole host of applications for telomerase research that substantially impact disease research and treatment. "You never know where there might be applications," said Szostak

Szostak's perspective on chemistry may be unique because his background and training is not in synthetic chemistry. In fact, Szostak was originally trained in yeast genetics, which is when he made the Nobel-Prize winning discovery that yeast without telomerase eventually stopped reproducing. However, after Szostak had spent some years studying yeast genetics, he felt that the field was getting more crowded. "Anything we did was going to be done by someone else sooner or later," said Szostak.

Szostak sat in on a variety of courses at Harvard in an attempt to find a new research focus. In one of those classes, taught by Dr. Jeremy Knowles, Szostak learned about the interesting mechanistic aspects of enzymology. The recently discovered ribozymes seemed like a particularly interesting target for study. "I was surprised more people weren't going into this field," Szostak said. "It was the perfect mix of a not-crowded field with interesting questions that were technically approachable." As a result, Szostak decided to pursue this field and ultimately switched his laboratory over to RNA biochemistry, which eventually led him to study the chemistry of the origin of life.

For somebody like Szostak who has a non-chemistry background, what strikes him about synthetic chemistry is really "how primitive it really is," said Szostak. "We can draw a nucleic acid with one minor structural change…and it might take two years to learn how to make that compound efficiently." If compounds were easier to synthesize, it would have a huge impact on biology, materials science, and a variety of other applications.

Szostak, who describes himself as "not the most organized person in the world," nonetheless gave time-management advice to new chemistry researchers. "Avoid getting in a situation where you are constantly going from crisis to crisis or demand to demand," said Szostak. "Spend some time with a blank piece of paper and think about the next experiment or the next problem you should be investigating."

The intense demands of academic life are compounded for those who also want to spend time with their families, but one advantage to academia is that the daily schedule is fairly flexible. Szostak indicated that his schedule sometimes allows him to take off in the afternoon to watch his sons' sports games. "I don't want to give the impression that it's easy," Szostak said, "but it is definitely doable."

In the aftermath of winning the Nobel Prize, Szostak's schedule has become even more demanding in some respects. "I have a lot of opportunities to talk to students and help the institution with fundraising," said Szostak, which he described as "very rewarding." Nonetheless, Szostak declines a fair number of speaker requests in the interest of spending time with his family and maintaining an active research lab. "I wasn't about to retire and spend my life traveling around the world," Szostak said. "It would be too easy to do that." ◇

Abstract

Continued from page 5

possible configurations for novel solar cells based on MEG in QDs and SF in molecules that could produce high conversion efficiencies at low cost will be presented, along with progress in developing such new types of solar cells. Recent analyses of the interesting effect of concentrated solar irradiance on the conversion efficiency of PV and water-splitting cells (to produce hydrogen fuel) will be discussed. ◇

Biography

Continued from page 5

photoelectrochemical energy conversion; photocatalysis; optical, magnetic and electrical properties of solids; and Mössbauer spectroscopy. He has published over 260 papers and book chapters in these fields, written or edited 5 books, holds 11 U.S. patents, and has delivered over 280 invited talks at universities, conferences, and symposia. He has served on numerous scientific review and advisory panels, chaired and organized many international and national conferences, workshops, and symposia, and received several awards in solar energy research, including the 2009 Science and Technology Award from the Intergovernmental Renewable Energy Organization associated with the U.N., the 2008 Eni Award from Italy, and the 2002 Research Award of the Electrochemical Society. Dr. Nozik has been a Senior Editor of The Journal of Physical Chemistry from 1993 to 2005 and is on the editorial advisory boards of the Journal of Energy and Environmental Sciences and the Journal of Solar Energy Materials and Solar Cells. A Special Festschrift Issue of The Journal of Physical Chemistry honoring Dr. Nozik's scientific career appeared as the December 21, 2006 issue. Dr. Nozik is a Fellow of the American Physical Society and a Fellow of the American Association for the Advancement of Science; he is also a member of the American Chemical Society, the Electrochemical Society, and the Materials Research Society. ◇

Events in Chemistry

Continued from page 2

tav R Kirchhoff. He was born on this date.

April 20, 1912
Gertrude E. Perlmann was born on this date and did research in protein chemistry. She received the Garvan Medal in 1965.

April 21, 1774
Jean-Baptiste Biot, who discovered optical activity, was born on this date.

April 22, 2007
Celebrated by ACS on this day, but the first Earth Day was founded by Sen. Gaylord Nelson, Father of Earth Day, and organized by Denis Hayes on April 21, 1970.

April 22, 1919
Donald J. Cram, a researcher in the application of stereochemical techniques to organic reaction mechanism, was born on this date. He invented carceplexes or guest molecules completely encapsulated by host molecules. (He synthesized a variety of host-guest complexes, including crown ether complexes, and shared the Nobel Prize in 1987 with C. J. Pedersen and J-M. P. Lehn for their development and use of molecules with structure-specific interactions of high selectivity.

April 23, 1917
Rohm & Haas Co. was incorporated on this date.

April 27, 1880
Charles James, who devised crystallization methods for separating the rare earth elements, was born on this day.

Additional historical events can be found at Dr. May's website, http://faculty.cua.edu/may/Chemistrycalendar.htm ◇

CAREER SERVICES

February Meeting

Continued from page 11

She also talked about the challenges facing the pharmaceutical industry with enormous layoffs and consolidations. She was hopeful that innovative, rapidly growing smaller biotechnology companies would help fill this void, but does not want to see a repeat of what happened to the IT industry. Energy research and our lack of commitment to renewable energy was another concern. The US is not even in the top 10 in spending (relative to GDP). "Turkey and Brazil are happening. Mexico spends more based on GDP than the US."

In education, "in Asia, 21% of bachelor degrees are in engineering, 12.5% in Europe, 4.5% in the US." Chemistry parallels engineering in these ratios. We must do better on STEM education both for scientists and non-scientists alike. Overall, a thoughtful and sobering look at the challenges facing chemists both locally and globally. ◇

BUSINESS DIRECTORY

SERVICES

SERVICES

SERVICES

BUSINESS DIRECTORY

SERVICES

SERVICES

SERVICES

Index of Advertisers

THE NUCLEUS
19 Mill Road
Harvard, MA 01451

NONPROFIT ORG.
U.S. POSTAGE PAID
NORTHEASTERN
SECTION
AMERICAN CHEMICAL
SOCIETY

Calendar

Check the NESACS home page for late Calendar additions: http://www.NESACS.org

Note also the Chemistry Department web pages for travel directions and updates.
These include:
http://chemserv.bc.edu/seminar.html
http://www.bu.edu/chemistry/events/
http://www.chem.brandeis.edu/colloquium.shtml
http://www-chem.harvard.edu/events/
http://web.mit.edu/chemistry/
www.chem.neu.edu/web/calendar/index.html
http://chem.tufts.edu/seminars.html [CHEM.]
http://ase.tufts.edu/chemical/seminar.htm
[CHEM. ENGG.]
http://www.chem.umb.edu/
www.umassd.edu/cas/chemistry/seminars.cfm
www.uml.edu/Dept/Chemistry/speakers.html
http://www.unh.edu/chemistry/seminars.html

Apr 04
The Max Tishler Prize Lectures
Dale Boger (The Scripps Research Institute)
Harvard, Pfizer Lecture Hall
4:00 pm

Apr 05
Prof. Victor Hruby (Univ. Arizona)
"Re-Examining Drug Design for Disease: Novel Approaches Using Design of Multivalent Peptide and Peptidomimetic Ligands"
Tufts Univ., Pearson, Room P-106
4:30 pm

Prof. Paramjit Arora (New York University)
"Synthetic Strategies for Targeting Protein-Protein Interactions"
Boston College, Merkert 130
4:00 pm

Apr 07
Prof. Shirley Tang (University of Waterloo)
"Interface Carbon Nanotube with Biological Systems: Applications and Environmental Impact"
Boston College, Merkert 130
4:00 PM

Tom Mallouk (Pennsylvania State University)
"Nanomaterials in One Dimension — Exploring Mesocopic Phenomena with Nanowires"
Harvard, Pfizer Lecture Hall
5:00 pm

Prof. Maria Flytzani-Stephanopoulos (Tufts University)
Chemistry and Sustainability Series:
"Nano- and atomic-scale catalysts in the fight for energy sustainability"
UNH, Room NB 104 (L103)
11:10 am

Apr 11
The Eli Lilly Symposium
Vy Dong (University of Toronto)
Harvard, Pfizer Lecture Hall
4:00 pm to 5:00 pm

Chris Chang (UC Berkeley)
Brandeis Univ., Gerstenzang 122
3:45 pm

Apr 12
Prof. J.D. Tovar (Johns Hopkins University)
"Topological and Supramolecular Considerations for Organic (bio)Electronics
Boston College, Merkert 130
4:00 pm

Prof. George O'Doherty (Northeastern University)
"De Novo Synthesis in Carbohydrate Synthesis and Medicinal Chemistry"
Tufts Univ., Pearson, P-106
4:30 pm

John Bercaw (California Institute of Technology)
Harvard, Pfizer Lecture Hall
4:15 pm

Apr 14
Rui Ding (UNH)
UNH, Room NB 104 (L103)
11:10 am

Apr 14 -15
O'Malley Visiting Scholar
Prof. Stephen White (University of California, Irvine)
Boston College, Merkert 130
4:00 pm

Apr 19
Prof. Vy Dong (University of Toronto)
Boston College, Merkert 130
4:00 pm

Amy M. Deveau (University of New England)
"No Pain, No Gain: Adventures in the Synthesis and Structural Evaluation of Biologically Interesting Naltrexol Analogs"
UNH, Room NB 104 (L103)
11:10 am

Prof. David Avnir (The Hebrew University of Jerusalem)
"Continuous symmetry and chirality measures"
Tufts Univ., Pearson, P-106
4:30 pm

Apr 20
James Mayer (University of Washington)
Harvard, Pfizer Lecture Hall
4:15 pm

Apr 21
Xiaowei Zhuang (Harvard University, CCB)
Harvard, Pfizer Lecture Hall
4:00 pm

Dr. Yi-Wen Huang (Harvard University)
UNH, Room NB 104 (L103)
11:10 am

Apr 25
Professor Shih-Yuan Liu (University of Oregon)
"Developing the Basic Science and Applications of Boron-Nitrogen-Containing Heterocycles"
Boston College, Merkert 130
4:00 pm

Frank H. Westheimer Prize and Prize Lecture
Roger Kornberg (Stanford Medical School)
Harvard, Pfizer Lecture Hall
4:00 pm

Apr 26
Shih-Yuan Liu (University of Oregon)
UNH, Room NB 104 (L103)
11:10 am

Apr 27
Suzanne Walker (Harvard Medical School)
"Structure, function, and inhibition of human O-GlcNAc transferase"
Harvard, Pfizer Lecture Hall
4:00 pm

Marina Petrukhina (State University of New York, Albany)
MIT, Room 6-120
4:15 pm

Apr 28
Prof. Timothy Dransfield (U Mass Boston)
UNH, Room NB 104 (L103)
11:10 am

Notices for The Nucleus Calendar of Seminars should be sent to:

Sheila E Rodman
Konarka Technologies, Inc.
116 John St. Suite 12, Lowell, MA 01852
email: srodman(at)konarka.com ◇