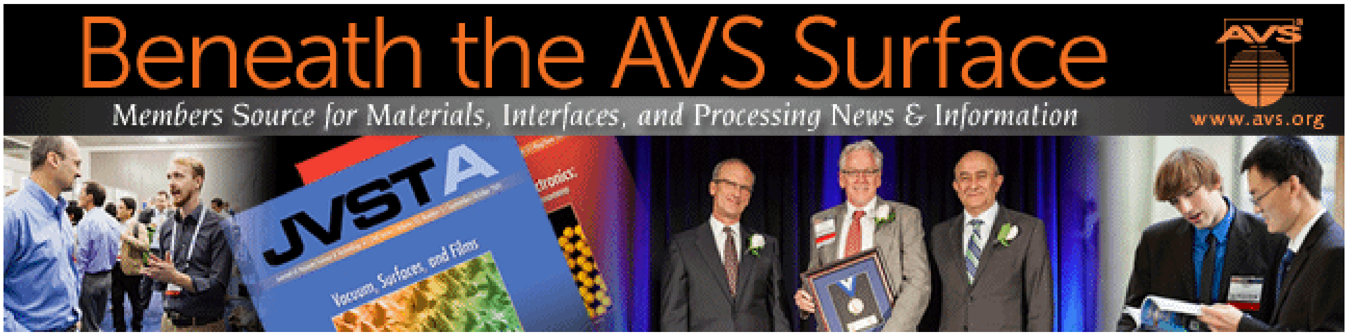

April 2016

PUBLICATION HIGHLIGHTS

*Three-dimensional Imaging of Cholesterol and Sphingolipids within a Madin-Darby Canine Kidney Cell

*Building Better Nanostructures with Improved Etching Tools

*Researchers Demonstrate Nanofabrication Methods for Antireflective Polymer Lenses

*Atomic Layer Deposition Shown to Produce Quality 2D Thin Films

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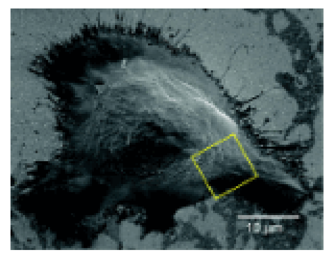
*Student and Divisional Awards Nominations Due May 2

PUBLICATION HIGHLIGHTS

Three-dimensional Imaging of Cholesterol and Sphingolipids within a Madin-Darby Canine Kidney Cell

Article: "Three-dimensional imaging of cholesterol and sphingolipids within a Madin-Darby canine kidney cell," Ashley N. Yeager, Peter K. Weber and Mary L. Kraft, Biointerphases 11, 02A309 (2016)



Metabolic stable isotope incorporation and secondary ion mass spectrometry (SIMS) depth profiling performed on a Cameca NanoSIMS 50 were used to image the ^{18}O-cholesterol and ^{15}N-sphingolipid distributions within a portion of a Madin-Darby canine kidney (MDCK) cell. Three-dimensional representations of the component-specific isotope distributions show clearly defined regions of ^{18}O-cholesterol and ^{15}N-sphingolipid enrichment that seem to be separate subcellular compartments. The low levels of nitrogen-containing secondary ions detected at the ^{18}O-enriched regions suggest that these ^{18}O-cholesterol-rich structures may be lipiddroplets, which have a core consisting of cholesterol esters and triacylglycerides. View Now

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Building Better Nanostructures with Improved Etching Tools

Article: "Faraday cage angled-etching of nanostructures in bulk dielectrics," Pawel Latawiec, Michael J. Burek, Young-Ik Sohn and Marko Loncar, J. Vac. Sci. Technol. B 34, 041801 (2016)

Nature abounds in nanostructures - a realm where one nanometer is 1-billionth of a meter. Scientists are racing to simulate the tiny structures and their novel dynamics to produce new materials and behaviors with highly desirable properties: strong, lightweight, high data storage and bright yet cool light.

New work from Harvard University researchers in Cambridge, Massachusetts, may improve nanostructure production to help fuel next-generation technologies. Demonstrating the universality and ease of Faraday cage angled-etching (FCAE) for fabricating nanostructures, their work appears in the current issue of the

CALENDAR

AVS Hudson Mohawk Spring Meeting
May 9, 2016
Niskayuna, NY
Website

AVS New Mexico Chapter Symposium, Short Courses and Exhibition
May 23-26, 2016
Albuquerque, NM
Website

AVS Mid-Atlantic Chapter DC Regional Meeting and Vendor Fair
May 26, 2016
Gaithersburg, MD
Website

AVS Western Pennsylvania Chapter Short Courses
May 31, 2016
Pittsburgh, PA
Website

60th International Conference on Electron, Ion, And Photon Beam Technology and Nanofabrication (EIPBN)
May 31-June 3, 2016
Pittsburgh, PA
Website

AVS New England Chapter Short Courses
June 16-17, 2016
Lowell, MA
Website

18th International Conference on Marine Corrosion and Biofouling -ICMCF 2016

Journal of Vacuum Science and Technology B.

The team's work expands the nanostructure etching toolkit available to investigators, according to team leader Pawel Latawiec, a graduate student in applied physics at Harvard's John A. Paulson School of Engineering and Applied Sciences.

"Scientifically and technologically, the most significant aspect of our work is the demonstration of the universality and ease of Faraday cage angled-etching (FCAE) for fabricating nanostructures," (Fig. 1), Latawiec said. "We wanted to show that this process was universal - that you could do this same type of angled etching no matter the material, etching chemistry, or chamber." The team's hope is that by reviewing their paper, other researchers can apply its lessons and implement them in their own etching tools.

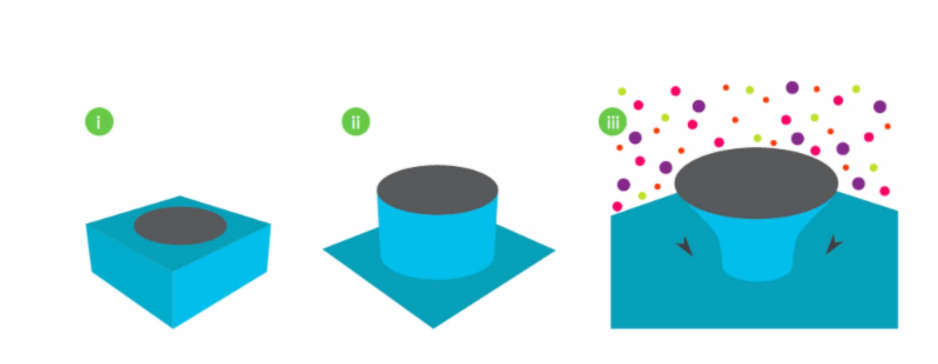

Fig.1. Schematic of angled etching. Directed by the equipotential on the cage boundaries, the ions are incident upon the sample at an angle. Shape of structure is defined by etch mask.

In their simulations, the team discovered key insights that clarify the etching process, chief among them: The behavior of the etching ions is affected by both the Faraday cage's mesh size (Fig. 2) and the sample location.

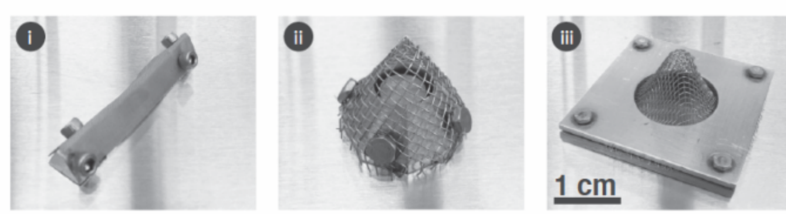

Fig. 2. Examples of cage styles used for etching are (l-r) triangular with fine mesh; wrapped with course mesh; molded with medium mesh.

A Faraday cage is a mesh enclosure used in the lab to control the electrostatic potential around an object. During etching, controlling and manipulating this potential can help direct the movement of charged etching ions, which then bombard and shape the final structure. Etching defines the three-dimensional geometry of a device, which strongly influences its behavior under optical or electrical fields.

The team developed their Faraday cage angle etching technique to etch three-dimensional photonic and mechanical nanostructures into diamond - a step needed because high-quality diamond is difficult to grow on a wafer platform. Instead, they needed to sculpt - by etching - the diamond. Co-author Mike Burek adapted and refined a triangular-milling technique to arrive at FCAE. "The etching ions come in from an angle and then undercut the structure. After much work and process optimization, he started to get fantastic diamond devices," Latawiec

June 19-24, 2016
Toulon, France
Website

Physical Electronics Conference (76th Annual PEC 2016)
June 20-23, 2016
Fayetteville, AR
Website

WoDiM - Workshop on Dielectrics in Microelectronics
June 27-30, 2016
Catania, Italy
Website

29th International Vacuum Nanoelectronics Conference (IVNC)
July 11-15, 2016
Vancouver, BC Canada
Website

ALD/ALE 2016
July 24-28, 2016
Dublin, Ireland
Website

Surface Analysis 2016
August 16-18, 2016
Albany, NY
Website

20th International Vacuum Congress
August 21-26, 2016
Busan, Korea
Website

Biointerface International 2016
August 23-25, 2016
Zurich, Switzerland
Website

AVS Pacific Northwest Chapter Annual Symposium
September 14-16, 2016
Website

32nd North American Conference on Molecular Beam Epitaxy (NAMBE 2016)
September 18-21, 2016
Saratoga Springs, NY
Website

AVS Rocky Mountain

explained.

In that earlier work the team refined its ability to exploit quantum properties of the color-centers in diamonds and bulk machining for developing nanoelectromechanical systems (NEMS), photonic, and quantum devices. In general, these are all devices that integrate mechanical, electrical, and optical functions at the nanoscale. They are part of the trend in technology toward increased miniaturization and functionality.

The silicon etching chemistry used led to the formation of a polymeric passivation layer around the structure during etching. "It meant that we had to play around with the chemistry to get the desired angle-etched profile," noted Latawiec.

In the current paper, the team extends their diamond work and also tests two other materials, silicon and quartz. Despite these materials' high potential for application in photonics and NEMS research, there are limited commercial substrates available for them - but the new method helps overcome this constraint, according to Latawiec. "Quartz, like diamond, can only be really found in bulk form. Using this technique, we can now make smaller quartz devices with new or improved functionalities. Overall, I hope researchers can take this technique and really get creative with the new device geometries it enables."

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Researchers Demonstrate Nanofabrication Methods for Antireflective Polymer Lenses

Article: "Polymer lenses with antireflection structures prepared using anodic porous alumina molds,"T. Yanagishita, T. Hidaka, M. Suzuki and H. Masuda, J. Vac Sci. Technol. B, Vol. 34, No. 2 (March/April 2016)

While the fictional vampire may come by his ability to be "antireflective" naturally, it isn't so easy for manufacturers of lenses for optical devices-cameras, microscopes and the like-to attain this special property. In the latest issue of the *Journal of Vacuum Science and Technology B*, a Japanese research team describes two novel nanoscale fabrication processes for producing polymer lenses with antireflective surfaces that maximize the amount of light passing through while eliminating reflection errors such as flares and ghost images.

Lenses with polymer structures composed of arrays featuring nanosize (250 nanometers or less) tapered conical pillars-tinier than the wavelength of incident light (between 400-700 nanometers)-have been valued by optics manufacturers because they effectively suppress all reflectance at the surface. Traditionally, these antireflective (AR) polymer structures have been difficult and expensive to produce. According to the paper's authors, the solution was to fabricate the fine polymer patterns into the lenses using nanoscale molds.

"We machined aluminum blocks to conform to the convex or concave shape of the lenses desired, and then used a precise combination of anodization and pore-widening treatment to produce a highly ordered array of nanopores," said

Chapter Short Course Program
September 20-23, 2016
Westminster, CO
Website

Events Calendar

JOBS

Postdoctoral Position in Atomic, Molecular, and Optical Physics
National Taiwan University

Postdoctoral Position
Illinois at Urbana-Champaign

Chair and Professor of Computer Science
Marshall University, Division of Computer Science

"The AVS Career Center was very helpful when I needed to quickly get qualified experienced candidate resumes for a recent opening. Our position was filled by an applicant who saw our posting on the AVS Job Openings web page." - **Larry Gilbert, Vacuum Solutions Group**

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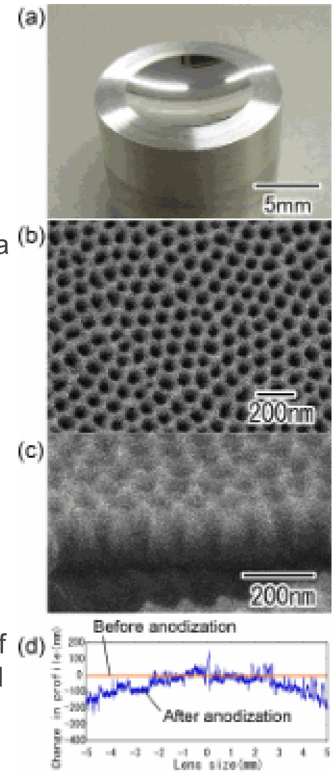
Hideki Masuda, professor of applied chemistry at Tokyo Metropolitan University and corresponding author of the paper. "The resulting mold with its nanopores can be used in two different ways to make an AR polymer lens: nanoimprinting and injection molding."



In the first method, the curved anodic porous alumina mold is imprinted into a sheet of polyethylene terephthalate polymer like a cookie cutter. What remains after removal of the mold is a precisely concave or convex lens with a uniform layer of tapered conical pillars that will eliminate reflection.

The second procedure involves electrodepositing nickel atop the anodic porous alumina template to create a "negative mold" for the AR structure only. This mold is placed in the top half of a chamber while a previously machined template in the bottom half defines the curve of the lens. With both halves of the chamber together, cyclo-olefin polymer is melted and injected inside. After cooling, the chamber walls are removed to produce the desired lens with its AR properties.

"The real beauty of both procedures is that the molds can be used repeatedly, making both methods very cost effective and yielding lenses with consistent quality," Masuda said.

Now that their AR polymer lens nanofabrication procedures have been shown to work, Masuda says that he and his colleagues are currently assessing the functionality and durability of the lenses. "Once the production methods are optimized, we believe that these lenses-with their gradually changing refractive index and ability to suppress reflection at the surface-will be applicable for many optical devices."

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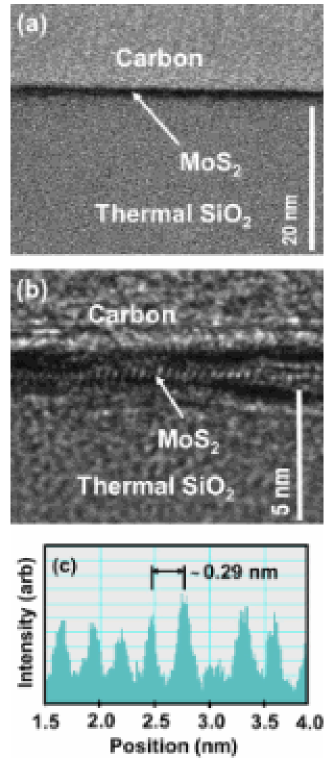
Atomic Layer Deposition Shown to Produce Quality 2D Thin Films

Article: "Atomic layer deposition of two dimensional MoS2 on 150 mm substrates," A. Valdivia, D.J. Tweet and J.F. Conley, J. Vac. Sci. Technol. A, Vol. 34, No. 2 (March/April 2016)



In microelectronic devices, the bandgap is a major factor in determining the electrical conductivity of the materials used to construct them. Substances with large bandgaps are generally insulators and those with smaller bandgaps are semiconductors, while conductors either have very small band gaps or none. The lack of a bandgap in graphene, a two dimensional single layer of carbon atoms, has led to the search for better semiconducting 2D materials including the class of compounds known as transition metal dichalcogenides (TMDs). Two-dimensional molybdenum disulfide (MoS_2) is a TMD that possesses a strong semiconducting bandgap, helping make it a leading candidate material for semiconductors in low power devices such as digital electronics, photonics and sensors. In the latest issue of the *Journal of Vacuum Science and Technology A*, researchers at Oregon State University and Sharp Labs of America demonstrate how they were able to successfully use a technique known as atomic layer deposition (ALD) to deposit one to two monolayers of MoS_2 on large area silicon and quartz substrates.

Traditionally, a monolayer of a material is uniformly deposited on a substrate by either mechanical exfoliation-the "lifting" of an individual layer of atoms from a crystal surface with Scotch tape which is then applied to the wafer-or chemical vapor deposition (CVD)-where at least two chemicals react with each other, or decompose together under high temperatures and pressures in the presence of the substrate.

"Unfortunately, exfoliation is impractical for mass production and CVD yields lower quality products with a lack of thickness control. So we turned to ALD to provide a reliable way to deposit 2D monolayers over a large surface area and ease their integration into the manufacturing environment," said John Conley Jr., professor of electrical and computer engineering at OSU and corresponding author of the paper.

Conley says that where CVD works by the continuous reaction of two precursors at the substrate surface within a vacuum chamber, ALD introduces a precursor and a reactant separately into the chamber, separated by nitrogen gas purges.

"This allows each one to take turns reacting in a self-limiting fashion on the wafer surface to deposit material a little less than a monolayer at a time," Conley explained. "The result is a thin film that is conformal, evenly thick throughout its length, dense and free of pinholes."

Conley and his colleagues investigated the use of molybdenum (V) chloride ($MoCl_5$) as the precursor and hydrogen sulfide (H_2S) as the reactant in their ALD process, and then looked at various properties of the MoS2 deposited over a range of temperatures. They also examined the impact of post-deposition elevated temperature annealing (heat treating) in an atmosphere containing sulfur, a procedure commonly used to improve a thin film's properties.

"We found that we could consistently deposit a one-to-two monolayer 2D MoS_2 film uniformly over a large surface area," Conley said. "Annealing the film in sulfur allowed us to see a strong photoluminescence peak, a hallmark of a monolayer material."

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With ALD microfabrication of MoS_2 monolayers successfully demonstrated, the researchers will next test their thin films in various applications such as transistors and catalysts while seeking ways to improve their quality, and search for other precursors that might be used in the ALD procedure.

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CONFERENCE ANNOUNCEMENTS

AVS Mid-Atlantic Chapter DC Regional Meeting/Vendor Fair/Student Poster Competition

May 26, 2016
NIST
Gaithersburg, MD
Website

Call for Student Posters
A student poster competition will be held where cash prizes will be awarded to the top three student poster presentations! Registration is free and must be completed by **May 19** to Jay Hendricks at jay.hendricks@nist.gov.

Invited Speakers
Four invited speakers will present cutting-edge research on "Nanotechnology Applied to Batteries:" Joe Dura (NIST), Kang Xu (ARL), Chuan-Fu Lin (UMd), and Corey Love (NRL).

Vendor Fair
Vendor tabletop displays are available. Please contact Doug Baker at douglas.baker@teledyne.com for details. Sponsorship is welcome.

NIST Tours
Special tour offerings of NIST laboratories will be available, including the Nanofab User Facility and the Photonic Sensors for Pressure and Temperature.

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AVS 63rd International Symposium & Exhibition Call for Abstracts

Division and Group Programs

- Advanced Surface Engineering
- Applied Surface Science
- Biomaterial Interfaces
- Electronic Materials & Phontonics
- Magnetic Interfaces & Nanostructures
- Manufacturing Science & Technology

- MEMS & NEMS
- Nanometer-scale Science & Technology
- Plasma Science & Technology
- Surface Science
- Thin Film
- Vacuum Technology

Focus Topics and Other Sessions

- 2D Materials
- Actinides & Rare Earths
- Advanced Ion Microscopy
- Exhibitor Technology Spotlight
- Fundamental Discoveries in Hetergeneous Catalysis
- *In Situ* and Operando Spectroscopy and Microscopy for Catalysts, Surfaces, and Materials
- Novel Trends in Synchrotron & FEL-Based Analysis
- Plasma Processing for Biomedical Applications
- Scanning Probe Microscopy
- Spectroscopic Ellipsometry
- Tribology

Plenary Lecture

- Dr. Heike Riel, IBM Fellow, Manager Materials Integration and Nanoscale Devices

Call for Abstracts   Submit Abstract

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MEMBER HIGHLIGHTS

Student and Divisional Awards Nominations Due May 2

The AVS National Student Awards include five (5) top-level awards and three (3) Graduate Research Awards (GRAs). The top-level AVS Graduate Student Awards include: Russell and Sigurd Varian Award, Nellie Yeoh Whetten Award, Dorothy M. and Earl S. Hoffman Award and Dorothy M. and Earl S. Hoffman Scholarships. In addition, numerous Divisional Awards in technical areas of interest to AVS are available.

Students may apply for a National Student Awards (Graduate Research Award/Top Level Award) and one Division Group Award in a given year. Please note that if you are submitting an abstract to a session co-sponsored by a division, you are still eligible to apply for that division's student award.

Click here for Nomination Procedures Guidelines
Click here to Start a Nomination

All material must be uploaded by **May 2, 2016,** at 12:00 PM (Midnight) EST No extensions will be granted. It is the student's responsibility to ensure that all documents are uploaded by the deadline.

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