

THE NUCLEUS

February 2018

Vol. XCVI, No.6



Monthly Meeting

Teri Quinn Gray, ACS District III Director, to speak at the Broad Institute

The NESACS Multi-Generational Mentoring Initiative

By Carol Mulrooney and Catherine Rawlins

Summer Scholar Report

By Rachael Howland and Patrick J. Cappillino, University of Massachusetts-Dartmouth

Summer Scholar Report

By William Coreas and Deno Del Sesto, Stonehill College

The NESACS Multi-Generational Mentoring Initiative

By Carol Mulrooney, NESACS Women Chemists Committee Chair, and Catherine Rawlins, NESACS YCC Past Chair

The idea for the NESACS Multi-Generational Mentoring Initiative was conceived as a collaboration of the Younger Chemists Committee (YCC), Women Chemists Committee (WCC), and Senior Chemists Committee (SCC) led by Catherine Rawlins, Carol Mulrooney, and Morton Hoffman, respectively.

We recognized that there were overlapping goals of these three committees and successfully received an Innovative Projects Grant from the ACS! There are many stages of your career in which mentoring is needed and we sought to combine our efforts to reach a broader audience as a team. Thus far, three events have been run in 2017 under this initiative.

Know Your Worth Workshop with Ashley Pare

During the Fall 2017 NSYCC Career Symposium at Boston University, we organized a workshop on building salary negotiation skills. This stemmed from

the Wage Gap Panel hosted by the WCC in April 2017. Because of the new Equal Pay laws in Massachusetts, there is a need for more training on salary negotiation as a way to close the gender wage gap.

This workshop was run by Ashley Pare, an expert on teaching negotiation skills with 10+ years in human resources whose company, Own Your Worth LLC, leads workshops in the Greater Boston Area. Ashley presented information on the wage gap among chemists and presented resources for chemists to find out what the expected salary range is for chemists of different backgrounds in industry. The undergraduate and graduate students attending the symposium learned about the need to negotiate their salary when starting their industry careers. In interactive sessions, the audience practiced negotiating by role-playing employer and prospective employee salary conversations. In the feed-

back from the post-symposium surveys, many cited this workshop as their favorite part of the day's events and felt that the training was valuable.

Graduate Programs in Chemistry: Deciding, Getting in and Succeeding

This panel discussion was geared towards undergraduate chemistry students considering graduate school and was co-hosted by the Department of Chemistry at Bridgewater State University. The four panelists ranged in experience from a BSU alumna in her first year in a graduate program to a University Professor in charge of graduate admissions. The panelists participating were Phoebe Kurriss, graduate student at Brown University, Catherine Rawlins, graduate student at Northeastern and a co-host of the panel, Dr. Mindy Levine, Associate Professor at University of Rhode Island, and Dr. Carla Mattos, Professor at Northeastern University. Carol Mulrooney, chair of the NESACS Women Chemists Committee, moderated the discussion.

Utilizing resources from the ACS, the discussion started with the decision to go to graduate school and moved to what the undergraduates would need to do to prepare themselves for the experience. The second part of the discussion revolved around each year of graduate school and what the milestones are that the students can expect to achieve during their time. The presentation included numerous references to the ACS website and the extensive resources available to undergraduate and graduate students. Pizza and refreshments were served before the panel and students were given the opportunity to network with the panelists after the event. We plan to direct more events such as this to undergraduate-only institutions to reach a broader audience.

Perspectives on a Life in Chemistry: Mentoring

This symposium was the third IPG

continued on page 13

NORTHEAST STUDENT CHEMISTRY RESEARCH CONFERENCE

YCC
The Future of Chemistry
Northeastern Student Younger Chemists Committee

SATURDAY, APRIL 14TH, 2018
NORTHEASTERN UNIVERSITY

KEYNOTE SPEAKER:

DR. JOHN E. MACOR
SANDH

FOR UPDATES + REGISTRATION:
WWW.NSYCC.ORG/NSCRIC

FOLLOW US TO STAY UPDATED
@YCCNORTHEAST
@YCCNORTHEAST
@NSYCC

ABSTRACT DEADLINE: WEDNESDAY, MARCH 14TH

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@nesacs.org
NESACS Homepage:
http://www.NESACS.org

Officers 2018

Chair

Mindy Levine
35 Cottage St
Sharon, MA 02067-2130
(516)697-9688
mindy.levine@gmail.com

Chair-Elect

Andrew Scholte
Sanofi

Waltham, MA
617-459-5145
ascholte@gmail.com

Immediate Past Chair

Leland L. Johnson, Jr.
WuXi AppTec
Brookline, MA
(617)304-6474
lelandljohanson@gmail.com

Secretary

Michael Singer
MilliporeSigma
3 Strathmore Rd, Natick, MA 01760
(774)290-1391, Michael.singer@sial.com

Treasurer

Ashis Saha
67 Bow St
Arlington, MA 02474-2744
(978)212-5462
sahaashish1909@gmail.com

Auditor

Patrick Gordon

Archivist

Ken Mattes

Trustees

Peter C. Meltzer, Dorothy Phillips, Ruth Tanner

Directors-at-Large

David Harris, June Lum, Michael P. Filosa,
John Neumeyer, James U. Piper, Ralph Scannell

Councilors/Alternate Councilors

Term Ends 12/31/2018

Katherine Lee	Ajay Purohit
Catherine E. Costello	June Lum
Ruth Tanner	Malika Jeffries-EL
Kenneth Mattes	VACANT
Jackie O'Neil	

Term Ends 12/31/2019

Thomas R. Gilbert	Jerry P. Jasinski
Mary Jane Shultz	Raj (SB) Rajur
Michael Singer	Matthew M. Jacobsen
Lisa Marcaurelle	Ashis Saha

Term Ends 12/31/2020

Michael P. Filosa	Robert Lichter
Carol Mulrooney	Morton Z. Hoffman
Patricia A. Mabrouk	Sonja Strah-Pleyne
Anna W. Sromek	Andrew Scholte
Sofia A. Santos	Patrick M. Gordon

All Chairs of standing Committees, the editor of THE NUCLEUS, and the Trustees of Section Funds are members of the Board of Directors. Any Councilor of the American Chemical Society residing within the section area is an ex officio member of the Board of Directors.



Contents

The NESACS Multi-Generational Mentoring Initiative _____ 2

By Carol Mulrooney and Catherine Rawlins

Announcements _____ 2,5,11

Northeast Student Chemistry Research Conference, The Norris-Richards Undergraduate Summer Research Scholarships, STEM Journey V: Robotics in the 21st Century

Going for the Gold _____ 4

By Steve Lantos

Monthly Meeting _____ 5

Teri Quinn Gray, ACS District III Director, to speak at the Broad Institute

Summer Scholar Report _____ 6

Scalable, Versatile Synthesis of Bio-Inspired Vanadium Compounds for High Stability, High Solubility Flow Battery Active Materials
Rachael Howland and Patrick J. Cappillino, University of Massachusetts, Dartmouth, MA

Summer Scholar Report _____ 8

Gas-Surface Reaction Dynamics Studied using Molecular Beams
By William Coreas, Deno Del Sesto, Stonehill College, North Easton, MA

STEM Journey IV: NASA's Mission to Mars _____ 11

By Jack Driscoll and Jennifer Maclachlan, NESACS Public Relations

Business Directory _____ 15

Calendar _____ 16

Cover: Photo taken at the January Meeting held at Nova Biochem (L-R) Peter Dorhout (ACS President), Dorothy Phillips (ACS Director-at-Large), Tom Gilbert (NESACS Councilor). Photo by Morton Z. Hoffman.

Editorial Deadlines: April 2018 Issue: February 22, 2018
May 2018 Issue: March 22, 2018

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., 18 Tamarack Road, Medfield, MA 02052 Email: mpf1952@gmail.com; Tel: 508-843-9070

Associate Editors: Myron S. Simon, 60 Seminary Ave. apt 272, Auburndale, MA 02466
Morton Z. Hoffman, 23 Williams Rd., Norton, MA 02766

Board of Publications: James Phillips (Chair), Mary Mahaney, Ajay Purohit, Ken Drew, Katherine Lee

Business Manager: Vacant

Advertising Manager: Vacant: contact Michael Filosa at mpf1952@gmail.com

Calendar Coordinator: Xavier Hérault, Email: xherault@outlook.com

Photographers: Morton Hoffman and James Phillips

Proofreaders: Donald O. Rickter, Morton Z. Hoffman

Webmaster: Roy Hagen, Email: webmaster@nesacs.org

Copyright 2018, Northeastern Section of the American Chemical Society, Inc.

Going for the Gold

By Steve Lantos (Chair, High School Education Committee), Brookline High School

At its November meeting, NESACS recognized the 2017 International Chemistry Olympiad (IChO) Team USA and one of its students, Joshua Park of Lexington High School, together with his three teammates, Harrison Wang (Hinsdale Central High School, IL), Steven Liu (Monta Vista High School, CA), and Brendan Yap (Carmel High School, IN), who are freshman at MIT. Given their location, NESACS honored 'Team Alpha Kappa' (so named because it is the 34th team sent to the IChO, starting with the first year's 'Alpha' team, then at the end of the 24 Greek letters beginning with a second letter, again starting with alpha) at the meeting for its outstanding four-gold medal performance at the 49th annual IChO in Thailand. In fact, NESACS has had a longstanding relationship with the United States National Chemistry Olympiad (USNCO) and the IChO that dates to the origins of our country's involvement with the world chemistry competition.

The IChO began in 1968 as an inter-country competition among several European nations, including Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and Austria. Today, it includes 75 countries with over 290 students making up the four-person teams from each nation. Each nation conducts competitions to select the top students as representatives to the world event.

How does one get to the world competition? It's a long process that obviously begins in the classroom with the study of chemical concepts and lots of practice with laboratory work. Good teaching certainly helps! In the U.S., the first step is to take an exam. There are more than 140 ACS local sections throughout the country that offer either their own exam or one provided by the ACS Office of K-12 Education, that consists of a 60-question multiple choice exam, covering fundamental chemical concepts at a level of a more challenging Chemistry SATII. Here in NESACS, given the level of ability of many of our top students, we have cho-



(l-r) Brendan Yap, Steve Liu, Joshua Park, Harrison Wang. (Photo by Cecilia Hernandez; C&EN, Vol. 95, Issue 30, July 24, 2017, p. 4).

sen instead to write our own 85-90-question multiple-choice exam, called the Avery Ashdown Exam in honor of the longtime MIT chemistry professor, to differentiate the top scorers. We permit a maximum of five students per high school to compete.

Typically, over 16,000 students nationwide take some form of the local section exam each year in early April. From this entry-level group, the ACS has allotted a fixed number of students to qualify for the next round of competition, the USNCO. Thanks to Ron Ragsdale of the University of Utah who has been involved with the USNCO from its beginning in the mid-1980s, the ACS uses a federated system whereby the number of

continued on page 10

ResMed: Residential School on Medicinal Chemistry and Biology in Drug Discovery
June 10-15, 2018
Drew University, Madison, NJ

This graduate level course concentrates on the fundamentals that are useful in drug discovery spanning initial target assay evaluation through clinical development. Case histories of recent successful drug development programs will also be presented. The five-day program covers:

Principles of Med Chem	DMPK
Cheminformatics	Toxicophores
Lead ID & Optimization	GPCRs
Epigenetics	Kinase Inhibitors
Fragment-based Drug Design	Ion Channels
Structure-based Drug Design	Enzyme Inhibitors
Drug-like Properties	Bioisosteres
Protein-Protein Interactions	Preclinical Toxicology
Molecular Modeling	Clinical Development
Antibody-Drug Conjugates	

Bill Greenlee, Vince Gullo & Ron Doll – Co-organizers

Attendees will be staying at the Madison Hotel

www.drew.edu/resmed
e-mail: resmed@drew.edu
phone: 973/408-3787; fax: 973/408-3504

NESACS Sponsors 2017

Platinum \$5000+

Boston Foundation Esselen Award
SK Life Science
Amgen, Inc
Johnson Matthey
Vertex Pharmaceuticals
Davos Pharma
Biogen
PCI Synthesis
Navin Fluorine International Ltd

Gold \$3000 up to \$5000

Merck Research Corp
Signal Pharmaceuticals
J-Star Research
IPG Women Chemists
Abbvie

Silver \$1500 up to \$3000

Mettler Toledo
Sanofi US Services
Warp Drive Bio
Pfizer
LAVIANA
Strem Chemicals

Bronze \$500 up to \$1500

Chemical Computing Group
Xtuit Pharmaceuticals
Cydan Development Inc
Achillion Pharmaceuticals
Alkermes
FLAMMA
Safety Partners Inc
Piramal Pharma Solutions'
Selvita, Inc.
Organix
CreaGen Life Science
Entasis Therapeutics
Morphic Therapeutic
Interchim, Inc
Xtal Biostructures
Quartet Medicine
Anton Parr USA
Biotage
Bioduro
Novalix Pharma
Thermo Fisher
Cresset Group
Custom NMR Services

Monthly Meeting

The 976th Meeting of the Northeastern Section of the American Chemical Society

Thursday, February 8, 2018

Broad Institute

415 Main Street, Cambridge, MA 02142

4:30 pm NESACS Board Meeting

5:30 pm Social Hour (Yellowstone Room, 415 Main St.)

6:30 pm Dinner

7:30 pm Andrew Scholte, NESACS Chair-Elect, Presiding

Keynote Presentation

(Auditorium, 415 Main St):

Dr. Teri Quinn Gray (<https://goo.gl/images/9VBUHv>).

DowDuPont Transportation & Advanced Polymers
District III Director - American Chemical Society



Dr. Teri Quinn Gray

**YOU MUST REGISTER IN ADVANCE TO ATTEND THE MEETING:
THERE IS NO REGISTRATION FEE TO ATTEND THE MEETING
DINNER RESERVATIONS ARE REQUIRED.
THE PUBLIC IS INVITED**

- For those who would like to join us for dinner, register by noon, Thursday, February 1, at the NESACS Eventbrite page: <https://february-2018-nesacs-gray.eventbrite.com> Cost: Members, \$30; Non-members, \$35; Retirees, \$20; Students, \$10. Dinner reservations not cancelled at least 24 hours in advance will not be refunded
- If you wish to join us for this meeting and not eat dinner, please register by noon, Thursday, February 1, using <https://february-2018-nesacs-gray.eventbrite.com>

If you have any questions or require additional information, contact the Administrative Coordinator, Anna Singer, via email at secretary@nesacs.org.

Parking: Parking is available in the Yellow Garage behind the Broad Institute, access by either Ames St. or Galileo Galilei Way. Metered street parking is available on Main St. and Ames St.

The Broad is 2 blocks from the MIT/Kendall T Stop on the Red Line.

March Meeting: The March Meeting will be held at the Museum of Fine Arts (MFA) on TUESDAY, March 13, 2018. ◇

Biography:

Teri Quinn Gray is Six Sigma Consultant and New Product Commercialization Manager with DuPont Crop Protection in Newark, DE. She's a native of Jackson, Mississippi and honors graduate of Jackson State University with a BS degree in chemistry. She holds a PhD in

analytical chemistry from the University of Maryland, College Park and worked as NRC Postdoctoral Fellow at NIST in 1995-1997. She is President of the DE State Board of Education, appointed by Governor Jack Markell in June 2009. Teri currently serves on the ACS Women Chemists Committee and as chair of the ACS Diversity & Inclusion Advisory Board. ◇

Announcement

The Norris-Richards Undergraduate Summer Research Scholarships

March 29, 2018 Deadline

The Northeastern Section of the American Chemical Society established the James Flack Norris and Theodore William Richards Undergraduate Summer Scholarships to honor the memories of Professors Norris and Richards by promoting research interactions between undergraduate students and faculty.

Research awards of \$3500 will be given for the summer of 2018. The student stipend is \$3000 for a minimum commitment of ten weeks of full-time research work. The remaining \$500 of the award can be spent on supplies, travel, and other items relevant to the student project.

Institutions whose student/faculty team receives a Norris/Richards Undergraduate Summer Research Scholarship are expected to contribute toward the support of the faculty members and to waive any student fees for summer research. Academic credit may be granted to the students at the discretion of the institutions.

Award winners are required to submit a report (~5-7 double-spaced pages including figures, tables, and bibliography) of their summer projects to the Editor of *The Nucleus* by November 1, 2018 for publication in *The Nucleus*. They are also required to participate in the Northeast Student Chemistry Research Conference (NSCRC) in April 2019.

Eligibility:

Applications will be accepted from student/faculty teams at colleges and universities within the Northeastern Section. The undergraduate student must be a chemistry, biochemistry, chemical engineering, or molecular biology major in good standing, and have completed at least two full years of college-level chemistry by Summer, 2018.

Criteria for Selection:

- scientific merit - important factors include the originality of the project,

continued on page 14

Summer Scholar Report

Scalable, Versatile Synthesis of Bio-Inspired Vanadium Compounds for High Stability, High Solubility Flow Battery Active Materials

Rachael Howland and Patrick J. Cappillino

Department of Chemistry and Biochemistry, University of Massachusetts, 02747

Abstract:

Non-aqueous redox flow batteries (NRFBs) offer a viable solution to grid-scale energy storage. However, their implementation has been hindered by poor stability and low solubility of the active materials within the electrolyte solutions. To mitigate this issue, a bio-inspired approach was taken to find a vanadium complex that had been optimized for stability through natural selection.¹ Amavadin, produced by the *Amanita muscaria* mushroom, is a metal complex consisting of a vanadium ion bound by two tetradentate hydroxyiminodipropionic acid ligands that has the strongest binding for a vanadium compound ever reported.² An analogous, synthetic version of Amavadin, vanadium(IV)bis-hydroxyiminodiacetate (VBH²⁻), retains this unique binding structure making it an auspicious candidate for an NRFB active material. Previous experiments with the calcium salt of this analogue, calcium(ii)vanadium(IV)bis-hydroxyiminodiacetate (Ca²⁺VBH), showed promising stability to deep cycling. However, it exhibited low solubility in all solvents tested other than dimethyl sulfoxide (DMSO) and water, neither of which are practical NRFB solvents. This investigation addressed the need for VBH²⁻ analogues that are soluble in battery-relevant solvents by changing the counter cation from calcium to alkylammoniums. High concentration NRFB electrolytes have been prepared in tetrahydrofuran (THF), and γ -butyrolactone (GBL) without compromising the inherent stability, as measured with UV-vis spectroscopy. These new compounds were characterized with X-ray crystallography and FTIR.

In addition, modifications to the synthesis of these compounds were made. Leveraging the remarkable stability of VBH²⁻, a direct synthetic scheme was employed that obviates the need for costly ion-exchange resins that were used in the previously reported procedures. This scalable approach allowed for the Ca²⁺VBH to become a reagent in the formation of new complexes by exploiting the low K_{sp} of calcium fluoride, facilitating cation metathesis between Ca²⁺ from the Ca²⁺VBH and alkylammonium fluoride salts. These changes support the commercial feasibility of these electrolytes by removing limitations on scalability and providing a versatile synthesis pathway for VBH²⁻ active materials with arbitrary cations.

Introduction:

The adoption of renewable energy to the electrical grid system is hindered by the intermittent nature of the sources, such as wind and solar power.³ Developing grid-scale energy storage to mitigate the supply and demand discrepancy has been recognized as an integral component in transitioning energy dependence from fossil fuels to sustainable sources.⁴ With predictions from the U.S. Energy Information Administration

(EIA) indicating an increase in renewable energy usage⁵, the need to develop and improve existing strategies is increasing.

Redox flow batteries (RFBs) have been a promising technology in energy storage for decades due to their design versatility, efficiency and unique scalability.⁶⁻⁸ A generic model of the RFB includes redox-active electrolytes stored independently and then pumped into a cell containing two half cells, positive and negative, that are separated by an ion selective membrane and connected to a power and a load source, respectively.³ This design accounts for their scalability given that power can be scaled by increasing the electrochemical apparatus and capacity is a function of the volume and concentration of the electrolyte solution.⁴

State-of-the-art RFBs consist of vanadium ions in aqueous, acidic solutions for both the anode and cathode active materials.⁹ However, non-aqueous systems (NRFBs) have begun to garner attention since they offer several key advantages with respect to the composition of their electrolyte solutions. These include wide electrochemical windows, low vapor pressures, high dielectric constants, potentially greater thermal stability and improvements in power and energy density.¹⁰⁻¹¹ Notwithstanding these clear advantages, development of NRFBs has been severely inhibited by the instability of the active materials within the electrolyte solutions during cycling, especially at high current densities.¹⁰ This degradation can result in as much as 80% capacity loss after only modest cycling¹²⁻¹⁵ crippling the batteries' lifespan. In addition, it is difficult to predict the behavior of active materials in advance, creating a general reliance on commonly known, commercially available compounds and discouraging more novel approaches.

Prior research had posited that a bio-inspired approach, that recognized nature had been optimizing for the stability of metal complexes through eons of evolution, led to the exploration of the biomolecule Amavadin. Amavadin binds a vanadium (IV) ion with two tetradentate ligands and has the strongest binding constant ($\log K = 23.4 \pm 5$), for that ion ever recorded.² A synthetic version of the molecule, vanadium (IV) hydroxyiminodiacetate (VBH²⁻), was used as a scaffold for active materials in NRFB electrolytes.¹ In initial experiments, conducted with a known Amavadin analogue, calcium(ii)vanadium(IV)bis-hydroxyiminodiacetate (Ca²⁺VBH), cyclic voltammetric (CV) analysis and exhaustive, deep redox cycling between vanadium(IV/V) in both static cell and flow battery showed excellent chemical and stability and negligible capacity-fade.¹ In addition, Ca²⁺VBH was stable in both the reduced and oxidized states over time, as verified by UV-vis spectroscopy.¹

continued on page 7

Howland/Cappillino Scholar

Continued from page 6

While the promising stability of Ca^{2+}VBH has been demonstrated, it was only soluble in water and DMSO, neither of which are ideal solvents for NRFBs. This redirected the focus of the investigation from stability to solubility and the idea that different counter cations could have an impact on active material concentrations and in more relevant solvents. Initially, (bis)tetramethyl-ammonium vanadium(IV)bis(hydroxy-iminodiacetate) ($[\text{N1111}]_2\text{VBH}$), was synthesized and dissolved in propylene carbonate (5 mM). This was an improvement over Ca^{2+} , allowing electrochemical evaluation and further suggested that changing the counter cation was a useful approach to increasing solubility.¹

Two challenges in terms of synthesis became apparent at this stage. First, the published synthesis for Ca^{2+}VBH was not scalable due to the use of an ion exchange column.² To provide perspective, a recent trial at Case Western Reserve University used 45 gallons of electrolyte solution to produce a 1 KW scale prototype flow battery.¹⁶ To match this prototype scale, a 608 litre (160.0 U.S. gallon) ion-exchange column would be necessary! Second, a versatile synthesis, allowing either purification of VBH^{2-} with cations, or direct preparation of electrolytes was necessary. The commercial viability of VBH^{2-} as an NRFB active material scaffold would be improved if a scalable method could be found that also eliminated the need for an ion exchange column.

Methods:

General:

Bromoacetic acid, 98% (Alfa Aesar), hydroxylamine hydrochloride, 99% (Alfa Aesar), zinc acetate dihydrate (Acros Organics), calcium chloride (Fischer Technical), tetraethylammonium hydroxide, 35 wt% in water (Sigma Aldrich), tetraethylammonium fluoride $\geq 98.0\%$ (VWR), tetrabutylammonium fluoride 70-75% water (TCI), vanadium (IV) bis(acetylacetonato) oxide 98% (STREM), γ -butyrolactone (Sigma Aldrich) and tetramethylammonium hydroxide 25% in water (Acros Organics) were purchased and used without purification. Zinc hydroxyiminodiacetate (ZnHIDA) was prepared according to literature procedures.²

Physical Methods:

FTIR Analysis was conducted using a Nicolet iS5 spectrometer with iD7 ATR attachment (Thermo Scientific) UV-vis spectroscopy was performed with an Evolution 220 UV Visible spectrophotometer (Thermo Scientific) and XRD was collected with a Bruker D8 Venture X.

UV-vis spectroscopy was carried out for both the initial synthesis concentrations of the analogues in their respective solvents and at a 1:10 volumetric dilution. The extinction coefficient $\epsilon_{825}=24.8 \text{ M}^{-1}\text{cm}^{-1}$ had previously been determined for Ca^{2+}VBH and was used in this experiment.¹ Before determination of concentration any precipitate was removed using either centrifuging or vacuum filtration.

Preparation of (bis)tetraethylammonium vanadium(IV) (bis)hydroxyiminodiacetate $[\text{N2222}]_2\text{VBH}$ – Method A: In

3 mL of solvent, 0.795 g (0.003 mol) Ca^{2+}VBH (265 g/mol), 1.11 g (0.006 mol) tetraethylammonium fluoride (185 g/mol) were combined and stirred overnight. Solvents used were either water, DMSO, GBL or PC. A bright blue solution formed with off-white solid. The precipitate was removed through centrifuging and then filtration.

Crystallization-

Crystals suitable for X-ray diffraction were obtained from samples of the compound that had been synthesized with Method B: In 40 mL of water, 3.4 g (0.008 mol) $[\text{N2222}]\cdot\text{OH}$ (35% wt H_2O ; 147.26 g/mol), 1.06 g (0.004 mol) $\text{VO}[\text{acac}]_2$ (265 g/mol), 1.2 g (0.008 mol) hydroxyiminodiacetic acid (H_3HIDA) (149 g/mol) were combined and stirred for 1 hour. A bright blue solution formed and was then roto-evaporated until a solid formed. This was filtered, dissolved in ethanol and slow diffused with diethylether; FTIR 3391(NH) 2991(CH) 1603(CO)1178(CC) 1005(CC)

Preparation of (bis)tetrabutylammonium vanadium(IV) (bis)hydroxyiminodiacetate $[\text{N4444}]_2\text{VBH}$ – This compound was prepared by Method A above: In 5.0 mL of solvent, 1.3 g (0.005 mol) Ca^{2+}VBH (265 g/mol), 2.8 g (0.010 mol) tetrabutylammonium fluoride (280.5 g/mol) were combined and stirred overnight. The solvents used were either water, DMSO, GBL or THF. A bright blue solution formed with an off-white solid. The precipitate was removed through centrifuging and then filtration.

Crystallization-

Crystals suitable for XRD were obtained from slow diffusion of diethylether into a high concentration THF solution prepared by method A; FTIR 3419(NH) 2957(CH) 1615(CO) 1127(CC)

Results and Discussion:

Modification of the Ca^{2+}VBH synthesis

The synthesis method for creating the VBH^{2-} analogues was modified in two ways; elimination of the ion exchange column and a cation metathesis approach utilizing the fluoride salt of the desired cation. One of the precursors to the Ca^{2+}VBH preparation from the literature is a zinc salt of the hydroxyiminodiacetate (HIDA).¹ In that procedure, an ion exchange column was used to remove the Zn^{2+} cation from the zinc salt of the hydroxyiminodiacetate ligands HIDA , leaving a protonated version, hydroxyiminodiacetic acid (H_3HIDA) that could then be reacted with calcium chloride (CaCl_2) and vanadium (IV) bis(acetylacetonato) oxide ($\text{VO}(\text{Acac}_2)$) to produce Ca^{2+}VBH . (Scheme 1) The logarithm of the stability constant for Zn-Hida is 5.05(10) compared to that of 23.0(10) for VBH^{2-} , suggesting a strong preference of HIDA for the vanadium(IV) ion.¹ Initially, attempts were made to dissolve the ZnHIDA with phosphoric acid in the presence of vanadyl acetylacetonate $\text{VO}[\text{acac}]_{2(s)}$ since zinc phosphate has a K_{sp} of 5×10^{-36} ¹⁷ and should have precipitated, leaving VBH^{2-} in solution without further purification on the column. However, both the zinc phosphate and the Ca^{2+}VBH precipitated and this pathway was abandoned after various efforts to isolate the product. The next attempt was to use 12 M hydrochloric acid

continued on page 12

Summer Scholar Report

Gas-Surface Reaction Dynamics Studied Using Molecular Beams

By William Coreas, Deno Del Sesto, Stonehill College, North Easton, MA

During the summer of 2017, the process of steam reformation was studied, specifically, the rate-determining C-H bond cleavage step in steam reformation. The overall reaction which takes place in steam reformation is important, as it is the main industrially pathway for production of H₂ gas, a clean and powerful energy source that has the potential to replace other pollutant fuels currently used in the world, and is used in the production of synthetic fertilizer. The process which the Utz research group¹ focuses on is shown in Equation 1, which is performed over a nickel catalyst.



Equation 1. Steam-reforming process

The reason this reaction is known as a heterogeneous catalysis is as the catalyst is in a different physical state than the reagents and products in the reaction, as the methane and water are in gaseous states while the nickel is in solid state. This reaction is very important, as the hydrogen gas that is formed from the reaction seen in Equation 1 can be used then used in the Haber-Bosch reaction, which is seen in Equation 2.



Equation 2. Haber-Bosch process

The hydrogen gas is reacted with nitrogen to produce ammonia; this ammonia can be used to produce synthetic fertilizers. This process is vital, as 48% of the world's population was supported and fed using synthetic fertilizers made using ammonia.² The world's population is also growing at a fast pace, so more fertilizer must be produced, meaning more hydrogen gas needs to be produced. The problem that arises is that the current industrial process used currently for steam reformation is not as efficient as it could be, and it is also costly. By studying the rate determining C-H bond cleavage step shown in Equation 3,



Equation 3. Rate-determining step of heterogenous catalysis

where the CH₃ and the H are adsorbed to the surface, the overall reaction can be made more efficient. Very few methane molecules that interact with the nickel catalyst react, as the reaction transition state has strict geometric and energetic requirements. To maximize the efficiency of adsorption of the methane on the nickel catalyst, industrially the methane gas is heated to high temperatures to maximize energy and is at very high pressures to increase collisions with the catalyst.

The machine built in the Utz lab which is used to study the reaction of methane on the nickel catalyst has four differ-

entially pumped vacuum chambers; there is the source, where the methane gas is thermalized and the molecular beam is produced; the 1st differential chamber, which is where the methane molecules can be excited via an IR laser, the 2nd differential chamber, which is where beam analysis takes place, and the main chamber, which contains the nickel single crystal sample. To determine the exact nature of the interaction of methane with nickel, and to understand the restrictions on the transition state, methane can be produced with a specific kinetic and vibrational energy. These variables can give insight into the energetic and geometric restrictions on the minimum pathway to reactivity.

A mixture of methane gas, as well as lighter gases such as hydrogen, are pumped into the molecular beam, which is held at 40 psi, inside of the source chamber, held at a pressure of the magnitude 10⁻⁴ torr. The hydrogen gas is added into the mixture to bring down the average mass of the mixture, allowing for the kinetic energy of the methane to increase by increasing the velocity of the mixture of gases. Once the gases were thermalized, the molecular beam travels to the 1st chamber, where it is excited by the IR laser, then travels to the 2nd chamber, which then selects only the molecules that are traveling in a straight path to the nickel catalyst to pass the chamber.

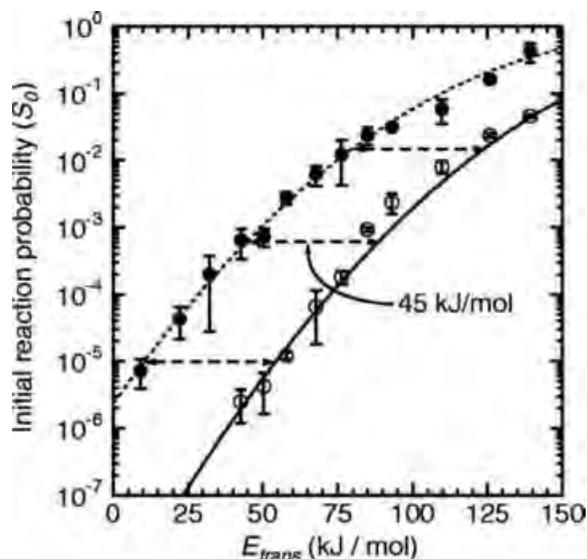


Figure 1. Sticking probability curves of methane on nickel with and without laser³

The IR laser is important as it excites the molecules vibrationally, meaning the molecules are vibrating in a specific energy. Figure 1 above shows the sticking probability, or the likelihood of methane to react with the nickel surface, of methane that was excited by

continued on page 9

Coreas/Del Sesto Scholar Report

Continued from page 8

a laser compared to methane that was not. The curve on the right shows the reactivity of methane without laser excitation while the curve on the left shows methane in an excited state. The difference in energy in both curves is 45 kJ/mol, meaning the energy barrier of reaction decreases by that amount to react methane on nickel surface.

In order to carry out these experiments, however, the main chamber must be dry and not contain any gases. The machine is kept under vacuum at very low pressures, and any time that analysis is done, the main chamber must first be baked in order to get rid of any impurities in the chamber. Baking refers to wrapping the chambers up in heat tape, then wrapping everything in aluminum foil, in order to insulate the heat and prevent it from escaping. In the time spent in lab, there was a period of one to two weeks in which the machine was baking, so in this time period, the importance of the research was discussed, as well as, how everything was approached in lab. The parts of the chambers were discussed, how they were fixed, and any sort of troubleshooting that could be done during the bake was also done. One major difficulty that arose during this time was the position of the nickel crystal and where it was being held. In the main chamber, the crystal is attached to a small metal plate, which is then welded to six arms which hold the crystal in place. Heating filaments, which heat the chamber, are near the crystal; one of the filaments became loose, so the crystal hit the filament, causing the crystal to scratch. The crystal was removed from the chamber, breaking the vacuum, which resulted in another three-day bake. Afterwards, due to the position of the crystal changing, assistance was able to be given in order to find the optimal positioning of the nickel crystal in order to maximize reactivity of the methane on the crystal, as well as, to find optimal positions to analyze the amount of methane on the surface after reaction.

Table 1. Positions of dosage beam, Auger Electron gun, and the sputter gun 7/11/17

Positions	7/11/2017		
Axes	Dose	AES	Sputter
X	0.885	0.2	0.1
Y	0.65	0.5125	0.65
Z	2.213	0.8375	2.05
θ	2°	235°	160°

Table 1 above shows the positioning of the crystal in regard to dosage, Auger Electron spectroscopy, and the sputter gun. Auger Electron spectroscopy was done in order to get a model of the nickel surface, while the sputter gun was used to clean any impurities off of the crystal's surface. After finding the optimal position of the crystal in the main chamber, it was believed that the molecular beam could finally be run, as the nickel had the clean surface; however, after running a residual

gas analysis using the Quadrupole Mass Spectrometer (QMS) seen in Figure 2 below, it could be seen that the chamber had a large peak at 19 m/z, indicating the presence of fluorine in the main chamber.

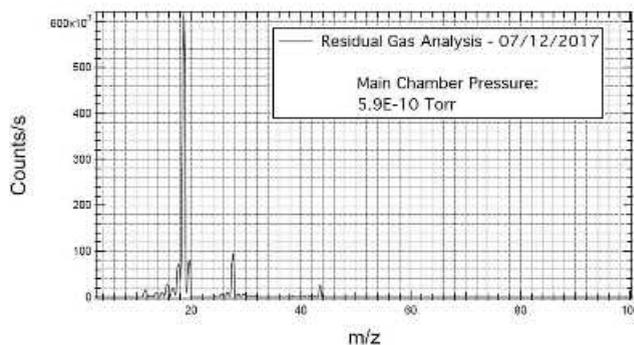


Figure 2. Gas analysis of the main chamber on 07/12/2017

This problem could have stemmed from different problems; since the chamber had been recently baked, there could have been a possibility that there was a technological malfunction, causing the reading above. Historically, the data shows that after baking, the residual gas analysis should resemble the graph shown in Figure 3.

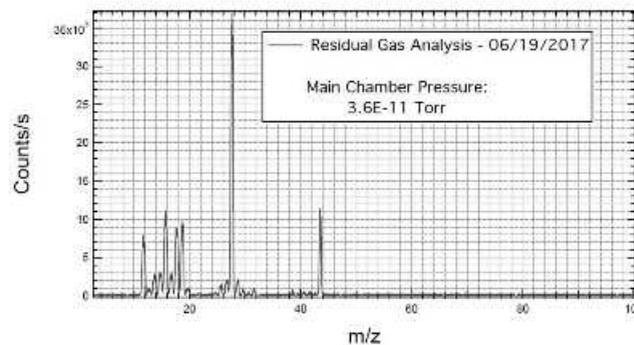


Figure 3. Gas analysis of the main chamber on 06/19/2017

Though there were many issues in terms of equipment, the skills that were gained during the summer are priceless, as being able to work on a problem hands-on is a valuable skill to have. This also shows that science does not always go as expected, and there are always roadblocks which you must face, and it is necessary to take on the roadblocks without giving up.

continued on page 10

¹ Utz Research Group. (n.d.). Retrieved November, 2017, from <http://ase.tufts.edu/chemistry/utz/progress.htm>

² How many people does synthetic fertilizer feed? (2017, November 07). Retrieved November 12, 2017, from <https://ourworldindata.org/how-many-people-does-synthetic-fertilizer-feed/>

³ Smith, R. R., Killelea, D. R., Del Sesto, D. F., & Utz, A. L. (2004, May 14). Preference for Vibrational over Translational Energy in a Gas-Surface Reaction. Retrieved November 12, 2017, from <http://science.sciencemag.org/content/304/5673/992.full>

⁴ Utz Research Group. (n.d.). Retrieved November, 2017, from <http://ase.tufts.edu/chemistry/utz/progress.htm>

Going for the Gold

Continued from page 4



Joshua Park with his teacher Janice Compton

qualifying students in a section is based on its ACS membership. Given the large number of members of NESACS, we are allotted one of the larger groups of qualifiers (26 participants as of 2017).

The USNCO, administered nationally in late April, consists of three parts: a 60-question multiple-choice section, an eight-question free-response section, and, as of 1995, a two-part laboratory practical portion. NESACS thanks the Simmons College Chemistry Department for the generous use of its classroom and laboratory space for the many years NESACS has run the chemistry competition. Approximately 1,000 students nationwide sit for the USNCO; from this group, the top 20 are selected based on a composite of their scores from the three-part exam. These 20 students are invited to attend the Study Camp held during the first two weeks of June at the U.S. Air Force Academy in Colorado Springs. They are provided with college-level textbooks prior to their arrival at the camp, and are expected to study and learn topics not typically seen in the high school or AP curriculum, such as physical chemistry, advanced organic chemistry, quantitative analysis, etc. Once at the camp, the Air Force Academy's Chemistry Department provides the group with daily lectures, laboratory experiments, individual and group tutoring and studying, and regular assessment. The two-week camp is intensive, to say the least. Three adult mentors live in the dormitory on campus with the 20 students. At the end of the camp, a series of final assessments is given to select the top four (and

one alternate) to proceed to the IChO. The ACS covers the expenses of the team to the city and country of the IChO, typically held in mid-July.

This past year's site was Nakhon Pathom, Thailand; the 2018 site will be in Prague and Bratislava. The last year the world competition was held in the U.S. was 2012 at venues in and around Washington, D.C. From the first year of participation by the U.S. in 1984 with only 45 local sections participating and 76 individuals taking the USNCO, there were, as of last year, 144 participating sections with 297 students at the USNCO. The level of interest has only increased over the years!

The connection of NESACS to the world competition dates to 1984 when the U.S. sent a team to Frankfurt. The four-member team included Peter Capofreddi from Newton North H.S. Also on that first U.S. team was Seth Brown, who went on to attend MIT in the late 1980s, and is now a professor of chemistry at Notre Dame. He also serves as the Chairperson of the USNCO Examinations Task Force, which is charged with creating each year's written examination questions.

In 1985 Glen Whitney from Medfield H.S. won a bronze medal at the IChO held in Bratislava, Czechoslovakia. His brother, Wayne, represented the U.S. five years later, winning a gold medal at the 1990 IChO in Paris. In 1996 Alex MeVay of the Groton School (teacher: Donald Lea), scored first place on the Ashdown Exam, went on to the study camp, and was selected for the 'Alpha Delta' team; he won a gold medal at the IChO in Moscow. Colin Whittaker of Wayland H.S. (teacher: Jay Chandler) took a silver at the 2002 IChO in Groningen, The Netherlands.

It took another fifteen years to 2017 before another NESACS student, Joshua Park from Lexington (teacher: Janice Compton), would get to the IChO. "From the moment I learned that I was a member of Team USA, I devoted all of my time to preparing for the international competition," Park said. His and his fellow teammates' devotion to chemistry paid off big time in Thailand when they won four gold medals for Team USA, a first in our country's participa-

Coreas Scholar Report

Continued from page 9

I would like to acknowledge the Utz research group at Tufts University for allowing me the opportunity to be in lab with them, as well as for teaching me many new and interesting techniques that I would not be able to be exposed to in other situations. I would also like to thank my research advisor Professor Del Sesto for introducing me to an interesting field in science, as well as introducing me to a great group of people at Tufts University.

References:

How many people does synthetic fertilizer feed? (2017, November 07). Retrieved November 12, 2017, from <https://ourworldindata.org/how-many-people-does-synthetic-fertilizer-feed/>

Utz Research Group. (n.d.). <http://ase.tufts.edu/chemistry/utz/progress.htm>

Smith, R. R., Killelea, D. R., Del Sesto, D. F., & Utz, A. L. (2004, May 14). Preference for Vibrational over Translational Energy in a Gas-Surface Reaction. Retrieved November 12, 2017, from <http://science.sciencemag.org/content/304/567/3/992.full> ◇

tion at the IChO!

Given the high interest from students, their teachers, and schools throughout NESACS, I am confident we will continue to represent the high level of chemical education our public and private-school students across the section receive, and the strong standing NESACS holds among other sections throughout the country.

For a report of Team Alpha Kappa's accomplishments following last year's IChO, see <<http://cen.acs.org/articles/95/web/2017/07/US-team-makes-history-IChO.html>>.

Steve Lantos wrote the Ashdown Exam from 1989-2002, served as the Chair of the Laboratory Practical portion of the USNCO from 2001-2010, and was a Mentor to the USNCO Study Camp in 2011. He is completing doctoral work by examining best teaching practices among award-winning Boston-area high school chemistry teachers. ◇

STEM Journey IV: NASA's Mission to Mars

By Jack Driscoll, Chair NESACS Public Relations Committee and Jennifer Maclachlan, NESACS Public Relations Committee

STEM Journey IV, was organized by the Cape Cod & Islands Council, Boy Scouts of America; the Northeastern Section of the American Chemical Society; Sandwich STEM Academy and PID Analyzers, LLC. Our mission is to generate a continued interest in science and related fields for K-12 students. Our fourth such event was held on Saturday, March 4, 2017 from 12:00 Noon to 4:00 PM at Sandwich High School/Sandwich STEM Academy.

The event was free and open to the public. In the morning, there were Merit Badge opportunities for Boy Scouts including the following: Digital Technology, Engineering, and Fingerprinting. Nine girl scouts and ten boy scouts signed up for the fingerprinting class given by the Barnstable County Sheriff's Office.

Dr. Luke Roberson, Senior Research Scientist and payload engineer at NASA's Kennedy Space Center, Cape Canaveral, Florida was the keynote speaker. Dr. Roberson earned a B.S. (1999), a M.S. (2002), and a Ph.D. (2005) from Georgia Institute of Technology. He is deeply involved in the Mission to Mars and discussed many of the issues with the mission.

Dr. Roberson was introduced by Dr. Peter Dorhout, 2017 President-Elect of the American Chemical Society. Dr. Dorhout is Vice President for Research at Kansas State University. Dr. Dorhout is an Eagle Scout and serves on the Executive Board of the Coronado Area Council.

He said that it was impossible to carry all the materials needed for a round trip mission. Oxygen would have to be re-generated from the carbon dioxide exhaled by the astronauts.

Water would have to be recycled and a water source would have to be found on Mars (possibly extracted from the soil). An underground lake was recently reported to be on Mars. Luke described the difficulties of growing plants in space but this is something that the astronauts have been doing for some time on the International Space Station. There are many technological problems that have to be solved before NASA's mission in the 2030's. There were more than 400 people attending Dr. Roberson's lecture at the Sandwich STEM Academy's auditorium.

STEM Journey included more than 40 interactive displays by a variety of businesses and organizations related to STEM.

STEM Journey IV: What was Included?

NASA talk was from 12:30PM-2PM. This is an ALL ages talk focusing on NASA's Mission to Mars and what got guest lecturer and NASA Technology Expert, Dr. Luke Roberson interested in his STEM career field

MATE ROV underwater remotely operated vehicles interactive demonstration/competition in the pool at Sandwich High School from 12:30pm-3:30pm. Several aquatic themed exhibits will be co-located near the pool area.

Hands-On Science, Technology, Engineering & Math themed activities and demonstrations occurred from noon-4PM in the gym

Exhibitors included:

Cape Light Compact, Northeastern Section of the American

continued on page 13

STEM JOURNEY V

Saturday March 3, 2018

Hosted by Sandwich STEM Academy

11am-5pm, Free. All-ages general public event. Hands-on activities and Robotics Lecture.

Keynote Address: Andrew Reichel, iRobot

Opening Remarks: Dr. Dorothy Phillips, "Women in STEM"

facebook.com/STEMJourney

Organized by:

The Cape & Islands Boy Scouts of America

The Northeastern Section of the American Chemical Society

PID Analyzers, LLC and Sandwich STEM Academy



ROBOTICS

© Can Stock Photo / nmcanndre

in the 21st Century

Howland/Cappillino Scholar Report

Continued from page 7

in place of the phosphoric acid to dissolve the solid reagents, VO[acac]_{2(s)}, ZnHIDA and CaCl₂, once they were placed in water. (Scheme 1) The reagent mixture immediately turned a translucent blue color consistent with VBH²⁻ with the addition of the acid, at a pH of 0.24. The solution was then treated directly with isopropanol (9° C) for precipitation and resulted in a purple powder consistent with Ca²⁺VBH through FTIR analysis and XRD after recrystallization in slow liquid diffusion with water and IprOH. Typical yield for this direct precipitation of Ca²⁺VBH is 17.75 g, 75.5% compared to 0.447 g, 91% Ca²⁺VBH for the literature procedures.¹⁹



Scheme 1. Ca²⁺VBH synthesis modification with the original pathway from literature in red and showing the use of the ion exchange column and the new method shown with the blue arrow and going directly from the Zn-HIDA to Ca²⁺VBH.

The next challenge was developing a versatile, scalable synthesis method for VBH²⁻ compounds with varying cations. Appreciating the strength of the coordination between the vanadium(IV) and the HIDA ligands, calcium salts with low K_{sp} values were researched with the expectation that they would form as a solid and leave the desired product remaining in solution. Calcium fluoride has a K_{sp} of 3.9 × 10⁻¹¹ and when the Ca²⁺VBH was mixed in solution with the two fluoride salts of tetraethylammonium and tetrabutylammonium, products were obtained. This method was useful in obtaining pure compounds for analysis and was also reproducible in water, DMSO, PC, and GBL. This suggests the potential to directly prepare VBH²⁻ based electrolytes in various battery-relevant solvents by removing the CaF₂ solid, without isolation.

Synthesis of alkylammonium compounds in battery relevant solvents

The compound (bis)tetraethylammonium vanadium(IV)(bis)hydroxyiminodiacetate, [N2222]₂VBH was synthesized and electrolytes of 0.79 M in water, 0.2 M in PC, and 0.5 M in GBL were prepared. (Figure 1). The crystal structure was determined using XRD (Figure 2) and the compound was further characterized by FTIR. Similarly, (bis)tetrabutylammonium vanadium(IV)(bis)hydroxyiminodiacetate, [N4444]₂VBH was synthesized and electrolyte concentrations of 0.5 M in water, 0.76 M in THF, and 0.58 M in GBL. (Figure 1) The structure was characterized with both XRD (Figure 2) and FTIR. It should be noted that these concentrations are not necessarily the maximum concentrations achievable for the compounds in these solvents.

The exchange of the Ca²⁺ ion for the alkylammonium cations and the resulting trend from Ca²⁺VBH being insoluble in PC, THF and GBL to the range of concentrations seen between the three alkylammonium analogues strongly suggests that this would be a viable mechanism for addressing the need to increase active material concentrations in NRFB electrolytes. This is important because the concentration of active material in an electrolyte solution directly correlates with its energy density.

Figure 1. UV-vis spectra of solutions of [TBA]₂[VBH] in γ-BL (a.) and THF (b.) and [TEA]₂[VBH] in H₂O (c.), after dilution. Blank spectra are shown with black lines in (a.), (b.) and (c.). A photograph of 0.76 M [TBA]₂[VBH] in THF is shown in the inset of (b.). Concentrations are calculated using the absorbance and extinction coefficient of [VBH] at 825 nm of 24.8 M⁻¹cm⁻¹.

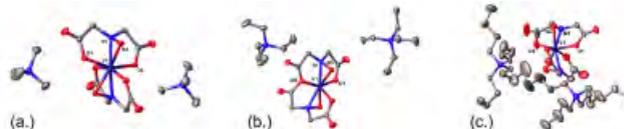
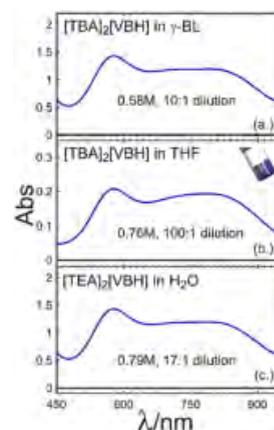


Figure 2. X-ray crystal structures of bis-TMA (a.), bis-TEA (b.) and bis-TBA (c.) [VBH] compounds. Thermal ellipsoids at 40% probability for (a.) and (b.) and 30% for (c.). Atoms labels show the position of the vanadium ion and the four donor atoms of one of the two ligands in all three structures.

Conclusions:

Utilizing the unique binding strength of VBH²⁻ and the low K_{sp} of calcium fluoride, two alkylammonium VBH compounds were produced at high concentration in battery-relevant solvents. The counter cation has a direct effect on solubility and will continue to be investigated both in terms of synthesis and electrochemical analysis. The fact that higher concentrations of alkylammonium salts of VBH²⁻ were obtainable in all solvents investigated, compared to Ca²⁺, suggests that factors affecting the lattice enthalpy, rather than solute-solvent interactions are more important in determining the solubility. The ability to directly synthesize active materials in NRFB solvents could provide advantages commercially in terms of ease of synthesis and scalability.

Acknowledgements:

The authors would like to thank Dr. James Golen for the X-ray crystallography.

Citations:

- Huang, H., Howland, R., Agar, E., Nourani, M., Golen, J., Cappillino, P. Bioinspired, High Stability, Nonaqueous Redox Flow Battery Electrolytes. *J. Mater. Chem. A*, 2016.
- G. Anderegg, E. Koch and E. Bayer, *Inorg. Chim. Acta*, 1987, 127, 183–188.

continued on page 14

Mentoring Initiative

Continued from page 2

sponsored event, held at Northeastern University on December 5th. Four established, successful chemists spoke of their experiences from both having and being mentors. Throughout the presentations, a common theme surfaced and sent a powerful message about the benefits of mentoring. Opening remarks were given by Dr. Mindy Levine, NESACS 2018 Chair. Mindy shared some observations on her experiences with her past mentors, including some direct pieces of advice she has received, some helpful, some... not so helpful. The goal of this symposium was to share the wisdom from years of experience to students and early career scientists to guide them in their scientific journey. These were the highlights from each speaker:

Dr. Morton Hoffman, Professor Emeritus, Boston University spoke of his friendships with his mentors and mentees, and of the benefits of being a mentor in academia. These include the good feelings gained from helping someone and gaining a life-long friend. Mentors helping new professors also humanize an academic department by encouraging people to talk to each other. He summarized with an observation: everybody needs a mentor, although some hesitate to reach out for help.

Dr. Dorothy Phillips, Retired, Waters Corporation, introduced her presentation by defining mentoring as a key element of leadership. She spoke of the mentors she has had during her career as close friends. While moving up the industry career ladder, she received key pieces of advice, including one from a close friend and colleague who stressed publishing one paper a year. She also talked about how she asked for mentoring when serving in the National ACS leadership. Her plan when seeking advice was to introduce herself to one of the leaders, ask for some time and prepare specific questions for her prospective mentor. Dorothy ended her talk by specifying her most important mentoring relationships: her family.

Dr. Tom Gilbert, Associate Professor, Northeastern University,⁰ shared his observations on what it takes to be an effective mentor: a strong base of knowl-

Mission to Mars

Continued from page 11

Chemical Society (NESACS), Rhode Island Section of the American Chemical Society, Palladium Science Academy of NY, Teledyne Inc., Sandwich STEM Academy, National Marine Life Center, Frogmen Divers, Cambridge Science Festival's Science on the Street, Woods Hole Oceanographic Institution—Applied Ocean Physics and Engineering department, Marine Renewable Energy Collaborative, RC Flying Club of Cape Cod (Drones), Barnstable Amateur Radio Club, Barnstable County Sheriff, The Math Learning Center of Cape Cod, Whydah Pirate Museum, Wicked Cool Fun for Kids, UMASS Boston

STEM RESOURCES FOR EDUCATORS:

American Association of Chemistry Teachers (AACT), Cape Cod Museum of Natural History, American Association of Chemistry Teachers (AACT), edge and experience, and an understanding of the value of being a mentor- that you lift yourself by lifting up others. Tom told us of a mentor-turned-collaborator who helped him grow as a teacher by understanding the needs of the students. Among the mentors Tom spoke of was our final speaker, Dr. Vouros, with whom Tom described as the “quintessential mentor.”

Dr. Paul Vouros, Professor Emeritus, Northeastern University, talked of mentoring as something that can come naturally, not having to be planned. He uses his past positive experiences with mentors to inform his own mentorship. His description of a good mentor included knowledge and excellence in the field of study, patience, warmth, and an interest in students' goals and objectives.

The undercurrent of warmth, friendship and collaboration ran through each presentation and served to inspire the audience. We are extremely grateful for the opportunity to learn how to be mentors from these excellent speakers!

Looking ahead to 2018, we plan to host more events targeting the different demographics represented by each of the three committees and expand our network to other organizations in the Greater Boston Area! ◇

American Industrial Hygiene Association, American Chemical Society

STEM-RELATED GROUPS, MUSEUMS, CAMPS, PRE-SCHOOL PROGRAM:

Cape Cod Technology Council, Cape Cod Museum Trail, Cape Cod & Islands Council, Boy Scouts of America, The Hundred Acre School at Heritage Museums & Gardens

RECRUITERS FROM THE FOLLOWING COLLEGES/UNIVERSITIES:

Bristol Community College, Suffolk University, Benjamin Franklin Institute of Technology, Wentworth Institute of Technology, Cape Cod Community College, Massachusetts Maritime Academy, Wheaton College, U Mass Dartmouth, U Mass Boston, Bridgewater State University

STEM Journey IV Organizers:

- Eben Franks - Chairman- STEM Journey
- Dr. Jack Driscoll - CCC BSA Executive Board, NESACS- PR Chair, PID Analyzers, STEM Journey
- Jennifer Maclachlan - NESACS PR, PID Analyzers, CPRC Chair - American Chemical Society
- Michael Riley - CCC Boy Scouts of America, Executive Director
- Gilbert Newton - Sandwich STEM Academy

Publicity for STEM Journey IV:

<https://www.capecod.com/events/stem-journey-iv-nasas-mission-to-mars/>

<http://analyzersource.blogspot.com/2017/03/what-to-expect-if-you-are-attending.html>

<http://analyzersource.blogspot.com/2017/01/stem-journey-iv-mission-to-mars.html>

<http://www.sandwichk12.org/news/story-details/~post/stem-journey-iv-mission-to-mars-20170206>

<https://www.facebook.com/SandwichSTEM-Academy-891599570946068/>

<https://www.nasa.gov/content/journey-to-mars-overview>

Cape Cod Broadcasting Media Interview & Science Outreach-Jennifer Maclachlan

Expand the Reach of your Outreach Ac-

continued on page 14

Howland/Cappillino

Continued from page 12

- 3 Weber, A.Z., Mench, M.M., Meyers, J.P. et al. *J Appl Electrochem* (2011) 41:1137. <https://doi.org/10.1007/s10800-011-0348-2>
- 4 G. L. Soloveichik, *Chem. Rev.*, 2015, 115, 11533–11558.
- 5 U.S. Energy Information administration, Short-Term Energy Outlook (STEO), September 2016, <https://www.eia.gov/forecasts/steo/archives/may16.pdf>, accessed September 29, 2016, 2016.
- 6 J. Winsberg, T. Hagemann, T. Janoschka, M. D. Hager and U. S. Schubert, *Angew. Chem., Int. Ed.*, 2016, 55, 2–28.
- 7 S. Ha and K. G. Gallagher, *J. Power Sources*, 2015, 296, 122–132.
- 8 V. Viswanathan, A. Crawford, D. Stephenson, S. Kim, W. Wang, B. Li, G. Coffey, E. Thomsen, G. Graff, P. Balducci, M. Kintner-Meyer and V. Sprenkle, *J. Power Sources*, 2014, 247, 1040–1051.
- 9 J. Winsberg, T. Hagemann, T. Janoschka, M. D. Hager and U. S. Schubert, *Angew. Chem., Int. Ed.*, 2017, 56, 686–711.
- 10 J. D. Milshtein, A. P. Kaur, M. D. Caselman, J. A. Kowalski, S. Modekrutti, P. L. Zhang, N. Harsha Attanayake, C. F. Elliott, S. R. Parkin, C. Risko, F. R. Brushett and S. A. Odom, *Energy Environ. Sci.*, 2016, 9, 3531–3543.
- 11 Gong, Q. Fang, S. Gu, S. F. Y. Li and Y. Yan, *Energy Environ. Sci.*, 2015, 8, 3515–3530.
- 12 W. T. Duan, R. S. Vemuri, J. D. Milshtein, S. Laramie, R. D. Dmello, J. H. Huang, L. Zhang, D. H. Hu, M. Vijayakumar, W. Wang, J. Liu, R. M. Darling, L. Thompson, K. Smith, J. S. Moore, F. R. Brushett and X. L. Wei, *J. Mater. Chem. A*, 2016, 4, 5448–5456.
- 13 E. V. Carino, J. Staszak-Jirkovsky, R. S. Assary, L. A. Curtiss, N. M. Markovic and F. R. Brushett, *Chem. Mater.*, 2016, 28, 2529–2539.
- 14 P. J. Cappillino, H. D. Pratt, N. S. Hudak, N. C. Tomson, T. M. Anderson and M. R. Anstey, *Adv. Energy Mater.*, 2014, 4, 1300566.
- 15 Shinkle, A. E. S. Sleightholme, L. D. Griffith, L. T. Thompson and C. W. Monroe, *J. Power Sources*, 2012, 206,

Mission to Mars

Continued from page 13

activities C&E News March 6, 2017, p 40
Sandwich TV- <https://vimeo.com/203127565>
Podcast- <https://m.youtube.com/watch?v=FNCJUUnLZyno>

Summary

STEM Journey was our first event at Sandwich STEM Academy. This location provided all activities in one place which is an advantage on cold wintry days in New England in March. The auditorium, the pool for the Mate ROV, and the Gym for the 50+ exhibitors were on the first and second floors.

We had more than 800 excited parents and K-12 students at this event. We talked to several 5th grade students and asked what they were interested in the future and it was “Archeology”, a number of scouts indicated a strong interest in science (note that nearly 80% of the merit badges are STEM related), a number of students said that this was the “best STEM Journey ever”. ◇

-
- 490–496.
- 16 “Researchers building flow battery prototype to augment grid.” *The Daily*, 28 June 2017, <http://thedaily.case.edu/researchers-building-flow-battery-prototype-augment-grid/>. (<http://thedaily.case.edu/researchers-building-flow-battery-prototype-augment-grid/>)
 - 17 D. C. Harris, *Quantitative Chemical Analysis*. 8 ed.; W.H. Freeman and company New York, 2010; p 796.
 - 18 Patnaik, P., *Handbook of Inorganic Chemicals*. 1 ed.; McGraw-Hill Professional: New York, 2002; p 1086.
 - 19 P. D. Smith, R. E. Berry, S. M. Harben, R. L. Beddoes, 10 M. Helliwell, D. Collison and C. David Garner, *J. Chem. Soc., Dalton Trans.*, 1997, 4509–4516, DOI: 10.1039/A703683C. ◇

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.

Richards Scholarship

Continued from page 5

- depth of the investigation, the significance of the scientific questions you pose, and the methods you propose to use.
- feasibility - evidence must be provided to demonstrate that the project can be completed by you in the time available and with the facilities at your disposal.
 - preparation - your academic record, your ability to handle the project, and the background study you have made on your research problem will be taken into consideration.
 - commitment - the depth of your commitment, and that of your department, faculty, and institution to independent research as a vital component of science education will be assessed.

Application for 2018:

- Announcement Letter
- Instructions
- Student Application Form
- Faculty Information Form

Application available at http://www.nesacs.org/awards_norris-richards.html

Completed applications are to be **received** by the Chair of the Selection Committee no later than **March 29, 2018**. Please note that applications via email (PDF format) are strongly preferred. Applicants will be notified of the results by email by April 13, 2018, with written confirmation to follow.

Selection Committee Chair:

Email: jonathan.rochford@umb.edu
Professor Jonathan Rochford
Department of Chemistry
University of Massachusetts Boston
100 Morrissey Boulevard
Boston, MA 02125-3393 ◇



Join
NESACS
on facebook

www.facebook.com/nesacs

BUSINESS DIRECTORY

SERVICES

NMR Service 500MHz
***Mass**
***Elemental Analysis**
NuMega Resonance Labs
 numegalabs.com P- 858-793-6057

Custom Synthesis of Chemicals
 Gram to Commercial Production
 On-time Delivery, Quality & Competitive Price
TYGER Scientific Inc.
 324 Stokes Ave. Ewing, NJ 08638
 Phone: 888-329-8990
 Email: sales@tygersci.com

TELL OUR ADVERTISERS
 Membership surveys show that you want more articles in our newsletter. If you tell our advertisers that you saw their ad here, they will provide more financial support and this will allow us to add more articles.

SERVICES

ORGANIX INC.
Your Partner in Organic & Medicinal Chemistry
 Providing Services Since 1985

Services:

- Custom Synthesis
- Hit-to-Lead Programs
- Structure Activity Programs
- 1H NMR and 13C NMR
- LC/MS Services

Strengths:

- Outstanding Communications
- Reliable Time Management
- Experienced Ph.D. Scientists

On Target - On Time - On Budget

Massachusetts, USA
 Phone: (781) 932-4142
 Fax: (781) 933-6695
 Email: organix@organixinc.com
www.organixinc.com

SERVICES



PCI Synthesis Inc. is a custom chemical manufacturer of new chemical entities (NCE's), and other specialty chemical products.

- Process Research
- Process Development
- Analytical Development
- Process Validation
- Regulatory Support
- FDA filing

PCI Synthesis
 Together Moving Ideas Forward

9 Opportunity Way, Newburyport, MA 01950

978.462.5555
www.pcisynthesis.com

Micron Analytical Services



**COMPLETE MATERIALS CHARACTERIZATION
 MORPHOLOGY CHEMISTRY STRUCTURE**

SEM/EDXA • EPA/WDXA • XRD XRF • ESCA • AUGER • FTIR • DSC/TGA

Registered with FDA • DEA GMP/GLP Compliant

3815 Lancaster Pike Wilmington DE. 19805 Voice 302-998-1184, Fax 302-998-1836
 E-Mail micronanalytical@compuserve.com Web Page: www.micronanalytical.com

WANT MORE ARTICLES

When you tell our advertisers that you saw their ads here they have more confidence in our newsletter's viability as an advertising medium. They advertise more. This supports our many activities.

Index of Advertisers

Drew University	4
Eastern Scientific Co.....	16
Micron, Inc.	15
NuMega Resonance Labs	15
Organix, Inc.	15
PCI Synthesis.....	15
Robertson Microlit Labs..	15
Tyger Scientific, Inc.	15



Robertson Microlit Laboratories

Where speed and accuracy are elemental

Elemental CHN, S, X, Analysis (same day service)	GC-MS
Metals by ICP-OES, ICP-MS, A/A	Polarimetry
FTIR, UV/VIS Spectroscopy	DSC, TGA, melting point
Ion Chromatography	KF Aquametry, Titrimetry

1705 U.S. Highway 46 • Suite 1D • Ledgewood, NJ 07852 • 973.966.6668 • F 973.966.0136
www.robertson-microlit.com • email: results@robertson-microlit.com

Rapid Results • Quality • Accuracy • Competitive Pricing

Eastern Scientific

www.easternsci.com

781-826-3456



Vacuum Pump Problems?

Eastern Scientific specializes in the repair and precision rebuilding of all makes of mechanical vacuum pumps.

*Free pick-up & delivery
Restrictions apply*



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://www.bc.edu/schools/cas/chemistry/seminars.html>
- <http://www.bu.edu/chemistry/seminars/>
- <http://www.brandeis.edu/departments/chemistry/events/index.html>
- <http://chemistry.harvard.edu/calendar/upcoming>
- <http://www.northeastern.edu/cos/chemistry/events-2/>
- <http://chemistry.mit.edu/events/all>
- <http://chem.tufts.edu/seminars.html>
- <http://engineering.tufts.edu/chbe/newsEvents/seminarSeries/index.asp>
- <http://www.chem.umb.edu>
- <http://www.umassd.edu/cas/chemistry/>
- <http://www.uml.edu/Sciences/chemistry/Seminars-and-Colloquia.aspx>
- <http://www.unh.edu/chemistry/events>
- <https://www.wpi.edu/academics/departments/chemistry-biochemistry>

January 30

Prof. Eliot Chaikof (Beth Israel-Deaconess Medical Center)
Tufts, Pearson, Rm. P106 4:30 pm

February 1

Prof. Jessica Hoover (West Virginia)
"Copper-Catalyzed Oxidative Decarboxylative Coupling Reactions."
WPI, Gateway Park, Room 1002 12:00 pm
Prof. Aaron Beeler (Boston University)
Dartmouth, Steele, Rm 006 10:30 am

February 6

Prof. Heather Kulik (MIT)
U. of New Hampshire, Parsons N104 11:10 am
Prof. Revati Kumar (LSU)
Tufts, Pearson, Rm. P106 4:30 pm

February 7

Prof. Trevor Hayton (UCal-Santa Barbara)
Harvard, Pfizer Lecture Hall
4:15 pm

February 8

Prof. Helma Wennemers (ETH Zurich) & Dr. Jonathan Reeves (Boehringer-Ingelheim)
MIT, Room 6-120
4:00 pm
Prof. Yoan Simon (Univ. Southern Mississippi)
WPI, Gateway Park, Room 1002
12:00 pm

February 12

Prof. Amit R. Reddi (Georgia Tech)
MIT, Room 4-270 4:00 pm

February 13

Prof. Ian Tonks (U. of Minnesota)
Boston College, Merkert 130 4:00 pm
Dr. Simon Bonyhady (Lanxess)
"An Inorganic Chemist's First Year in Industry."
Univ. New Hampshire, Parsons N104
11:10 am
Prof. Matthew Shoulders (MIT)
Tufts, Pearson, Rm. P106 4:30 pm

February 15

Prof. Andy Gewirth (Illinois-Urbana Champaign)
Boston College, Merkert 130 4:00 pm
Prof. X. Peter Zhang (Boston College)
WPI, Gateway Park Room 1002
12:00 pm
Prof. Amit R. Reddi (Georgia Tech)
Dartmouth, Steele, Rm 006 10:30 AM

February 20

Prof. Sherine Elsawa (Univ. New Hampshire)
Univ. New Hampshire, Parsons N104
11:10 AM
Prof. Erin Iski (University of Tulsa)
Tufts, Pearson, Rm. P106 4:30 pm

February 21

Prof. Hemamala Karunadasa (Stanford)
MIT, Room 4-370 4:15 pm

February 22

Prof. Jen Heemstra (Emory)
Boston College, Merkert 130
4:00 pm
Prof. Ryan Shenvi (Scripps Research Institute)
Dartmouth, Steele, Rm 006 10:30 am

February 26

Prof. Benjamin Cravatt (Scripps Research Institute)
MIT, Room 4-270 4:00 pm

February 27

Prof. Gonghu Li (Univ. New Hampshire)
"Surface Molecular Catalysis for Solar Fuel Research."
Univ. New Hampshire, Parsons N104
11:10 am
Dr. Nicholas Yoder (ImmunoGen Inc.)
Tufts, Pearson, Rm. P106 4:30 pm

February 28

Prof. Deborah Perlstein (Boston University)
Boston College, Merkert 130
4:00 pm

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

Xavier Herault, email:
xherault@outlook.com ◇