THE NATIONAL ACADEMIES

RESEARCH ASSOCIATESHIP PROGRAMS

The Postdoc

Spring 2014

2013 NOAA AEROSE

NOAA Aerosols and Ocean Science Expedition acquires unique data for studying the Atlantic Ocean Ozone Wave-One and validation of NOAA satellite-derived trace gases.

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National Research Council (NRC) Postdoctoral Research Associate Dr. Jonathan W. Smith (right) with NRC Adviser Dr. Nicholas R. Nalli (left) preparing a radiosonde for a morning launch aligned with the MetOp-A environmental satellite overpass in November 2013 aboard the NOAA R/V Ronald H. Brown.

NOAA Ship *Ronald H. Brown* in Bridgetown, Barbados, November 2013, just prior to the 2013b AEROSE campaign.

"The Postdoc" newsletters, which highlight research and activities of NRC Associates and Advisers, are available in PDF via our website: http://sites.nationalacademies.org/PGA/RAP/PGA_047804, or in GoogleDoc via our Facebook Page, or in hardcopy (National Academy Press) via the newsletter manager.

Ray Gamble, Director
NRC Postdoctoral Associateship Programs
Suzanne White, newsletter manager

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NRC Representation at 2014 Meetings

AIAA	American Institute of Aeronautics and Astronautics	01/13/14-01/17/14	National Harbor	MD
AMS	American Meteorological Society	02/02/14-02/06/14	Atlanta	GA
APS-RAP	American Physical Society	03/03/14-03/07/14	Denver	CO
Postdoc Conf	Postdoctoral Conference and Career Fair	04/24/2014	Bethesda	MD
EB	Experimental Biology	04/26/14-04/30/14	San Diego	CA
ASM	American Society for Microbiology	05/17/14-05/20/14	Boston	MA
ACS-Fall	American Chemical Society -- Fall	08/10/14-08/14/14	San Francisco	CA
FEF-McKNIGHT	FEF - McKnight Scholars Conference	10/01/14-10/01/14	Tampa	FL
HACU	Hispanic Association of Colleges and Universities	10/04/14-10/06/14	Denver	CO
MAES	Mexican American Engineers and Scientists	10/15/14-10/18/14	San Diego	CA
SACNAS	Soc for the Adv of Chicanos & Native Ams in Science	10/15/14-10/19/14	Los Angeles	CA
ASTMH	American Society of Tropical Medicine and Hygiene	11/02/14/11/06/14	New Orleans	LA
ABRCMS	Am Biomedical Research Conf for Minority Students	11/12/14-11/15/14	San Antonio	TX
AISES	American Indian Science and Engineering Society	11/13/14-11/15/14	Orlando	FL
AGU	American Geophysical Union	12/15/14-12/19/14	San Francisco	CA

Meet Jenny at NETL!

Dr. Jennifer M. Frederick, NRC Fellow at NETL Methane Hydrates

Jennifer M. Frederick, a new NRC Research Fellow supported by the NETL Methane Hydrates Fellowship, was selected for an “Outstanding Contribution by an Early Career Investigator” award at the 2014 Gordon Research Seminar on Natural Gas Hydrate Systems in Galveston, TX this March. She was one of three young investigators to be selected by the conference organizing committee to give a short talk on the subject of their research during the Gordon Research Conference. Jennifer's talk was entitled *The effect of submarine groundwater discharge on relict subsea permafrost and Arctic gas hydrate stability*.'

As an NRC postdoctoral fellow at the Desert Research Institute in Reno, Nevada, Jennifer is studying how subsea permafrost and Arctic gas hydrates respond to warming under natural climate variations in the Arctic. Through this study, she aims to gain a better understanding of the Arctic's contribution to the global methane budget. Gordon Research Conferences promote discussions and the free exchange of ideas at the research frontiers of the biological, chemical and physical sciences, with a focus on keeping the attendance-size small. Scientists with common professional interests come together for a full week of intense discussion and examination of the most advanced aspects of their field. These conferences provide a valuable means of disseminating information and ideas in a way that cannot be achieved through the usual channels of communication - publications and presentations at large scientific meetings.

Gordon Research Seminar link: http://www.grc.org/programs.aspx?year=2014&program=grs_natgas

Gordon Research Conference link: http://www.grc.org/programs.aspx?year=2014&program=naturalgas

Jennifer’s website: www.dri.edu/jenn-frederick

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The NOAA Aerosols and Ocean Science Expeditions (AEROSE), a collaborative project with NOAA and Howard University, have collected atmospheric data since 2004 off of the coast of West and Central Africa on the NOAA R/V *Ronald H. Brown* (Figure 1) [Morris et al., 2006; Nalli et al., 2011]. **As part of his National Research Council (NRC) Postdoctoral Associateship, Dr. Jonathan W. Smith joined NOAA/NESDIS/STAR Scientist, AEROSE Co-Principle Investigator, and NRC Advisor Dr. Nicholas R. Nalli** (Figure 2) to participate in the ninth and most recent AEROSE campaign conducted in Nov-Dec 2013 (Figure 3). The R/V *Brown* (Figure 1) sailed from Bridgetown, Barbados to Recife, Brazil on an eastward trajectory towards the Cape Verde Islands and southward along 23°W (Figure 3).

Ozonesonde and radiosonde measurements aligned with satellite sounder Environmental Data Records (EDRs) were obtained for validation of trace gas profile retrievals. Specifically, the Infrared Atmospheric Interferometer (IASI) and NOAA Cross-track Infrared Microwave Sounder Suite (CrIMSS) are two primary trace gas EDR products generated by NOAA/NESDIS/STAR. These products contain global trace gas profiles including carbon monoxide (CO, an ozone precursor) and ozone for research purposes.

The Sounder CO mixing ratio product is sensitive in the middle troposphere and ozone is sensitive in the upper troposphere lower stratosphere (UT/LS). In addition to CO and ozone, the NOAA-unique sounder products also include water vapor mixing ratio. The water vapor mixing ratio can be converted to humidity which can help narrow the potential sources of ozone at a particular altitude. The nearly decade worth of launches and sounder products provide a view of the development, peak, and waning of the Ozone Wave-One pattern over the eastern Equatorial Atlantic Ocean.

Fig. 1 NOAA Ship *Ronald H. Brown* in Bridgetown, Barbados, November 2013, just prior to the 2013 AEROSE campaign.

Fig. 2 National Research Council (NRC) Postdoctoral Research Associate Dr. Jonathan W. Smith (right) with NRC Adviser Dr. Nicholas R. Nalli (left) preparing a radiosonde for a morning launch aligned with the MetOp-A environmental satellite overpass in November 2013 aboard the NOAA R/V Ronald H. Brown.

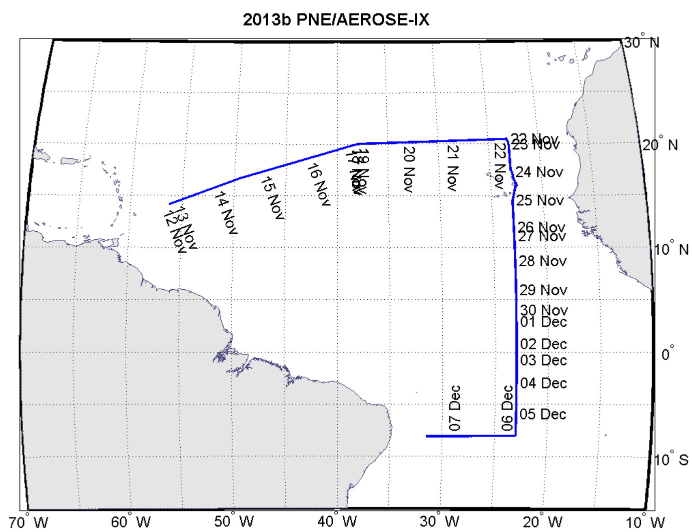

Fig. 3 Cruise track of the NOAA Ship *Ronald H. Brown* during the 2013 AEROSE campaign, Nov-Dec 2013.

Radiosondes were launched 4 times daily. During each campaign including 2013b, ozonesonde launches (Figure 4) were based on the four primary weather/chemistry regimes forecasted by students and postdocs: 1) the ship was downwind or underneath a jet in the upper troposphere, 2) significant biomass burning, 3) intense lightning-producing convection, or 4) Saharan dust over or near the African or South American Continents.

Regime 1 infers the presence of stratospheric ozone intrusions into the troposphere and the regimes 2-4 were dependent of location. For example, we would only expect lightning-induced nitrogen oxide to produce ozone when the ship was in the vicinity of the Inter-tropical convergence zone (ITCZ).

In addition to ozonesonde and radiosonde measurements there are were Microtops handheld sunphotometer

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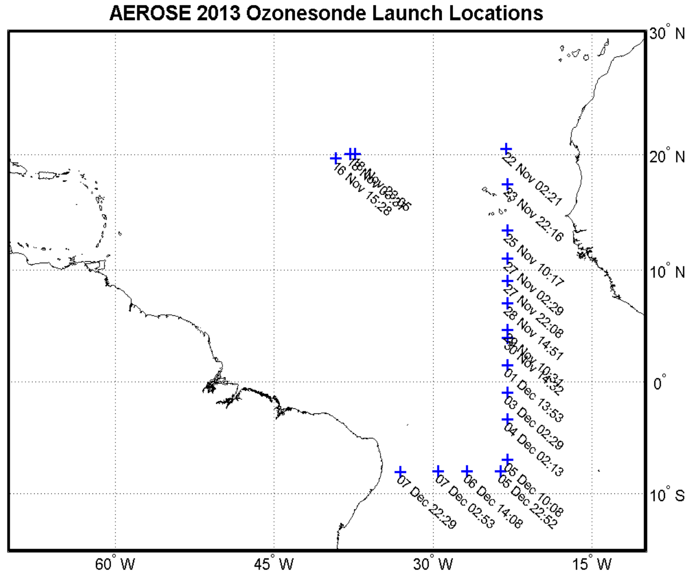

Figure 4: A map of the trajectory and times and locations of ozonesonde launches aboard the R/V Ronald H. Brown during the 2013b AEROSE Cruise.

measurements of ozone and aerosol optical thickness measurements at various wavelengths. Weather conditions surrounding the ship were monitored for science and operations, including daily weather briefings.

The synoptic wind regime affects transport of aerosols or biomass burning emissions that could impact overall aerosol optical depth or ozone. The prediction of the wind speed and direction also help us in knowing the ocean significant wave heights and the direction of those waves. The amplitude of the waves affected how much the ship pitched and rolled and our overall safety at launch time. The synoptic regime was a strong indicator of the significant wave height. The upper tropospheric synoptic regime provided indication of the subtropical jet dynamics. The jet perturbs the tropopause and allows for the intrusion of high mixing ratios of stratospheric ozone which can significantly increase tropospheric ozone mixing ratios. There were several models that predicted aerosol optical depth and aerosol concentrations predicted by the Navy Aerosol Analysis and Prediction System Model. There also several remotely sensed aerosol optical depth products such as the parameters output by Advanced Very High Resolution Radiometer (AVHRR) and the Moderate Resolution Imaging Spectroradiometer (MODIS).

The motivation for AEROSE was to collect aerosol dust samples downwind of the Saharan Air Layer transported off of the coast of North Africa and to examine the emissions output of ozone sources on and in the vicinity of the African Continent [e.g., Morris et al., 2006; Hawkins 2007; Jenkins et al. 2008; Nalli et al., 2011; Smith 2012]. Examining dust was important because aerosols and particulate matter attenuate satellite retrievals. In addition to the transport of dust aerosols in the eastern Atlantic Ocean, enhanced tropospheric ozone was observed. Examining ozone is important because of the semi-permanent average Wave-One Ozone mixing ratio and troposphere column abundances maximum over Equatorial Atlantic Ocean [e.g., Thompson et al., 2000; Sauvage et al., 2006].

The Wave-One Ozone is comprised of semi-permanent ozone minima over the Equatorial Pacific Ocean and Southern Hemisphere Africa and maxima over the Equatorial Atlantic Ocean and Southern Hemisphere Indian Ocean. The ridges and the minima ozone mixing ratios and column abundances increase during the Northern Hemisphere spring and summer to their peak in September. The ridge is a result of the ozone generated from increasing biomass burning emissions intensity and areal coverage and the number of lightning flashes increasing with stronger mesoscale convective systems producing abundant nitrogen oxides that form ozone.

AEROSE has become a vital dataset, temporally and spatially one of the most consistent datasets in this region. The combination of each AEROSE voyage has covered the entire solar year (all four seasons) so the ozone generated from the bi-modal biomass burning regimes/LNO_x regimes can be covered and their transitions can be examined. Numerical models have been used to examine tropospheric ozone enhancement over the eastern Equatorial Atlantic Ocean to fill the temporal and spatial observations gaps. Many of these studies have been global chemistry transport model (GTCM) studies have been done to quantify the biomass burning and LNO_x contributions.

Although there have been many GTCM studies with coarse resolution, there have been few mesoscale chemistry modeling studies. The fully combined meteorology/chemistry mesoscale model WRF-Chem has simulated ozone increases over the eastern Equatorial Atlantic Ocean [Smith, Ph.D. Dissertation, 2012]. Smith et al. [2014a, in prep] suggests that biomass burning ozone precursors produce 30 + ppbv of ozone and a considerable majority of this is in the lower troposphere. Smith et al. [2014b, in prep] suggests that LNO_x produces 11-15 ppbv additional ozone over the Equatorial Atlantic Ocean.

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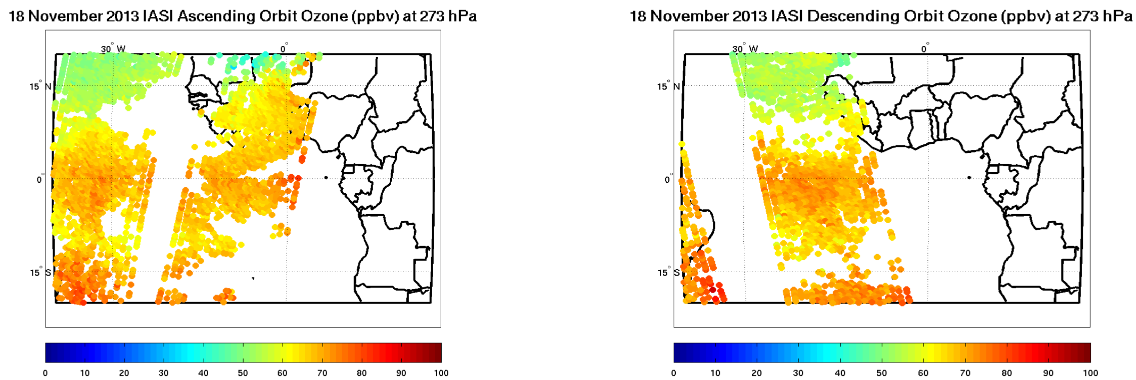

Figure 5: Scatter map of NOAA-Unique IASI (left) ascending and (right) descending ozone mixing ratio at 273 hPa.

Figure 5a and b show the ozone mixing ratios at 273 hPa of 60-75 ppbv over the Sahel for both the ascending and descending overpasses. The highest ozone mixing ratios are along the Equator. Mixing ratios are 70-85 ppbv. Values appear to be approaching 85 ppbv over the Gulf of Guinea which align with maximum tropospheric column ozone abundances of 44 Dobson Units off of the coast of Angola and Democratic Republic of Congo during September, October, and November 1979-1992 [Jenkins et al., 2004a]. There is substantial biomass burning over the Sahel of Africa during November. Some of the biomass burning emissions are transported westward and southward towards the Equator. The LNO_x emissions are generally confined to the SH of Africa during November and early December.

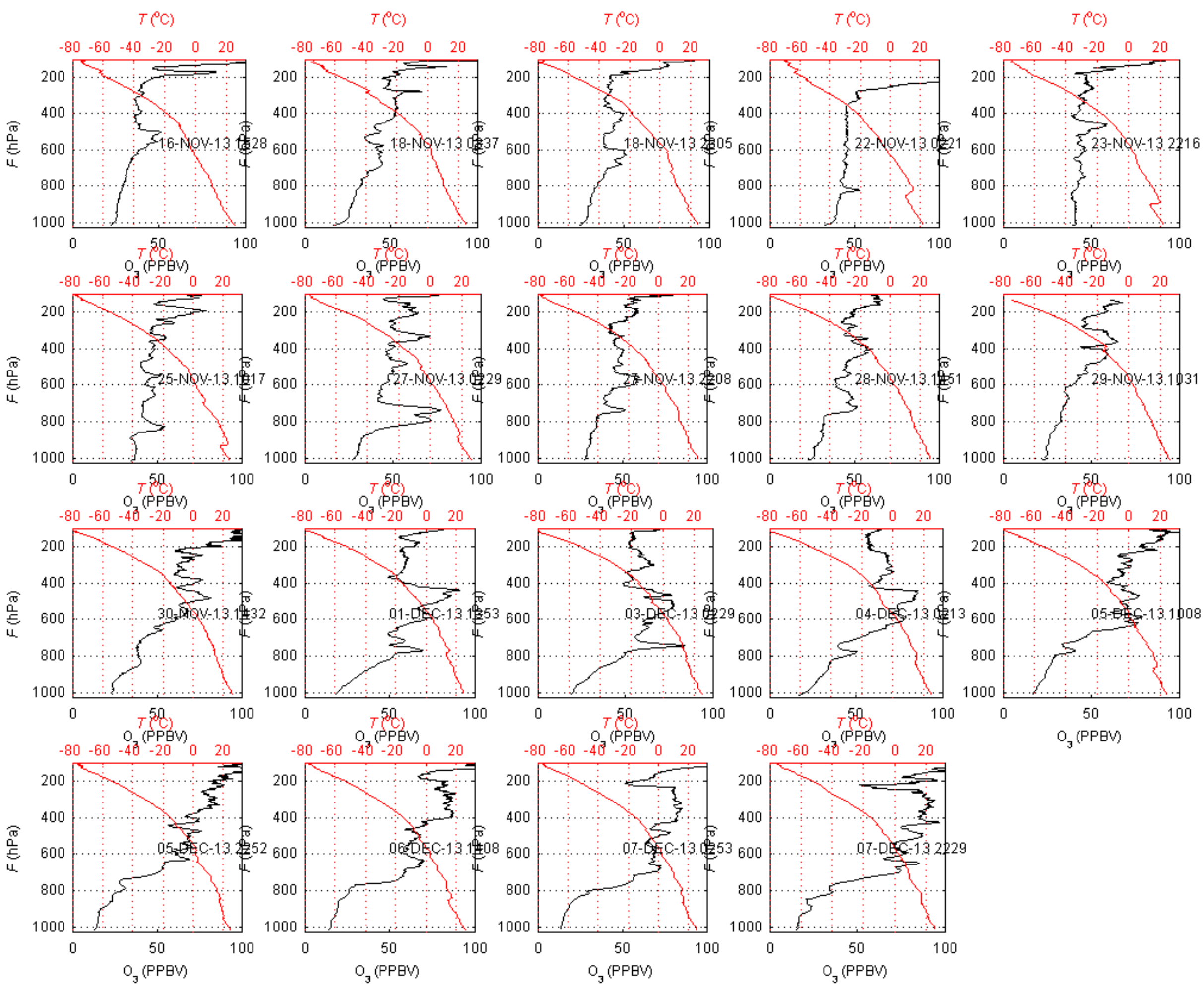

Figure 6: Ozonesonde vertical profiles of ozone mixing ratio (ppbv) and temperature (°C) versus pressure.

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The AEROSE 2013b Cruise observed enhanced middle and upper tropospheric ozone (Figure 6). Over the R/V *Ronald H. Brown*'s journey eastward and then southward adjacent to the African continent, there were consistent 10-20 ppbv ozone enhancements in the 800-600 hPa layer. As the ship crossed the equator and returned westward, it encountered extremely robust ozone enhancement extended from 800-200 hPa and ozone increases had maxima of 25–40 ppbv, particularly on the December 6-7.

In the next year of the NRC Postdoctoral Associateship, Dr. Smith plans to apply the combined, meteorology/chemistry model WRF-Chem as a validation tool for the NOAA IASI and NOAA CrIMSS trace gas products. Dr. Smith will also examine the 2010 and 2013a AEROSE time periods. There will be control simulations that include anthropogenic and biogenic emissions, biomass burning simulations that add fire emissions, an LNO_x simulation that uses lightning as an origination point of the nitrogen oxide emission, and a simulation where the LNO_x parameterization from version 3.5 of WRF-Chem is turned on.

He will assess how much ozone increases from the biomass burning and LNO_x sources and compare it to NOAA IASI horizontally and through vertical profiles of the upper troposphere. Carbon monoxide is an efficient biomass tracer, so examining its mixing ratio increase in the NOAA IASI and CrIMSS products is critical. A Lagrangian trajectory model will also be used to estimate where the parcels originate. Future work includes testing the model output as a first guess and the satellite retrievals as chemistry initial and lateral boundary conditions in WRF-Chem. Additional ozone observations and satellite trace gas sounder measurements over the eastern Equatorial Atlantic Ocean will also be utilized.

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NRL Video

March 10, 2014, Duration: 22:20

The Pentagon Channel's pilot episode of "Armed with Science" explores Navy Research Laboratory and Army Research Laboratory science that shapes the future of defense. In the pilot episode, viewers get an inside look at NRL space robotics research and ARL work in novel weapons design and infrared imaging. View the full episode and segments on NRL's YouTube Channel.

http://www.nrl.navy.mil/media/videos/armed-with-science-pilot-episode

This STEM Career Fair was held April 24, 2014. So, stay tuned to our Facebook Page and next newsletter issue

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Partner Event: 8th Annual Postdoc Conference

April 24

Outstanding S.T.E.M (Science, Technology, Engineering and Math) Postdocs are ready to join your company. We (a consortium of local economic development organizations, federal agencies, technology organizations, etc) want to connect you with these highly educated and motivated professionals. Register today to access this incredible talent pool!

Last year over 450 postdocs attended, and we expect a similar turnout this year. This event attracts highly educated and skilled professionals who are looking for a job in industry and who embody the dedication, skills and motivation employers such as you value. Because we charge our postdocs only a nominal $10 fee, we rely on exhibitor fees and sponsorships to cover the costs. Visit the web site at www.PostdocConference.org for more information and to register.

We look forward to your participation as an event sponsor and/or exhibitor at the career fair and I encourage you to contact me if you have questions about the event.

NRL's LASR building receives design award

The design firm Wiley Wilson, of Lynchburg, Virginia has received the Grand Award from the American Council of Engineering Excellence Awards competition for the design of the U.S. Naval Research Laboratory's (NRL's), Laboratory for Autonomous Systems Research (LASR) building. The LASR building also won the council's Pinnacle Award, announced at the ACEC Virginia Gala on February 6th at the Jefferson Hotel, in Richmond, Virginia.

The design firm Wiley Wilson has been honored with the Grand Award and Pinnacle Award from the American Council of Engineering Excellence Awards competition for their design of NRL's Laboratory for Autonomous Systems Research building.

According to project manager from Wiley Wilson, Bob Bibee, ***"Taken on the whole, [a facility like] this building has never been done before to our knowledge anywhere." "The projects this year were amazing," Nancy Israel, executive director of ACEC Virginia said in a news release. "Wiley Wilson's unique Navy and Marine Corps training facility is a one-of-a-kind facility worldwide."***

In attendance at the awards ceremony, were Mike Holland from Naval Facilities Command, and Dr. Richard Colton, Superintendent, of NRL's Chemistry Division. Colton noted, ***"Felt like we were at the Academy Awards, everyone in their finest dress awaiting the announcement of the Pinnacle awardee...may I have the envelope please...and the winner is...Naval Research Laboratory, Laboratory for Autonomous System Research by Wiley Wilson, hurrah!"***

LASR, the 47,000-square-foot building, is a unique laboratory that provides specialized facilities to support highly innovative research in intelligent autonomy, sensor systems, power and energy systems, human-system interaction, networking and communications, and platforms. LASR supports a broad range of research related to autonomous systems, from basic to applied, and for integration across different disciplines. Some of its unique features include:

- Prototyping High Bay, which can be used for small autonomous air and ground vehicles, and the people who work with them. This space contains the world's largest real-time motion capture volume, allowing scientists to get extremely accurate ground truth of the motion of vehicles and people, as well as allowing closed loop control of systems.
- Littoral High Bay, which features a 45-foot by 25-foot by 5.5-foot deep pool with a wave generator capable of producing directional waves, and a slope that allows littoral environments to be recreated.
- Desert High Bay, which contains a 40-foot by 14-foot area of sand 2.5-feet deep, and contains 18-foot-high rock walls that allow testing of robots and sensors in a desert-like environment.
- Tropical High Bay, which is a 60-foot by 40-foot greenhouse that contains a re-creation of a southeast Asian rain forest.
- Outdoor test range, which is a 1/3rd acre highland forest with a waterfall, stream and pond, and terrain of differing difficulty including large boulder structures and earthen berms.
- Electrical and machine shops, which allow prototypes to be constructed. The facility includes several types of 3D prototyping machines allowing parts to be directly created from CAD drawings. LASR also has a dedicated sensor lab that includes large environmental and altitude chambers and an anechoic chamber, as well as a power and energy lab.

Dr. Weilin Hou, NRC Adviser, and Mr. Bob Arnone Chair SPIE Ocean Sensing and Monitoring IV

Dr. Weilin "Will" Hou (left) and Mr. Bob Arnone (right)
For information about the Ocean Sensing and Monitoring conference, visit www.spie.org/oceans.

Dr. Weilin "Will" Hou, NRC Adviser at NRL SSC, and Mr. Bob Arnone, both oceanographers in the Oceanography Division at NRL Stennis Space Center, chaired the International Society of Photo-Optical Instrumentation Engineers (SPIE) Defense Security and Sensing's fourth Ocean Sensing and Monitoring conference April 23-27, 2012. SPIE aims to further the science and application of light.

Dr. Hou developed the Ocean Sensing and Monitoring conference for SPIE and has chaired the conference with Arnone since 2008. NRL's Dr. Alan Weidemann and Dr. Sarah Woods serve on the program committee along with representatives from other federal agencies and private companies. The conference, held in Baltimore, Md., in April 2012, focused on research and development efforts in the open and coastal ocean with respect to defense and security interests.

Hou and Arnone placed a special emphasis on in situ and remote monitoring, deep-sea operations, forecasting, new technology and techniques, monitoring of unique events, and environmental limitations and impacts of note to those in the homeland security and defense sectors. Modern defense and security forces demand accurate information where it is needed-whether deep ocean or coastal ocean-when it is needed, including future environmental conditions. Ocean optics affect signal processing, diver visibility, mine hunting and anti-submarine model performance prediction, all of which pose a substantial interest to the Navy and other security forces.

In the NRL Ocean Sciences Branch, Arnone specializes in remote sensing oceanographic processes, remote sensing of optical properties and processes and coupled models of both bio-optical and physical processes. In the Ocean Hydro Optics Sensors and Systems Section, Hou develops and manages new programs to improve understanding of adaptive optics, turbulence quantification, optical flow and signal transmissions over turbulence. The combined use of in situ observations, remotely sensed data and physical models is a rapidly evolving field, although improved assimilation of available data into models still poses a challenge. Hou is leading NRL efforts in designing an automated data quality control system to the Navy's unmanned underwater vehicles.

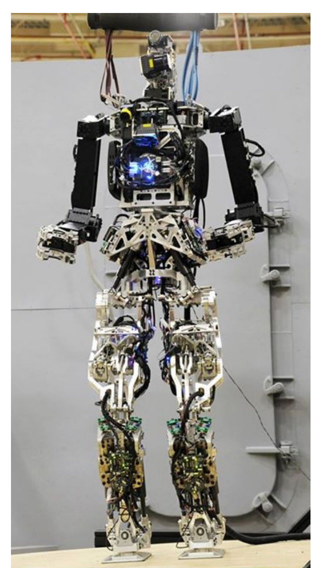
Arnone and Hou's optics research and remote sensing products further the general understanding of optics-related parameters through remote sensing.

(LASR), Alan Schultz (left), and Dr. Will Bridewell (right) meet with Dr. Tom McKenna, managing program officer of the Computational Neuroscience and Biorobotics program at the Office of Naval Research (ONR). The consortium of robotics researchers from NRL, the University of Pennsylvania and Virginia Tech's Robotics and Mechanics Laboratory (RoMeLa) met January 2014 at NRL's Autonomy Lab located in Washington, D.C. The university researchers were on-hand to demonstrate and discuss advancements in the shipboard robotic firefighting program and the Shipboard Autonomous Firefighting Robot (SAFFiR).

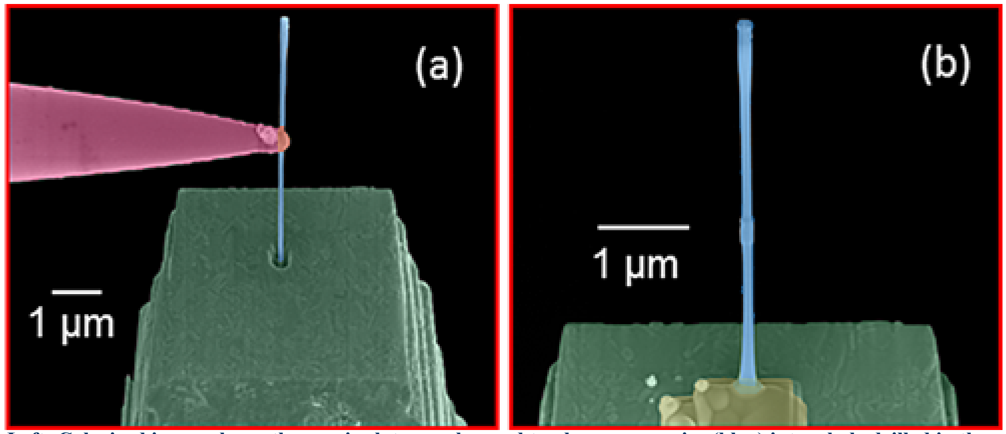
NRL Autonomy Lab hosts Shipboard Fire Robotics Consortium

The U.S. Naval Research Laboratory (NRL) Laboratory for Autonomous Systems Research (LASR), partner in the Navy's Damage Control for the 21st Century project (DC-21), recently hosted robotics research teams from the Virginia Polytechnic Institute and State University (Virginia Tech) and the University of Pennsylvania (Penn) to demonstrate the most current developments of advanced autonomous systems to assist in discovery, control, and damage control of incipient fires.

http://www.nrl.navy.mil/media/news-releases/2014/nrl-autonomy-lab-hosts-shipboard-fire-robotics-consortium



Probing the Inner Secrets of Nanowires



Left: Colorized image shows the manipulator probe used to place a nanowire (blue) into a hole drilled in the mounting post (green). Right: The nanowire is welded in place with platinum and the manipulator arm is removed.

Semiconductor nanowires (NWs) are vanishingly small: NWs from a recent batch made by scientists in PML's Quantum Electronics and Photonics Division measure about 200 nanometers in diameter (less than 1/500th the thickness of a human hair) and 6 to 10 micrometers long, with embedded layers as thin as 3.3 nm. But despite their size, semiconductor NWs are poised to play a very large role in solid-state lighting, chemical sensors, and nanoscale scientific probes.

First, however, researchers will need to determine how to fabricate high-efficiency NW light-emitting diodes (LEDs) that are reliably uniform in composition and morphology, each with the same optical emission spectrum and other critical properties. And that, in turn, will require a detailed understanding of how to achieve the optimal placement and localization of different atomic species as the wire and its various layers are formed.

Now **Dr. Norman Sanford, NRC Advisder, and colleagues from the Optoelectronic Manufacturing Group, with collaborators at the Colorado School of Mines**, have made major progress toward that goal in a new study.* They used the group's signature molecular beam epitaxy (MBE) method to grow GaN nanowires with thin layers of InGaN embedded at intervals. To use such a NW as a light source, a voltage is applied to the wire, and the InGaN sections form quantum wells that trap electron-hole pairs which recombine to produce luminescence.

"The quantum well makes this recombination-luminescence process way more efficient than if you just had a simple, abrupt p-n junction in GaN," Sanford says. ***"However, in order to be an efficient source of luminescence within a narrow wavelength band, the quantum well must remain compact and uniform. If the indium diffuses into surrounding regions, the well gets spread out, and it won't work efficiently. Different spatial portions with different indium concentrations will have different bandgaps and thus tend to emit light at different wavelengths. We wanted to investigate which factors affect whether a well remains localized or is dispersed as the structure is grown."***

Optimal growth conditions for the separate GaN and InGaN segments can be different. So the researchers fabricated different NWs over a range of temperatures and molecular-beam properties, and then examined the effect those conditions had on the wells. To do so, they used a version of a technique called laser-assisted atom probe tomography (L-APT). In an ultra-high vacuum chamber at about 54 K, a constant high voltage is applied to a NW. At the same time, energy from a pulsed ultraviolet laser is directed at the extreme tip of the wire. Atoms at the tip ionize, are pulled from the tip under the high electric field, and travel to a two-dimensional ion detector about 90 mm away.

The detector records the location of each arriving

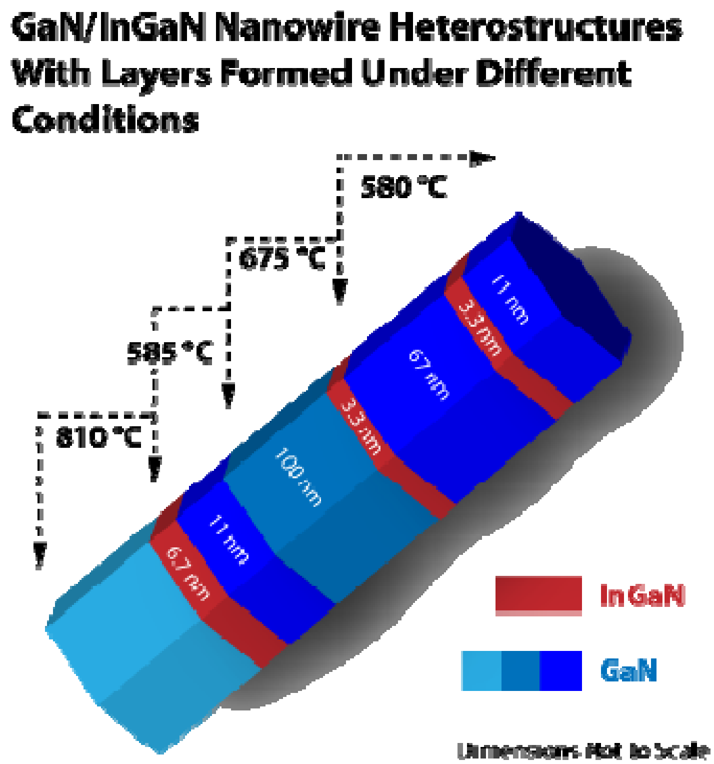


Diagram of a nanowire with multiple layers of InGaN embedded during the growth process.

ion; then by using the laser pulses as timing signals, researchers can determine each ion's time of flight – and hence its charge-to-mass ratio. The ion impact events on the detector are mapped back to their origin from the sample tip, and the accumulated data are used to build up a 3-dimensional picture of the chemical composition of each part of the wire.

The group found that wire formation conditions had a very significant effect on the localization of InGaN layers. **"It is possible to induce diffusion and dispersal of the InGaN layers if the growth conditions of the subsequent GaN layers are not adjusted correctly to ensure that the InGaN regions remain intact,"** Sanford says.

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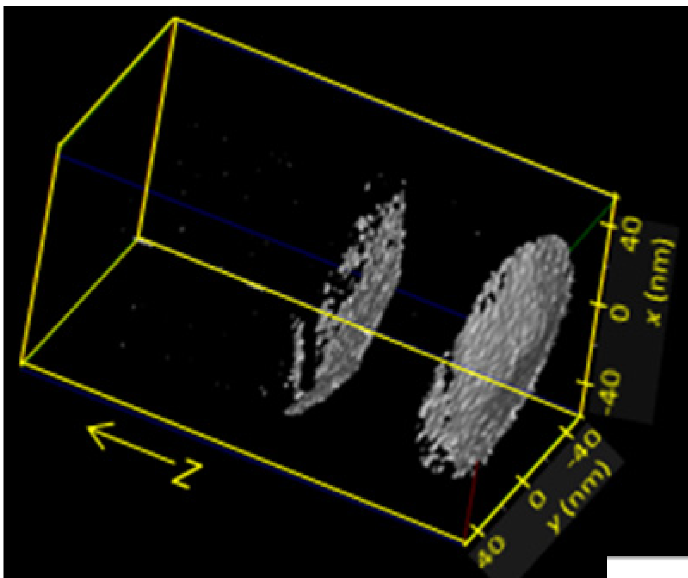
"In some instances we find that the consolidation of the InGaN layers can be destroyed during the subsequent growth of a GaN segment—even without any obvious outward signs of this revealed in the nanowires. Moreover, the InGaN quantum wells that remain localized are found to be in the shape of thin conical InGaN shells embedded in the GaN nanowires (and axially concentric with them) rather than flat disc-like structures. L-APT is particularly well suited to showing a 3D rendering of the InGaN quantum wells and the distribution of indium throughout the nanowire device. As far as we are aware, this is the first time L-APT has been used to examine the impact of growth process variations in the study of these structures."

The results were in good agreement with NW measurements made by another composition-revealing technique, high-resolution transmission electron microscopy.



Computed isoconcentration surface shows that indium layers are not flat, but form as hollow conical shells atop the GaN during molecular -beam epitaxy

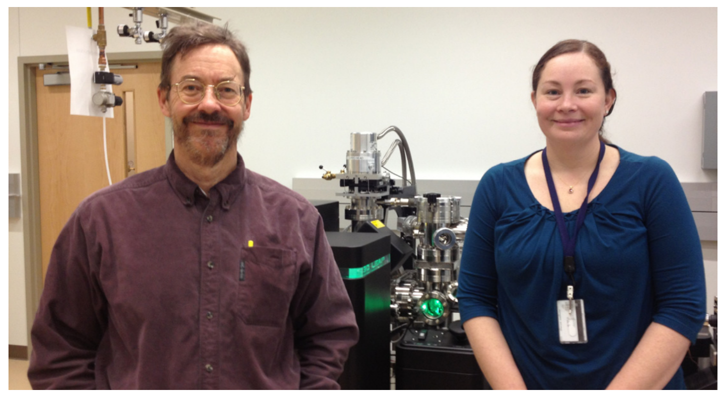
The scientists also found that varying certain L-APT parameters, such as the laser pulse energy, can cause spurious measurements of the apparent ratio of gallium and indium to nitrogen, indicating a seeming (but nonphysical) overabundance of the metal constituents compared to nitrogen. This phenomenon, the researchers speculate, may result from high laser pulse energies causing neutral nitrogen atoms to desorb from the NW. Those atoms would not be counted by the ion detector.

Not surprisingly, it is uncommonly difficult to manipulate individual nanowires of these dimensions. For the L-APT analysis, a tungsten manipulator probe was "welded" with platinum to a single wire. Then the wire was placed in a hole drilled in the sample post and welded in. Finally, the manipulator probe was snapped off, leaving the NW standing vertically on the post and ready for L-APT analysis.

"Probably the greatest challenge is coming up with a reliable mounting scheme so that the samples survive the entire L-APT analysis process without catastrophically fracturing," Sanford says. "It required dozens of sample mounting attempts in order to attain the results presented. The problem arises since the electric field strength at the tip of the sample during operation is on the order of 10 V/nm. That's a pretty high electric field, but it has to be that high in order to rip ions and clusters of ions right off of the sample tip for subsequent time-of-flight mass spectral analysis. We are still working to improve the sample mounting scheme to make it more reliable and survivable."

But for now, ***"even with the likely ambiguity in the absolute 3D concentration mapping of nitrogen,"*** says Sanford's colleague Kris Bertness, leader of the Semiconductor Metrology for Energy Conversion project, ***"it is clear that the L-APT-resolved 3D mapping of gallium and indium has, for the first time, provided essential information to help guide the growth process for these important GaN/InGaN nanoscale heterostructures."***

*** N.A. Sanford et al, "Laser-assisted atom probe tomography of MBE grown GaN nanowire heterostructures," forthcoming in *Physica Status Solidi*.**



Drs. Norman Sanford and Ann Chiaramonti Debay, NRC Advisers, NIST, standing in front of the atom probe system on which they collaorate

Phys. Status Solidi C **11**, No. 3–4, 608–612 (2014) / **DOI** 10.1002/pssc.201300579

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Laser-assisted atom probe tomography of MBE grown GaN nanowire heterostructures

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Received 27 September 2013, revised 31 October 2013, accepted 13 December 2013
Published online 24 February 2014

Keywords atom probe, gallium nitride nanowires

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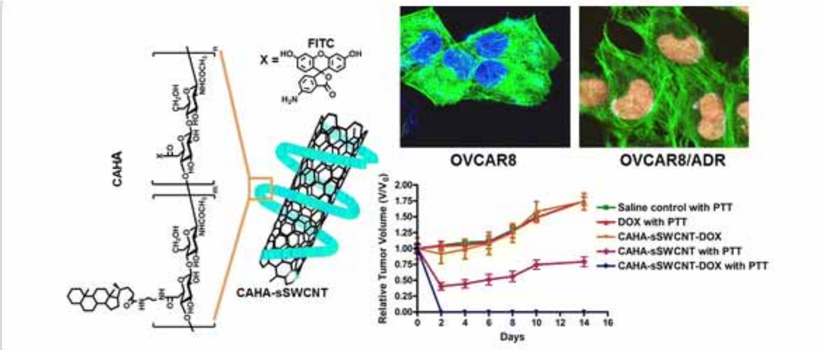
Laser-assisted atom probe tomography (L-APT) was performed on GaN nanowires (NWs) and axial GaN/InGaN nanowire heterostructures. All samples were grown by MBE on Si(111) substrates. The laser pulse energy (PE) at 355 nm used in L-APT analysis of GaN NWs was restricted to the range of 2-50 fJ in order to recover the correct GaN stoichiometry within experimental uncertainty. Higher PE at 355 nm generally returns an apparent (but unphysical) deficit in N composition for GaN. Axial GaN/InGaN NW heterostructures were also grown by MBE. In these experiments a GaN NW segment was first grown at 820 °C followed by GaN-capped InGaN marker layers grown variously at 585 and 615 °C. The capped InGaN markers were separated by GaN spacer layers. L-APT revealed that under certain growth conditions, In diffused throughout the quantum well region. These observations were corroborated by HRTEM. Moreover, L-APT performed on the GaN/InGaN NWs with PE = 2 fJ revealed that regions with dispersed In showed an (unphysical) N deficit but regions where the InGaN marker layers remained localized showed the approximately correct stoichiometry. Interestingly, even when the In markers remain localized, background In is still found in the GaN spacers between the markers.

Targeted therapeutic nanotubes influence viscoelasticity of cancer cells to overcome drug resistance

Dr. A.A. Bhirde, Laboratory of Molecular Imaging and Nanomedicine, National Institute of Biomedical Imaging and Bioengineering, National Institutes of Health



Resistance to chemotherapy is the primary cause of treatment failure in over 90% of cancer patients in the clinic. Research in nanotechnology-based therapeutic alternatives has helped provide innovative and promising strategies to overcome multidrug resistance (MDR). By targeting CD44-overexpressing MDR cancer cells, we have developed in a single-step a self-assembled, self-targetable, therapeutic semiconducting single-walled carbon nanotube (sSWCNT) drug delivery system that can deliver chemotherapeutic agents to both drug-sensitive OVCAR8 and resistant OVCAR8/ADR cancer cells. The novel nanoformula with a cholanic acid-derivatized hyaluronic acid (CAHA) biopolymer wrapped around a sSWCNT and loaded with doxorubicin (DOX), CAHA-sSWCNT-DOX, is much more effective in killing drug-resistant cancer cells compared to the free DOX and phospholipid PEG (PL-PEG)-modified sSWCNT formula, PEG-sSWCNT-DOX. The CAHA-sSWCNT-DOX affects the viscoelastic property more than free DOX and PL-PEG-sSWCNT-DOX, which in turn allows more drug molecules to be internalized. Intravenous injection of CAHA-sSWCNT-DOX (12 mg/kg DOX equivalent) followed by 808 nm laser irradiation (1 W/cm^2, 90 s) led to complete tumor eradication in a subcutaneous OVCAR8/ADR drug-resistant xenograft model, while free DOX alone failed to delay tumor growth. Our newly developed CAHA-sSWCNT-DOX nanoformula, which delivers therapeutics and acts as a sensitizer to influence drug uptake and induce apoptosis with minimal resistance factor, provides a novel effective means of counteracting the phenomenon of multidrug resistance.

ACS NANO

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NIST scientists get 2013 ABC Best Paper Award from Springer


Dr. **Sherrie Elzey, NRC ARRA postdoc at NIST**

The Springer journal *Analytical and Bioanalytical Chemistry* (ABC) chose **Drs. Sherrie Elzey** and De-Hao Tsai as the recipients of its Best Paper Award 2013. Elzey and Tsai are lead authors of a paper published in ABC which presents the development of a method to simultaneously characterize the size and elemental composition of nanoparticles, especially those used for nano therapeutics. The award, accompanied by 1,500 euros, was created by Springer to honor exceptional young scientists and to stimulate their research careers. The ABC Best Paper Award has been given since 2005.

The article — "Real time ESDMA-ICPMS" — was led by **Dr. Sherrie Elzey, NRC ARRA,** and was selected by the editor as a "Forefront" article in that Springer journal.

Drs. Elzey and Tsai, working in the Materials Measurement Laboratory at the **U.S. National Institute of Standards and Technology (NIST) in Gaithersburg**, MD, demonstrate a proof-of-concept for a measurement method that determines the elemental composition of size-separated particles, thereby providing both size and chemical information from a single hyphenated system. This analytical approach is broadly applicable to both chemical and biochemical research, as well as product development, for example consumer products, biomedical and diagnostic devices, and nanocoatings.

Prof. Alfredo Sanz-Medel, Editor of ABC, said, ***"The design and development of a novel hybrid instrument is described in the worthy paper ABC has chosen as the winner. The instrument presents a creative alternative to the limited number of available hybrid tools to fully characterize aqueous colloidal nanoparticles. The high analytical potential of the synergic coupling described by Elzey and Tsai will undoubtedly spur new nanotechnological applications and developments in the most varied fields where nanoparticle use is now booming."***

Sherrie Elzey earned her BS in chemistry and BA in physics from the University of Northern Iowa in Cedar Falls, IA. She received the National Defense Science & Engineering Graduate (NDSEG) fellowship and earned her Ph.D. at The University of Iowa in Iowa City, IA. Her graduate work focused on the applications and physicochemical characterization of engineered nanomaterials in environmental, health, and safety studies.

After completing her Ph.D., **she was awarded a National Research Council (NRC) postdoctoral fellowship at the National Institute of Standards & Technology (NIST)** in Gaithersburg, MD, with **Dr. Vince Hackley, NRC Research Advisor in the NIST Materials Measurement Science Division** . At NIST, she conducted research focusing on method development for measuring the size and elemental composition of representative therapeutic nanoparticles with functionalized surfaces.

After her NRC ARRA postdoctoral research at NIST, Elzey joined TSI Incorporated in Shoreview, MN, as an applications engineer. TSI Inc. is a leading instrument manufacturer for aerosol analysis. There she applied a variety of sizing methods to measure airborne and liquid phase nanoparticles. Sherrie is currently a Regional Sales Manager at TSI Incorporated.

http://www.springer.com/about+springer/media/pressreleases?SGWID=0-11002-6-1454342-0

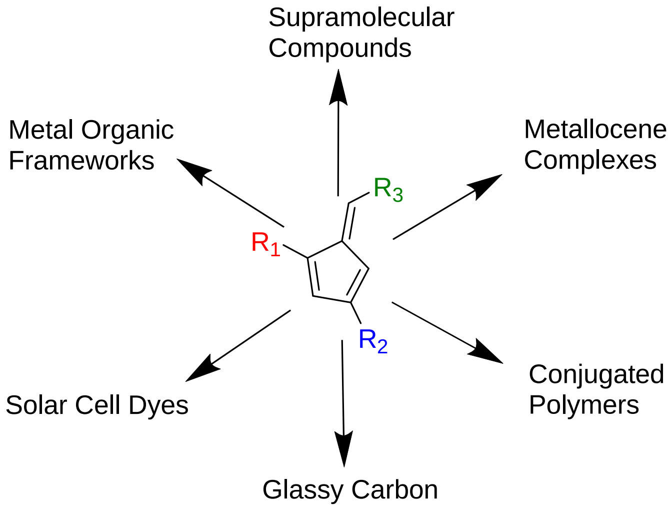
Anal Bioanal Chem (2013) 405:2279–2288
DOI 10.1007/s00216-012-6617-z

PAPER IN FOREFRONT

Real-time size discrimination and elemental analysis of gold nanoparticles using ES-DMA coupled to ICP-MS

Sherrie Elzey · De-Hao Tsai · Lee L. Yu · Michael R. Winchester · Michael E. Kelley · Vincent A. Hackley

Received: 4 October 2012 / Revised: 19 November 2012 / Accepted: 28 November 2012 / Published online: 22 January 2013



Fulvene-based polymers for organic electronics research grows materials chemistry undergraduate program at Air Force Academy

The chemistry of conjugated molecules and polymers has a close connection to the worldwide multi-billion dollar molecular electronics industry. This is due to the ability to specifically tailor the structure of these compounds in order to achieve a desired property or material for application in molecular electronic devices. Molecules that harvest light for solar energy application are an important example, and are of interest to the DoD at-large in an effort to become less reliant on petroleum-based sources of energy. In this effort, the US Air Force Academy has already made a significant move towards greener sources of energy with the installation of a silicon based 6-megawatt (MW) solar photovoltaic (PV) system encompassing 18,888 solar panels.

Reliance on solar energy at the installation is currently 30%, and is expected to be 100% by 2020. According to EPA estimates, the system at the Air Force Academy will avoid more than 9,400 tons of CO_2 emissions each year, the equivalent of removing 40,900 cars from Colorado's highways over 25 years. The solar panels generate the equivalent wattage of powering 1,200 average-sized homes per year. However, much of the technology currently commercial still suffers from poor conversion of energy and availability of inexpensive materials, particularly in light harvesting applications. Therefore, research directed towards the development of non-silicon based molecular and polymeric light harvesting systems is becoming more and more important.

Since Dr. Endrit Shurdha's (PhD, University of Utah) arrival in February 2012 as a NRC Associate, his research, under the advisement of NRC Adviser, Prof. Gary J. Balaich, NRC is directed towards the synthetic chemistry of new and novel pentafulvene molecules for applications in three areas of molecular electronics: (1) specialty polymers, (2) glassy carbon precursors and (3) donor-acceptor dyes for dye sensitized solar cells (DSSC's). His specific goals include the design and synthesis of pentafulvene based monomeric and polymeric molecules with substituents around the fulvene core that control or influence charge transport, photophysical properties or reaction chemistry. Dr. Shurdha's research efforts, leveraged with six cadet undergraduate researchers, have resulted in ground breaking contributions in pentafulvene chemistry including a new design and synthetic strategy for donor-acceptor solar cell dyes, monomer derivatives and synthesis strategies for specialty fulvene based polymers and melt-processable pentafulvene based glassy carbon precursors. This work so far has resulted in one submitted journal article, two other manuscripts in preparation, and attendance at two American Chemical Society National Meetings with presentations already accepted.

Dr. Gary J. Balaich, NRC AFRL Adviser, top row, first from left;
Dr. Endrit Shurdha, NRC Associate at AFRL, top row, second from left.

The Chemistry Research Center, under the direction of Prof. Scott Iacono, is an integral part of the US Air Force Academy's Department of Chemistry, which supports a strong interdisciplinary research program for undergraduates pursuing Bachelor of Science degrees in chemistry with tracks in materials chemistry and biochemistry. State-of-the-art instrumentation is housed in a centralized 10,000 square foot facility and made available for hands-on use by 2 postdoctoral associates, 34 faculty, 4 research staff and 30 active undergraduate researchers. Instrumentation capabilities rival large universities to include nuclear magnetic resonance, Fourier transform infrared, ultraviolet-visible and advanced chromatography coupled mass spectroscopic techniques, thermal analytical techniques such as calorimetry and thermogravimetric analysis, surface imaging including scanning electron microscope and atomic force microscopy, and even a facility for single crystal and powder X-ray diffraction work.

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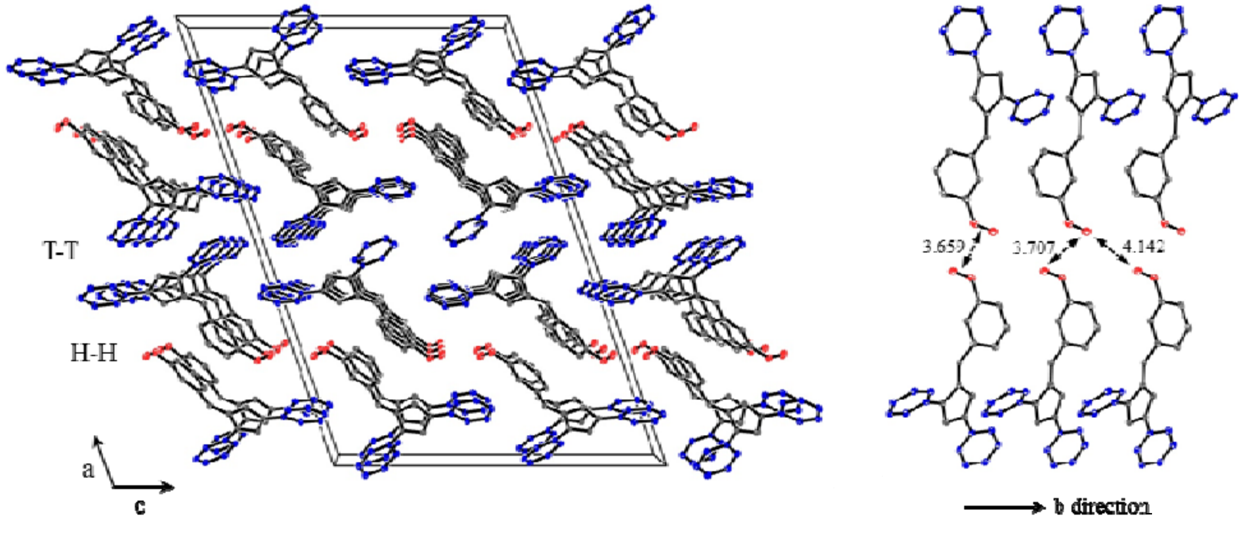

Figure 1. Molecular packing views of the styryl-fulvene (1,3-diphenyl-6-(3-vinylphenyl) fulvene): (a) left diagram, view down the *b*-axis, (b) right diagram, view perpendicular to the *b*-direction showing closest vinylic-vinylic distances in the H-H region. Thermal ellipsoids are shown at the 30% probability level. Hydrogen atoms were omitted for clarity. Distances shown are in Å.

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impact formation of glassy carbon, an important material for molecular electronic devices. Crystallographic results as well as the results of the thermal chemistry of this new styryl-fulvene compound were submitted to the journal, *Tetrahedron*, and also presented at the 2014 spring American Chemical Society National Convention in Dallas, Texas. Dr. Shurdha's crystallographic work on the perfluorocyclpentene arylamine monomer was also presented at this convention. The importance of this work revolves around the solution processability of the polymer derived from this unique monomer, a property that is important in fabrication of molecular electronic devices. This crystal structure was a key feature in a poster presented by a USAFA chemistry/materials track major, Cadet First Class Ford Carty. The poster won the American Chemical Society's Division of Polymer Chemistry undergraduate award in polymer research for best poster among 31 presented from various universities including Penn State, Texas A&M, the University of Texas, the University of Akron, and California Technical University. During Dr. Shurdha's tenure, he has immensely contributed to the active undergraduate research program, which will have his stamp on a multitude of future cadet-led projects.

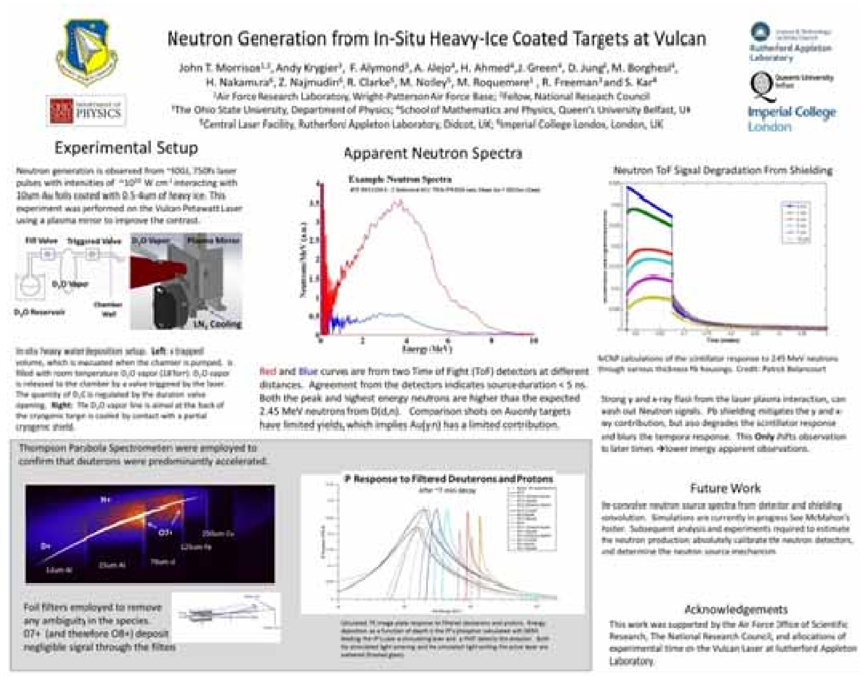
LLNL Best Poster-Morrison

Dr. John Morrison, a National Research Council (NRC) Associate (postdoctoral researcher) working at Air Force Research Laboratory (AFRL) with Dr. William Melvyn Roquemore, NRC Adviser, received a prestigious honor on February 10, 2014— the Best Post-Doctoral Poster award at the Lawrence Livermore National Laboratory National Ignition Facility/Jupiter Laser Facility users meeting. This annual gathering brings together renowned researchers from throughout the scientific committee to learn about these world-class facilities and to present their own research efforts.

Dr. Morrison's research focuses on methods of producing neutrons by femtosecond (high-speed) laser induced fusion. These neutrons can then be used for neutron imaging of structures. In this type of imaging, neutrons are directed at structures in much the same way as X-rays, to allow inspectors to evaluate material and structural soundness. Neutron imaging is a very effective way of seeing into structures such as aircraft because neutrons are absorbed at different rates by different types of materials, making it easy to discern structural defects. John's research could lead to the development of a practical, lower-cost neutron source for non-destructive evaluation of materials and system components.

Several laboratories have demonstrated neutrons can be produced by laser induced fusion. However, the high-energy lasers required to produce the neutrons are very expensive and fire at a slow rate. John's focuses on ways to produce neutrons by using low-energy lasers capable of firing very quickly. His calculations indicate although the number of neutrons produced with each low-energy laser pulse is small, the high pulse rate could result in neutron production equal to that of the high-energy lasers.

The poster describes his recent neutron generation experiments conducted using the Vulcan laser during his post-doctoral research at the Rutherford Appleton Laboratory in England.



Dr. Morrison's poster on neutron generation experiments, which earned him the Best Post-Doctoral Poster award at the Lawrence Livermore National Laboratory National Ignition Facility/Jupiter Laser Facility users meeting. (AFRL graphic) *88ABW-2014-1158*

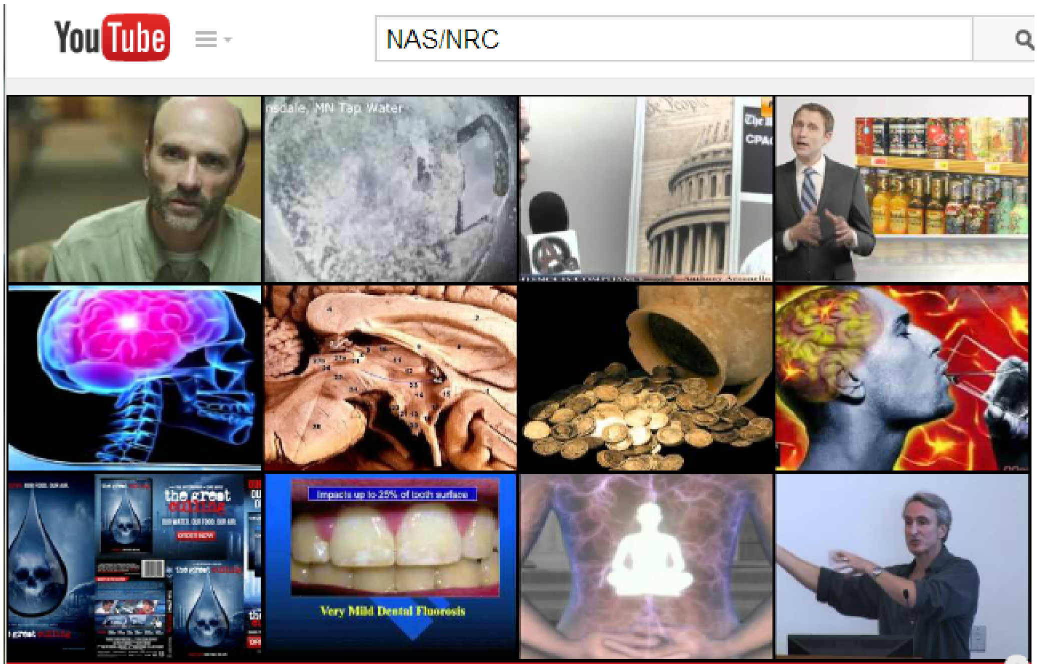
FLUORIDE: The Experts at NAS-NRC

http://www.youtube.com/watch?v=ykwoTo2PReE

NAS/NRC
(National Academy of Sciences/ National Research Council)

Video Highlight

http://www.youtube.com/watch?v=ykwoTo2PReE



NRC/RAP Website Highlight

http://sites.nationalacademies.org/pga/rap/

Explore Among 26 Programs | **Participating Agencies** | http://nrc58.nas.edu/RAPLab10/Opportunity/Programs.aspx

Name	Abbreviation	Reviews
Air Force Research Laboratory	AFRL	All
Armed Forces Radiobiology Research Institute	AFRRI	All
Army Aviation & Missile Research, Development, & Engr Center	AMRDEC	All
U.S. Army Medical Research & Materiel Command	AMRMC	All
U.S. Army Research Laboratory	ARL	All
Army Research Laboratory - U.S. Military Academy	ARL/USMA	All
U.S. Army Research Office	ARO	All
Chemical and Biological Defense Funded Laboratories	CBD	All
U.S. Army Edgewood Chemical Biological Center	ECBC	All
U.S. Environmental Protection Agency	EPA	All
EPA/Faculty Fellowship Program	EPA/FFP	All
FAA-Civil Aerospace Medical Institute	FAA/CAMI	All
Federal Highway Administration	FHWA	All
US Army Corps of Engineers Institute for Water Resources	IWR	All
Naval Marine Mammal Program	MMP	All
National Energy Technology Laboratory	NETL	All
Methane Hydrates Fellowship Program	NETL/MHFP	Feb., Aug.
National Institute of Standards and Technology	NIST	Feb., Aug.
Naval Medical Research Center/Naval Health Research	NMRC/NHRC	All
National Oceanic & Atmospheric Administration	NOAA	All
Naval Postgraduate School	NPS	All
Naval Research Laboratory	NRL	Feb., May, Aug.
U.S.Army Natick Soldier Research, Development & Engr Center	NSRDEC	All
U.S. Army Res, Dev & Eng Com/Armament Res, Dev & Eng Ct	RDEC/ARDEC	All
U.S. Army Research, Development & Engineering Command, NVESD	RDEC/NVESD	All
U.S. Army Criminal Investigation Laboratory	USACIL	All

2014 SCHEDULE

February Review

February 1	Application deadline
February 15	Deadline for supporting documents (transcripts/letter of recommendation)
March 18	Review results finalized
March 25	Review results available to applicants

August Review

August 1	Application deadline
August 15	Deadline for supporting documents (transcripts/letter of recommendation)
Sept 19	Review results finalized
Sept 26	Review results available to applicants

May Review

May 1	Application deadline
May 15	Deadline for supporting documents (transcripts/letter of recommendation)
June 20	Review results finalized
June 27	Review results available to applicants

November Review

Nov 1	Application deadline
Nov 15	Deadline for supporting documents (transcripts/letter of recommendation)
Jan 5, 2015	Review results finalized
Jan 12, 2015	Review results available to applicants

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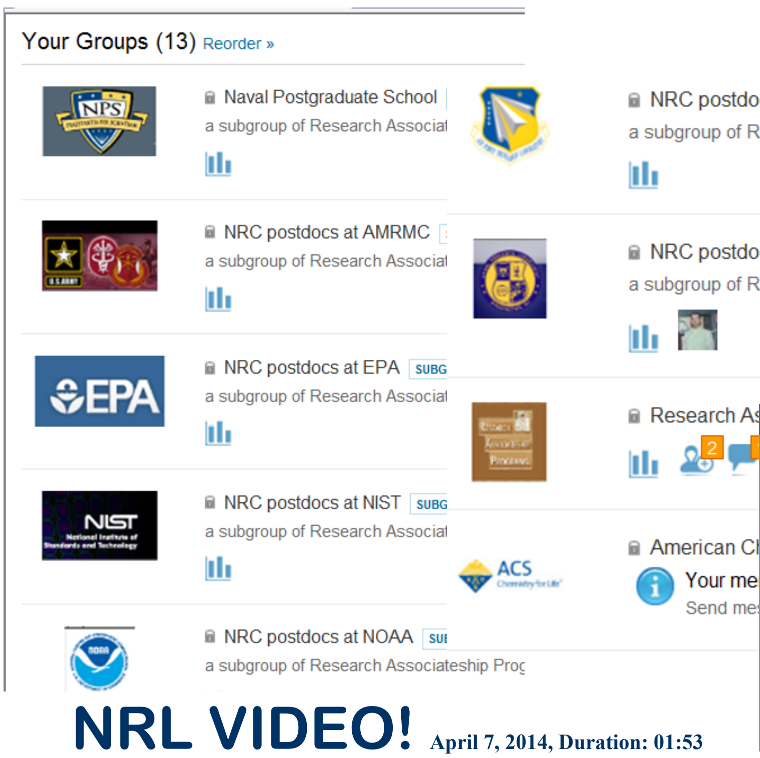

Or...

NRL VIDEO! April 7, 2014, Duration: 01:53

http://www.nrl.navy.mil/media/videos/future-navy-fuel

Researchers at the U.S. Naval Research Laboratory (NRL) have made significant advances in the development of carbon capture technologies. Using an innovative and proprietary NRL electrolytic cation exchange module (E-CEM), both dissolved and bound carbon dioxide (CO2) are removed from seawater at 92 percent efficiency by re-equilibrating carbonate and bicarbonate to (CO2) and simultaneously producing hydrogen gas (H2). In the laboratory CO2 and H2 gases have been converted to liquid hydrocarbons by a metal catalyst in a reactor system to produce fuel.

In March 2013, the team of scientists conducted a "run-up" test of the liquid hydrocarbon fuel using an off-the-shelf radio-controlled (RC) model aircraft powered by an unmodified two-stroke internal combustion engine. Later that same year the team demonstrated proof-of-concept, achieving sustained flight of the model aircraft at the laboratory's Blossom Point Proving Grounds, Blossom Point, Maryland. The flight test exhibited, for the first time, the potential for transition of this novel technology from the laboratory to full-scale commercial implementation.