AVS Texas Chapter Conference 2018

August 1\textsuperscript{st} - 3\textsuperscript{rd}, 2018

Texas Christian University

Agenda and Abstracts
Wednesday, August 1st
Sid Richardson Bldg. Lecture Hall 2

Session I
Moderator: Anton Naumov, Texas Christian University

8.10 – 8.20 am  Welcome Remarks

8.20 – 9.00 am  Invited Talk
Digital Atomic Scale Fabrication
John N. Randall, James H.G. Owen, Ehud Fuchs, and Joseph Lake
Zyvex Labs, 1301 N. Plano Rd., Richardson, Texas, 75081, USA

9.00 – 9.20 am  Synthesis and characterization of Amorphous InSb nanowires
Z. Algarni¹, and U. Philipose¹
¹Department of Physics, University of North Texas, Denton, Texas, 76203

9.20 – 9.40 am  Electrical transport in semiconducting InSb nanowire grown via
electrochemical deposition in anodic alumina oxide template
Abhay Pratap Singh¹, Usha Philipose¹
¹Department of Physics, University of North Texas, Denton, TX, 76203

9.40 – 10.00 am  Next Generation Heated Atomic Force Microscope Cantilever for
Nanolithography: Modelling, Simulation and Fabrication
Mohammadreza Soleymaniha¹ and Jonathan Robert Felts¹
¹Texas A&M University, Department of Mechanical Engineering, College
Station, TX USA

10.00 – 10.20 am  Coffee Break
1st floor outside  Lecture Hall 2

Session II
Moderator: John N. Randall, Zyvex Labs

10.20 – 11.00 am  Invited Talk
Data Analysis in Thin Film Characterization: Learning More With Physical Models
L. D. Gelb, A. V. Walker
Department of Materials Science and Engineering, University of Texas at
Dallas, Richardson, TX USA

11.00 – 11.20 am  First-Principles Study of Initial Di-sec-butylaminosilane Reaction with a
Plasma-activated H-Si(111) Surface
K. A Oyekan, L. F. Peña and Y. J. Chabal
Department of Materials Science & Engineering, The University of Texas at
Dallas, Richardson, TX USA
11.20 – 11.40 am  Understanding and Prediction of the Coupled Stress-Induced Evolution of Nanoscale Materials Interfaces
Jihyung Lee¹, Xiaoli Hu², Andrey Voevodin¹, Ashlie Martini², Diana Berman¹
¹Department of Material Science & Engineering, University of North Texas, Denton, TX USA
²Department of Mechanical Engineering, University of California at Merced, Merced, CA

11.40 am – noon  An investigation of self-healing processes in niobium-based oxides
J.J. Gu, S.M. Aouadi
Department of Materials Science and Engineering, University of North Texas, Denton, TX

noon – 12.20 pm  Rational design of semiconductor heterostructures for energy conversion
Junsang Cho, Sarbajit Banerjee
Texas A&M University Commerce, Commerce, TX USA

12.20 – 1.20 pm  Lunch
Sid Richardson Bldg. 2nd floor Lobby

Session III
Moderator: Yuri Strzhemechny, Texas Christian University

1.20 – 2.00 pm  Invited Talk
Size Effects in Light Emitting Perovskite Nanostructures Templated by Porous Silicon Nanotubes and Particles
Roberto Gonzalez-Rodriguez, Viviana Costa, and Jefferly L. Coffer
Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX USA

2.00 – 2.20 pm  Pyridophane based macrocycles for treatment of oxidative stress in neurodegenerative disorders.
Hannah Johnston¹, Maddie Barnett¹, Giri Akkaraju¹ and Kayla N. Green¹
Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX USA

2.20 – 2.40 pm  Graphene oxide and iron oxide nanocomposite with pH-sensing and MRI / fluorescence imaging capabilities
R. Gonzalez-Rodriguez, E. Sizemore, A. Naumov¹
¹Department of Physics & Astronomy, Texas Christian University, Fort Worth, USA.
2.40 – 3.00pm  Targeted Drug Delivery via reconstituted High Density Lipoprotein Nanoparticles for Cancer Therapy
Sangram Raut1, Nirupama Sabnis, Marlyn Panchoo, Ruhani Ahluwalia, and Andras Lacko
1Department of Physiology/Anatomy, UNT Health Science Center, Fort Worth, TX USA

3.00 – 3.20 pm  Single-Walled Carbon Nanotube-Assisted Multidrug/Gene Delivery for NASH Therapeutics.
Anton V. Naumov1
1Department of Physics & Astronomy, Texas Christian University, Fort Worth, USA.

3.30 – 5.30 pm  Poster Session
Sid Richardson Bldg. 2nd floor Lobby

Electroless Deposition of Copper on Self-Assembled Monolayers Monitored Using QCM-D
Tania Estrada1, and Amy V. Walker1,2
1 Department of Chemistry and Biochemistry, University of Texas at Dallas, Richardson, TX USA
2 Department of Materials Science and Engineering, University of Texas at Dallas, 800 W Campbell Rd, Richardson, TX, 75080

Fabrication of a Micro Secondary Electron Detection System
Zhengyang Wang1, M. Goeckner1 and L. Overzet1
1 Department of Electrical & Computer Engineering, the University of Texas at Dallas, Richardson, TX USA

Drug delivery and degradation behavior of nanostructured porous silicon-polyolactone composites
Nelli K. Bodiford1, Steven J.P. McInnes2, Nicolas H. Voelcker3, and Jeffery L. Coffer1
1 Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX USA
2 University of South Australia, GPO Box 2471 South Australia 5001, Australia
3 Monash Institute of Pharmaceutical Sciences, Monash University, Australia

Thermal Pathways of Hybrid Oxo-Cluster EUV Resists with in situ IR Spectroscopy
Y. Cabrera1, E.C. Mattson1, Y. Wang1, K. Oyekan1, and Y.J. Chabal1
1 Department of Material Science and Engineering, University of Texas at Dallas, Richardson, TX USA
Graphene Quantum Dots as Imaging, Sensing, and Delivery Agents
Elizabeth Sizemore¹, Md. Tanvir Hasan¹, Roberto Gonzalez¹ and A. Naumov¹
¹Department of Physics and Astronomy, Texas Christian University, Fort Worth, TX USA

Tunable Self-Healing Thermal Barrier Coatings
J.J. Gu, S.S. Joshi, Y.-S. Ho, B.W. Wei, T.Y. Hung, Y.Y. Liu, N.B Dahotre, S.M. Aouadi
Department of Materials Science and Engineering, University of North Texas, Denton, TX USA

Towards Optimization of Copper Nanowire Transfer and Crossbar Synthesis
J.S. Vienes¹ and A.V. Walker¹,²
¹Department of Chemistry and Biochemistry, The University of Texas at Dallas, TX US
²Department of Material Science and Engineering, The University of Texas at Dallas, TX USA

Silicon Nanotubes as A Platform for Platinum Nanocrystal Deposition
N. T. Le¹, J. L. Coffer¹
¹Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX, USA.

Self-healing properties of Nb-Ag-O coating
Asghar Shirani¹, Jingjing Gu¹, Samir Aouadi¹, Diana Berman¹
¹Department of Materials Science Engineering, University of North Texas, Denton, TX USA

Heteroatoms-doped Graphene Quantum Dots Synthesized via Bottom-up Approach for Multi-color Bioimaging Applications
Md. Tanvir Hasan¹, Roberto Gonzalez-Rodriguez¹, Elizabeth Sizemore¹, Giridhar Akkaraju² and Anton V. Naumov¹
¹Department of Physics and Astronomy, Texas Christian University, Fort Worth, TX USA
²Department of Biology, Texas Christian University Fort Worth, TX USA
PrMn$_2$O$_5$ Mullite-type Oxide as a Superior Catalyst over SmMn$_2$O$_5$ for Low-Temperature NO Oxidation
S. Thampy$^1$, N. Ashburn$^1$, S. Dillon$^1$, Y. Zheng$^1$, C. Liu$^2$, K. Xiong$^2$, Y. Chabal$^1$, K. Cho$^1$, and J. W. P. Hsu$^1$
$^1$Department of Materials Science & Engineering, University of Texas at Dallas, Richardson, TX USA
$^2$Dongguan Innovative New Materials Co. Ltd, Incubation Park for Sci&Tech SMEs, Songshan Lake, Dongguan, Guangdong China

Rapid Synthesis of Nanoporous Conformal Coatings via Plasma-Enhanced Sequential Infiltration of a Polymer Template
Yunlong She$^1$, Jihyung Lee$^1$, Benjamin Diroll$^2$, Byeongdu Lee$^3$, Elena Shevchenko$^2$,*; Diana Berman$^1$,*
$^1$Materials Science and Engineering Department, University of North Texas, Denton, TX USA
$^2$Center for Nanoscale Materials, Argonne National Laboratory, Argonne, IL USA
$^3$Advanced Photon Source, Argonne National Laboratory, Argonne, IL USA

Photophysical characterization of oligopeptide linked FRET system in PVA matrix and buffer to detect levels of MMP-9.
S. Shah$^1$, W. Mandecki$^2$, J. Li$^2$, Z. Gryczynski$^3$, J. Borejdo$^1$, I. Gryczynski$^1$, and R. Fudala$^1$
$^1$Department of Microbiology, Immunology and Genetics, Center for Fluorescence Technologies and Nanomedicine, University of North Texas Health Science Center, Fort Worth, Texas 76107
$^2$PharmaSeq, Inc., 11 Deer Park Dr., Suite 104, Monmouth Junction, New Jersey 08852
$^3$Department of Physics and Astronomy, Texas Christian University, Fort Worth, Texas 76129
Thursday, August 2\textsuperscript{nd}
Sid Richardson Bldg. Lecture Hall 2

Vendors are located at Sid Richardson Bldg. Lecture Hall 4

Session IV
Moderator: Chris Moffitt, Kratos Analytical

8.10 – 8.20 am  Welcome Remarks

8.20 – 9.00 am  Invited Talk
Resilient High Temperature UHV Sealing
Jacob Young\textsuperscript{1}
\textsuperscript{1} Sr. Business Development Specialist, Technetics Group, Columbia, SC 29209 USA

9.00 – 9.20 am  Temporally Resolved Optical Emission Spectroscopy for Studies of Level-to-Level Discharges.
University of Texas at Dallas, Richardson, TX USA

9.20 – 9.40 am  Multilayer nanostructures for highly-sensitive surface plasmon resonance sensors
H. Akafzade\textsuperscript{1}, S. C. Sharma\textsuperscript{1,*} and N. Hozhabri\textsuperscript{2}
\textsuperscript{1}Department of Physics, University of Texas at Arlington, Arlington, TX, 76019
\textsuperscript{2}Schimadzu Institute: Nanotechnology Research Center, University of Texas at Arlington, Arlington, TX, 76019

9.40 – 10.00 am  Nanosecond Scale, Corrected RF-IV Measurements of Pulsed Plasmas
A. Press\textsuperscript{1}, K. Hernandez\textsuperscript{1}, M. Gockner\textsuperscript{2} and L. Overzet\textsuperscript{1}
\textsuperscript{1}Department of Electrical Engineering, The University of Texas at Dallas, 800 W. Campbell Road, Dallas, TX, 75252
\textsuperscript{2}Department of Natural Sciences and Mathematics, The University of Texas at Dallas, 800 W. Campbell Road, Dallas, TX, 75252

10.00 – 10.20 am  Coffee Break
1\textsuperscript{st} floor outside Lecture Hall 2

Session V
Moderator: Jacob Young, Technetics Group

10.20 – 11.00 am  Invited Talk
Photoreactions of Monolayer MoS2 in Ambient Conditions
Zhenrong Zhang
Department of Physics, Baylor University, Waco, TX USA
11.00 – 11.20 am  Photoactivated CVD of Dimethyl(1,5-cyclooctadiene)platinum(II) on Functionalized Self-Assembled Monolayers
Bryan G. Salazar¹, Hanwen Liu², Lisa McElwee-White², Amy V. Walker³
¹Department of Chemistry and Biochemistry, University of Texas at Dallas, Richardson, TX USA
²Department of Chemistry, University of Florida, Gainesville, Fl USA
³Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX USA

11.20 – 11.40 am  Boron Carbide/Aromatic Films – Emerging Materials, Structure and Charge Transport
A. Oyelade¹, A. Ozonkie¹, A.J. Yost², N. Benker², B. Dong¹, P. A. Dowben² and J.A. Kelber¹
¹Department of Chemistry, University of North Texas, Denton, TX USA
²Department of Physics and Astronomy, University of Nebraska-Lincoln, Lincoln, NE USA

11.40 am – noon  Edge-Modification of MoS₂ for Improved Catalysis Inspired by First-Principles Modeling and Mapping of Electronic Structure
Abhishek Parija¹, Yun-Hyuk Choi¹, and Sarbajit Banerjee¹
¹Department of Chemistry and Department of Material Science and Engineering, Texas A&M University, College Station, TX USA

noon– 12.20 pm  Synthesis and Exploration of Electronic Properties in Monolayers of Molybdenum Disulfide
Y. Jiang¹ and U. Philipose¹
¹Department of Physics, University of North Texas, Denton, TX USA

12.20 – 1.20 pm  Lunch
Sid Richardson Bldg. 2nd floor Lobby

Session VI
Moderator: Zhenrong Zhang, Baylor University

1.20 – 2.00 pm  Invited Talk
Application of Gas Cluster Ion Source Etching to Inorganic Materials: LiPON
C. Moffitt¹ and J. Counsell²
¹Kratos Analytical, Inc., 100 Red Schoolhouse Rd., Chestnut Ridge, NY, 10977
²Kratos Analytical, Wharfside, Trafford Wharf Road, Manchester, M17 1GP, UK

2.00 – 2.20 pm  Chemical Bath Deposition of Substrate Selective Molybdenum Disulfide
J. K. Hedlund¹, A.V Walker¹,²
A photoelectron study of intrinsic and extrinsic p-type doping of pulsed laser deposited few layered WS$_2$ films.

Urmilaben P. Rathod$^1$, Jitendra Kumar Jha, Justin Egede$^1$, Andrey A. Voevodin$^1$, and Nigel D. Shepherd$^1$

$^1$Department of Chemistry & Biochemistry, University of Texas at Dallas, Richardson, TX USA

$^2$Department of Materials Science & Engineering, University of Texas at Dallas, Richardson, TX USA
Raman Spectroscopy Analysis of a New Copper-Cysteamine Complex
University of Texas at Arlington, TX USA

Optimizing the Growth of WS₂ with Laser Annealing
C. L. Arnold, S. Bakkar and A. A. Voevodin
Department of Material Science and Engineering, University of North Texas
Denton, TX USA

Single Junction GaAs Thin Film Solar Cells on Flexible Epi-ready Metal Tape for Low Cost Photovoltaics
Devendra Khatiwada, Monika Rathi, Carlos Favela, Pavel Dutta, Sicong Sun, Yongkuan Li, Sara Pouladi, Jae-Hyun Ryu and Venkat Selvamanickam
Advanced Manufacturing Institute Department of Mechanical Engineering Texas Center for Superconductivity University of Houston, Houston, TX USA

Synthesis and Characterization of Europium-Doped Cerium Oxide Nanotubes
A.E. D’Achille¹, J.L. Coffer¹
Department of Chemistry, Texas Christian University, Fort Worth, TX USA

Effect of Triethanolamine on the Electroless Deposition of Copper on Functionalized Organic Surfaces
D. Cortes¹, J. Vienes² and A.V. Walker²,³
Department of Chemistry, University of Texas at Austin, Austin, TX USA
Department of Chemistry and Biochemistry, University of Texas at Dallas Richardson, TX USA
Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX USA

Effect of differing electrode metals on reactive species generation in humid N2/O2 atmospheric pressure dielectric barrier discharge plasmas
A. Gemsheim¹, S. Patel¹, L. Overzet and M. Goeckner
Department of Electrical Engineering, University of Texas at Dallas, Richardson, TX USA

Thickness Control of Spin-Cast Polysulfone Thin Films as a Foundation for Optoelectronic Studies of Hydrophobic ‘Flipping’
John Reeks¹, Hunter Hilton¹, William Moss², Hijun Ryu³, Luc Le⁴, Rohan Maheshwari⁵, Alexander David³, Annie Zhi⁶, Yuri Strzhemechny¹
Department of Physics and Astronomy, Texas Christian University, Fort Worth, TX USA
Electric Field Induced Variation of the Optical Properties of Graphene Oxide
C. Ryan\textsuperscript{1}, T. Paz\textsuperscript{1}, F. Grote\textsuperscript{2}, and A. Naumov\textsuperscript{1}
\textsuperscript{1}Department of Physics and Astronomy, Texas Christian University, Fort Worth, TX USA
\textsuperscript{2}Department of Chemistry, University of Würzburg, Würzburg, Germany

Phosphonic acid self-assembled monolayers for wet thin film deposition
Milana C. Thomas\textsuperscript{1} and Yves J. Chabal\textsuperscript{1}
\textsuperscript{1}Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX USA

Morphology-Dependent Optoelectronic Properties of Hydrothermally-Grown Nano- and Microscale ZnO
William Moss\textsuperscript{1}, John Reeks\textsuperscript{2}, Bao Thach\textsuperscript{3}, Luc Le\textsuperscript{4}, Rohan Maheshwari\textsuperscript{5}, Hijun Ryu\textsuperscript{6}, Alexander David\textsuperscript{6}, Annie Zhi\textsuperscript{7}, Yuri Strzhemechny\textsuperscript{2}
\textsuperscript{1}Department of Chemistry and Biochemistry, Texas State University Dr., San Marcos, TX USA
\textsuperscript{2}Department of Physics and Astronomy, Texas Christian University, Fort Worth, TX USA
\textsuperscript{3}Department of Engineering, Texas Christian University, Fort Worth, TX USA
\textsuperscript{4}Keller Central High School, Keller, TX USA
\textsuperscript{5}Coppell High School, Coppell, TX USA
\textsuperscript{6}Trinity Valley School, Fort Worth, TX USA
\textsuperscript{7}Clark High School, Plano, TX USA

Geometrical factors affecting fluorescence experiments: the dangers of working with highly absorbing samples
J. L. Chavez\textsuperscript{1}, L. Ceresa\textsuperscript{1}, Z. Nurekeyev\textsuperscript{1}, J. Kimball\textsuperscript{1}, H. Doan\textsuperscript{1}, Harris To, Sunil Shah\textsuperscript{2}, I. Gryczynski\textsuperscript{2}, and Z. Gryczynski\textsuperscript{1,2}
\textsuperscript{1}Department of Physics and Astronomy, Texas Christian University, Fort Worth, TX USA
\textsuperscript{2}Department of Molecular Immunology and Genetics, University of North Texas Health Science Center, Fort Worth, TX USA
Friday, August 3
Sid Richardson Bldg. Lecture Hall 2

Session VII: Session Honoring Yves Chabal
Moderator: Lev D. Gelb, University of Texas at Dallas

9.10 – 9.20 am  Welcome Remarks

9.20 – 10.00 am  Invited Talk
Using FTIR to Study Surfaces – My Path Crossings with Yves Chabal in the Past 27 Years
Julia W. P. Hsu
1Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX USA

10.00 – 10.40 am  Invited Talk
Infrared spectroscopy in academic research and industrial applications
Katy Roodenko
Max-IR Labs, Dallas, TX

10.40 – 11.20 am  Invited Talk
Probing Structure evolution and Charge Transport at Discrete Electrical Energy Storage Interfaces
Janice E. Reutt-Robey1 and Jonathan Larson2
1Department of Chemistry & Biochemistry, University of Maryland, College Park, MD USA
2Department Physics, University of Maryland, College Park, MD USA

11.20 – noon  Invited Talk
Computational Spectroscopy for Atomic Level Processing of Semiconductor Surfaces
Thomas J.L. Mustard1 and Mathew D. Halls2
1Materials Science Division, Schrödinger Inc., 101 SW Main Street, Suite 1300, Portland, OR USA
2Materials Science Division, Schrödinger Inc., 10201 Wateridge Circle, Suite 220, San Diego, CA USA

noon  Conference Close
August 1\textsuperscript{st}, 2018

Abstracts
Digital Atomic Scale Fabrication

John N. Randall, James H.G. Owen, Ehud Fuchs, and Joseph Lake

Zyvex Labs, 1301 N. Plano Rd., Richardson, Texas, 75081, USA

Email: jrandall@zyvexlabs.com

Zyvex Labs has been developing Hydrogen Depassivation Lithography (HDL) as a digital process[1]. HDL is carried out with modified Scanning Tunneling Microscope (STM) instrumentation and uses electron stimulated desorption of H atoms from a Si (100) 2x1 H passivated surface. It is a form of low energy e-beam lithography. The process inherently has some digital aspects: 1) the resist has a digital response. 2) The resist distribution is quantized. 3) There are distinct imaging (reading) and lithography (writing) modes. Like any good digital process there are significant tolerances in the process. There is a wide parameter space in the dose, current, voltage, and tip position that produces single pixel (sub-nm) lines[2]. We have embraced the digital nature of this process to capitalize on the many advantages of digital processes.

We believe that there is a spectacular opportunity to learn from the tactics employed in information technology by Richard Hamming and many others that learned to deal with the inevitable errors in computation, transmission, and storage. This was accomplished by a host of error detection and error correction schemes. The current and rapidly evolving IT systems are incredibly complex and yet extremely reliable. We believe that by embracing and developing digital tactics with our nanofabrication processes, similarly impressive nanosystems that are not restricted to information processing will emerge.

Our ultimate goal at Zyvex Labs is the development of Atomically Precise Manufacturing where inevitable fabrication errors are detected and corrected. This technology will provide the nano-foundries required to produce the large array of nanotechnology products that have been promised but not yet delivered. I am describing a particular approach to nanofabrication, I believe that error detection/correction schemes can and will be developed in other atomic scale fabrication processes. We only need to look to the nanofabrication done in biology, to see that error detection processes are plentiful. I believe that the concept of digital atomic scale fabrication that uses error detection and correction is not only a sound idea, it is inevitable. We are knocking on the door. It is time for nanofabrication to go digital.

References:


Synthesis and characterization of Amorphous InSb nanowires

Z. Algarni¹, and U. Philipose¹

¹Department of Physics, University of North Texas, Denton, Texas, 76203

Email: ZainaAlgarni@my.unt.edu

Although various synthesis and characterization strategies have been employed for the synthesis of crystalline nanowires, there is very little work done on development of low-dimensional amorphous semiconductors. This paper presents a simple strategy to grow amorphous InSb (a-InSb) nanowires (NWs) in a chemical vapor deposition (CVD) system. The NWs were grown on Si substrate coated with indium film and the lack of crystallinity in the as-grown stoichiometric NWs was ascertained by Raman spectroscopy and electron transport measurements. A model proposed to explain the amorphous NW growth mechanism takes into account the fact that NW growth was carried out at the high temperature ramp-up rate of 75 °C/min. This high rate is believed to affect the growth kinematics and determine the arrangement of atoms in the growing NW. Raman spectrum of the as-grown sample shows a broad peak around 155 cm⁻¹, indicative of the presence of high density of homopolar Sb-Sb bonds in the amorphous matrix. It was also found that laser light intensity results in radiation-stimulated diffusion of defects in a-InSb and causes localized crystallization of the spot that is subjected to intense laser light. The nonlinear trend of the current-voltage characteristics for individually contacted a-InSb NWs was analyzed to prove that the non-linearity is not induced by Schottky contacts. At high bias fields, space charge limited conduction was the proposed electron transport mechanism. Post-growth annealing of the as-grown a-InSb NWs was found to be very effective in increasing its electrical conductivity.
Electrical transport in semiconducting InSb nanowire grown via electrochemical deposition in anodic alumina oxide template

Abhay Pratap Singh¹, Usha Philipose¹

¹Department of Physics, University of North Texas, Denton, TX, 76203

Email: abhaysingh@my.unt.edu

Template-assisted synthesis of nanowires by electrochemical method is commonly used in fabrication of semiconducting and metallic nanowires. It is a facile and cost effective approach compared to conventional lithography which requires expensive piece of equipment. The focus of this work is in two parts. First, we discuss on the various mechanism of mass transport during successive stages of the template assisted electrochemical growth of indium antimonide (InSb) nanowires in commercial anodic aluminum oxide (AAO) template. Second, we discuss the barrier layer thinning of home-grown AAO template for direct electrochemical growth of InSb nanowires. Barrier layer thinning provides a conducting path at the pore bottoms and AAO templates are suitable for electrodeposition. InSb nanowires were characterized by Raman spectroscopy for the optical properties, scanning electron microscopy (SEM) for the surface morphology, energy-dispersive X-ray spectroscopy (EDS) for the elemental analysis. We present electrical properties of these InSb nanowires connected in a back-gated nanowire field effect transistor (FET) configuration. The Sb-rich InSb nanowires that were fabricated by dc electrodeposition in nanoporous AAO template exhibited hole dominated electrical transport (p-type conduction) [1], [2]. Temperature-dependent transport measurement shows the semiconducting nature of these nanowires. InSb can be used as a material of choice for use in high-speed electronic devices, low-power logic transistors, nanowire field effect transistors (FETs), infrared (IR), nano-optoelectronics, thermoelectrics, and magnetoresistive sensors. In addition to electronics devices, AAO templates can be used in biomedical, separation, sensing applications.

References:

Next Generation Heated Atomic Force Microscope Cantilever for Nanolithography: Modelling, Simulation and Fabrication

Mohammadreza Soleymaniha1 and Jonathan Robert Felts1

1Texas A&M University, Department of Mechanical Engineering, College Station, TX USA
Email: soleymm1@tamu.edu

Over the last century, polymers have pervaded nearly every aspect of modern life, and the global economy now produces nearly 300 megatonnes of polymer per year. Because polymers are readily available, lightweight, flexible, and relatively cheap, much effort has been devoted to develop polymers with unique thermal, electrical, optical, and magnetic properties for use as active material in nano-electronics. Polymer chemistry has matured greatly over the past few decades, but it is still unclear how to integrate polymers into the nano-architectures required to make efficient optoelectronic devices. Thermal Dip-pen Nanolithography (tDPN) is an atomic force microscope (AFM) technique capable of creating nano-architectures from molten polymer. In tDPN, a nanometer sharp heated AFM tip is coated with polymer, placed in contact with a surface, and heated above the polymer glass transition temperature to print polymer onto the surface. The polymer mass flow rate depends on the balance between thermo-capillary and viscous force, such that hotter temperatures result in larger mass flow rates. The micro-cantilevers currently used in tDPN can write hundreds of polymer structures with sub 100 nm spatial resolution, but do not have sufficient polymer concentration or control over mass flow rate needed for large scale manufacturing. There is a need to develop a tDPN device capable of writing millions of polymer nanostructures with ~10 fg/s mass flow rate control to make this a viable nano-manufacturing technique.

Here we present an AFM cantilever design capable of patterning millions of polymer nanostructures with integrated mass flow sensing and control. The micro-cantilever has two embedded joule heaters connected via a microchannel, where thermo-capillary forces induced by the temperature gradient between heaters can deliver up to 25 ng of polymer to the tip. We used multi-physics finite element analysis to optimize the thermo-mechanical and thermo-fluidic performance of the device. A modal analysis of the cantilever vibration during operation show the resonant frequencies of the first four cantilever modes are sensitive to the location of the advancing polymer meniscus within the channel, where the frequency shifts by 1.7, 0.32, 0.66, and 0.1 percent for modes 1-4, respectively. The cantilever frequency shift thus provides a facile measure of mass flow rate within the channel. We further model the temperature rise in each heater, showing that each heater can reach temperatures exceeding 400 °C with a temperature gradients along the channel between the two heaters tunable from -1,000,000 to 1,500,000°C/m. Computational fluid dynamics simulations of molten polymer flowing in the microchannel shows the leading edge advances as √t according to Washburn’s equation, and the velocity of the leading edge depends significantly on the imposed temperature gradient. Large temperature gradients in the direction of polymer imbibition serve to increase the leading edge velocity for faster channel filling, while large temperature gradients opposing capillary filling can decrease filling speeds, hold the leading edge still, and even reverse polymer flow. Thus, the cantilever tip can be inked, cleaned, and re-inked by controlling the temperature of the integrated heaters. The design presented here provides a platform for wafer scale polymer nanostructure fabrication with mass flow control required for nano-manufacturing complex polymer-based devices.
Data Analysis in Thin Film Characterization: Learning More with Physical Models

L. D. Gelb, A. V. Walker

Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX USA

Email: lev.gelb@utdallas.edu

Chemical imaging methods, including imaging mass spectrometry (MS), are increasingly used for the analysis of samples ranging from biological tissues to electronic devices. Most chemical analyses for advanced materials, nanosystems, and thin films involve energetic beams of primary ions or electrons. A barrier to wider adoption of imaging mass spectrometry is the presence of matrix effects, which complicate quantitative analysis. Interactions between an analyte molecule and its surroundings (the “matrix”) can substantially alter both the yield and type of ions observed. Furthermore, such “intrinsic” effects can be confused with nonlinear response due to detector saturation and other instrument-related complications. All these phenomena lead to the same issue: the data measured are not necessarily representative of the elements or species originally present or their original locations. These effects can sometimes be exploited to provide new information or increased sensitivity, as in matrix-enhanced SIMS and the determination of overlayer thicknesses from attenuation of XPS substrate intensity.

We discuss analysis of such data using maximum a posteriori (MAP) reconstruction based on physically motivated models, and present progress towards the quantitative extraction of chemical concentration profiles and component spectra in the presence of matrix effects, using mixed self-assembled alkanethiolate monolayers as a test system. We demonstrate that incorporation of matrix effects to lowest order using a series-expansion approach is an effective strategy and that doing so provides improved quantitative performance in measuring surface compositions and can also yield information about interactions between species during the SIMS process. Finally, we discuss extension of this approach to other analytical methods, such as X-ray photoelectron spectroscopy (XPS).
First-Principles Study of Initial Di-sec-butylaminosilane Reaction with a Plasma-activated H-Si(111) Surface

K. A Oyekan, L. F. Peña and Y. J. Chabal

Department of Materials Science & Engineering, The University of Texas at Dallas, 800 W. Campbell Rd, Richardson, TX 75080

Email: kolade.oyekan@utdallas.edu

Plasma-enhanced atomic layer deposition (PEALD) has emerged as an important method in the deposition of silicon nitride (Si\(_3\)N\(_4\)) films at low-temperatures (<300 °C). Although PEALD silicon nitride growth from alkylaminosilane precursors shows great promise, the underlying reaction mechanisms and energetics for initial chemisorption on an activated surface must be established to derive a systematic understanding of plasma-enhanced processes. Some theoretical attempts have been made to understand the reactivity of chlorosilane and alkylaminosilane precursors with selected co-reactants on Si\(_3\)N\(_4\) surfaces; however, the reaction energetics for alkylaminosilane reactions on model surfaces, e.g., on an oxide-free monohydride-terminated Si(111) surface, has yet to be investigated.

In this work, we use density functional theory (DFT) calculations to investigate the energy landscape of di-sec-butylaminosilane (DSBAS) reaction with active sites, i.e., dangling bonds, on a H-Si(111) surface; assuming the active sites were created by hydrogen desorption induced by an Ar plasma treatment. DFT results indicate that the reaction is thermodynamically and kinetically favorable at temperatures below 200 °C. We also quantify the energy barrier to create additional active sites after initial DSBAS reaction with dangling bonds, e.g., after DSBAS reaction produces an amine radical byproduct that abstracts surface hydrogen to reach equilibrium. In addition, the effect of oxygen in the back-bone of Si-H is investigated as ICP remote plasmas are known to incorporate oxygen impurities during PEALD growth. We find that the Si-H bond dissociation energy increases (~10 kcal/mol) when an oxygen atom is incorporated in the back-bone, as compared to Si, making it more energetically demanding on plasmas to dissociate Si-H when oxygen impurities are present.
Understanding and Prediction of the Coupled Stress-Induced Evolution of Nanoscale Materials Interfaces

Jihyung Lee1, Xiaoli Hu2, Andrey Voevodin1, Ashlie Martini2, and Diana Berman1

1Department of Material Science & Engineering, University of North Texas, 1155 Union circle
#310440 Denton Texas 76203
2Department of Mechanical Engineering, University of California at Merced, 5200 N.Lake Rd
Merced, CA 95343

Email: Diana.Berman@unt.edu

Recent advances in two-dimensional (2D) materials synthesis and characterization lead to continuous efforts on their incorporation into flexible electronics devices and photonic devices [1]. Graphene, as a model material for the atomically thin contacts, poses the most of the interest. In this case, basic understanding of the evolution of the atomic scale contact is important for analyzing graphene’s performance both from tribological and electrical performance prospective [2]. Here, we combine experimental and theoretical approaches for precise investigation of how substrate material affects the contact dynamics in 2D films, and dependence of single and multi asperities of contact of metals. Using a conductive Atomic Force Microscopy (C-AFM) technique for graphene as free-standing, on soft, and on hard substrates, we analyze the changes in the electrical current flow between graphene and a metal tip. Our results demonstrate high dependence of the contact resistance on the nature of graphene support, highlighting importance of the substrate materials for establishing stable and highly conductive contacts. We investigated the role of the number of atomic scale contacts asperities on establishing a stable electrical contact when affected by Joule’s heating and mechanical deformation events.

References:


An investigation of self-healing processes in niobium-based oxides

J.J. Gu, S.M. Aouadi

Department of Materials Science and Engineering, University of North Texas, Denton, TX 76207, USA

Email: JingjingGu@my.unt.edu

Precipitation-induced stimulated-healing of Nb$_2$O$_5$ was carried out through the extrinsic addition of silver oxide nanoscale elemental inclusions to form ternary oxides at the crack site. Nb$_2$O$_5$ cylindrical pellets, 13 mm in diameter and 10 mm in length, were produced from powders using a cold isostatic press. The pellets were subsequently sintered at 1,100 °C. A scratch was created in the sintered Nb$_2$O$_5$ pellets and was subsequently filled with Ag$_2$O. The pellets were annealed to stimulate the self-healing process. X-ray diffraction was used to explore the evolution of phases, chemical compositions, and structural properties of the sintered samples before and after the stimulated-healing process. Energy dispersive X-ray spectroscopy revealed the elemental composition in the healed region. The on-site composition of the healed sample was determined by Raman spectroscopy and was compared to the spectrum outside of the scratch. Raman spectroscopy confirmed that precipitation proceeded via the following chemical reaction which was facilitated at elevated temperature: Nb$_2$O$_5$ + Ag$_2$O $\rightarrow$ 2AgNbO$_3$. In addition, a 3D reconstructed stylus profilometry image of the crack region confirmed that healing occurred. Healing by recovering 89% of the original material strength was confirmed using the three-point bend test.

References:

Rational design of semiconductor heterostructures for energy conversion

Junsang Cho and Sarbajit Banerjee
Texas A&M University Commerce, Commerce, TX 75428

Email: junsang.cho@chem.tamu.edu

Lead halide perovskites have rapidly emerged as promising next-generation candidates for photovoltaics, light-emitting displays, and other optoelectronic applications owing to their desirable electronic and optical properties such as tunable exciton binding energies, high absorption cross-sections, long carrier diffusion lengths, and near unitary photoluminescence quantum yields. Dimensional control provides a means to tune the optical, electronic, and magnetic properties of semiconducting materials as a result of quantum confinement effects. Ligand-mediated colloidal synthesis methods allow for control over nucleation/growth kinetics and enable precise modulation of nanocrystal dimensions through variation of reaction parameters such as the precursor concentration, reaction temperature, and the electronic and steric parameters of passivating ligands. I will focus on synthetic efforts at establishing dimensional control of semiconductor nanostructures with a particular emphasis on the ligand-mediated synthesis of two-dimensional (2D) lead halide perovskite nanocrystals guided by elucidation of crystal growth mechanisms. I will further discuss the design of semiconductor heterostructures for photocatalytic water oxidation that couple multiple polymorphs of vanadium oxide (V$_2$O$_5$) nanowires with semiconductor nanocrystals. The alkyl chain length, branching, ligand concentration, and temperature greatly influence the dimensional modulation of 2D perovskite nanoplatelets (MAPbBr$_3$ and CsPbBr$_3$). Our recent work demonstrates that the crystalline order of the ligand-shell assembly, as dictated by the length of the alkyl chains, the degree of branching, the reaction temperature, and ligand concentration, strongly influences the extent of dimensional confinement attainable for the perovskite nanoplatelets. The denticity, steric bulk, and concentration of the added alkylamine ligands further provide a means of modulating structural dimensionality from 3D CsPbBr$_3$ to 0D Cs$_4$PbBr$_6$ structures. Machine learning approaches for navigating synthetic landscapes have further been developed and provide control over layer thickness down to a single layer.

The rational design and interfacing of semiconductor heterostructures comprising light harvesting (charge donor) and wide-bandgap semiconductor (charge acceptor) elements is imperative for solar energy conversion within PEC cells wherein incident solar radiation is converted and stored as a chemical fuel. Such heterostructures need to be carefully designed to efficiently harvest a large portion of the incident solar radiation, which requires precise control of energetic offsets (governing the thermodynamic driving forces for charge separation) and the kinetics of charge transfer (determined in large measure by interfacial properties). I will discuss the design of V$_2$O$_5$/quantum-dot heterostructures that simultaneously optimize thermodynamics and kinetics. The ability to tune the V—O connectivity across multiple polymorphs of V$_2$O$_5$, and the specific composition of QDs allows for a broad palette of heterostructures to be systematically developed. This work was supported by the NSF under DMREF 1627197.
Size Effects in Light Emitting Perovskite Nanostructures Templated by Porous Silicon Nanotubes and Particles

Roberto Gonzalez-Rodriguez, Viviana Costa, and Jeffery L. Coffer

Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX 76129
E-mail: j.coffer@tcu.edu

Significant fundamental and application-relevant properties of organoammonium and cesium lead halide perovskite phases (ABX$_3$) continue to be reported at an impressive pace, notably in the areas of photovoltaics (PV) [1] and optoelectronics [2]. Issues regarding long term stability and control of crystallite size and phase remain a pragmatic concern, however. In principle such concerns can be addressed with the use of appropriate synthetic templates, e.g. a reaction vessel for the controlled formation of these perovskites. Silicon (Si) in nanotube (SiNT) or nanoporous particle (pSi) forms are among the most promising templates because: (a) unlike insulating porous metal oxides, they have a tunable semiconducting character (and associated band level energetics with doping), a sensitive control of template dimensions (tunable inner diameter, shell thickness, and length), and ultimately in terms of processing, a compatibility with current PV technology.

In this approach, we explore the formation of methylammonium lead iodide nanostructures inside porous SiNTs with a wall thickness of 10 nm and possessing inner diameters of 30, 70, or 200 nm. After structural characterization, the optical absorption and photoluminescence of these perovskite nanostructures as a function of temperature are evaluated, and compared to larger one-dimensional microwires of the same composition [3]. We interrogate not only the presence of size dependent shifts in absorption/emission features associated with a given perovskite structure, but also the effects of physical confinement on possible size-dependent phase behavior of these nanoscale semiconductors [4]. Similar experiments are also underway involving mesoporous (5-50 nm) porous Si particles as templates, derived from the anodic etching of crystalline Si.

With regard to bandgap tunability of these perovskites, we have also investigated the formation of CH$_3$NH$_3$PbI$_{3-x}$Br$_x$ nanostructures ($x = 0$, 0.25, 0.50, 0.75, and 3) using SiNTs as a template. To facilitate formation, we selected SiNTs with a wall thickness of 10 nm, an average length ~2 µm, and varying inner diameter of 30 nm, 70 nm, and 200 nm. In these experiments, for a given composition, we contrast the structure and photoluminescence (PL) properties of perovskites formed inside SiNTs with those of bulk-like CH$_3$NH$_3$PbI$_{3-x}$Br$_x$ microstructures.

In this presentation, results from both of the above areas will be described.

References:
Pyridophane based macrocycles for treatment of oxidative stress in neurodegenerative disorders.

Hannah Johnston¹, Maddie Barnett¹, Giri Akkaraju¹ and Kayla N. Green¹

¹Department of Chemistry and Biochemistry, Texas Christian University, 2950 S. Bowie, Fort Worth, TX, 76129

Email: kayla.green@tcu.edu

N-heterocyclic amines have served as ligand scaffolds for bioinorganic model compounds, imaging agents and catalysts. The function of a ligand in this family can be modified by changing the ring size, denticity, and donor atoms. The Green Research Group has applied this knowledge to produce a new group of pyridol based macrocycles incorporating a pyridol moiety into a 12-membered tetra-aza macrocyclic ring. Incorporation of the pyridol moiety adds radical scavenging reactivity and the opportunity to tune the electronic character of the ligand set. We have shown that these new ligands bind a range of transition metal ions (Mn(III/IV), Fe(III), Co(III), Ni(II), Cu(II), and Zn(II)) producing a range of geometries and coordination environments. Catalytic C-C coupling activity has been observed with Fe(III) derivatives and the ability for the ligand to control reactivity has allowed for investigations into the mechanistic pathways of the reaction. In a separate study, the ligands alone have been shown to mitigate the formation of toxic amyloid aggregates and reactive oxygen species related to the Alzheimer’s disease (AD). Both in vitro and in vivo results indicate that ligand L2, specifically, has the ability to cross the blood brain barrier and decrease the molecular features associated with AD. This presentation will focus on the inorganic coordination chemistry of pyridol containing 12-membered tetra-aza N-heterocyclic amines compared to similar, classic ligands as well as their applications in catalysis and medicinal chemistry.
Graphene oxide and iron oxide nanocomposite with pH-sensing and MRI / fluorescence imaging capabilities

R. Gonzalez-Rodriguez, 1 E. Sizemore, 1 A. Naumov 1

1Department of Physics & Astronomy, Texas Christian University, Fort Worth, USA.

Email: r.gonzalezrodriguez@tcu.edu

Graphene Oxide (GO) have attracted attention a biomaterial and tissue engineering due to physical and chemical properties, 1 superparamagnetic iron oxide nanoparticles (Fe3O4 NPs) have been used as biosensing, magnetic assisted drug delivery system and magnetic resonance contrast agent in MRI, Fe3O4 NPs are biocompatible. 2 The combination of these two materials we can have a fluorescence and magnetic nanocomposite for biological applications such as imaging and magnetic targeted drug delivery.

In this work, we describe the nanocomposite fabrication of GO-Fe3O4. GO have an average diameter of 260 nm were fabrication by functionalization of 5 nm Fe3O4 NPs with APTES then a coupling reaction with GO using EDC/NHS.

For the specific application of magnetic resonance imaging, the quality of an MRI contrast agent is often evaluated by the relaxivity parameters r1 or r2, which describe the ability of a contrast agent to shorten the T1 or T2 relaxation time of water. GO-Fe3O4 can be used as contrast agent in magnetic resonance imaging (MRI), for this purpose relaxivities values were measured, longitudinal r1 and transvers r2 in water at 37°C, we obtained r1=6.6 mM-1s-1 and r2=71.1 mM-1s-1, these values are better than single Fe3O4 NPs system, the samples showed relaxivity ratio r2/r1>2, placing them in the category of negative contrast agent.

In order to apply this new composite as a biomaterial, MTT assay was used to test cytotoxicity in HeLa cells, results show very low toxicity even at high concentrations of GO-Fe3O4. This material can be used as sensing material due pH changes in the environment. Cellular uptake studies were made these studies were analyzed by fluorescence microscopy and anti-cancer drugs were tested.

This new composite can be used as magnetic targeted drug delivery system, as well as bimodal imaging modalities, magnetic resonance imaging and fluorescence imaging in in vitro or in vivo.

References:

Targeted Drug Delivery via reconstituted High Density Lipoprotein Nanoparticles for Cancer Therapy

Sangram Raut, Nirupama Sabnis, Marlyn Panchoo, Ruhani Ahluwalia, and Andras Lacko

1Department of Physiology/Anatomy, UNT Health Science Center, Fort Worth, TX, 76107

Email: sangram.raut@unthsc.edu

Traditional chemotherapy is limited by long and short term side effects due to off target delivery of the anti-cancer agent employed. In fact, in many cases the side effects are worse than the disease itself. Lipoprotein-based technologies could address the above concerns via their ability to selectively deliver their payload to cancer cells and tumors via a receptor mediated mechanism [1,2,3]. Specifically, it has been shown that malignant cells consistently overexpress the scavenger receptor class B type 1 (SR-B1) receptors, compared to normal cells [1]. The therapeutic index of a drug can thus be significantly improved by enhancing the selective delivery and accumulation of the therapeutic agent in malignant cells and tumors vs. healthy cells and tissues, thus avoiding toxic side effects [4,5]. Lipoprotein-based nanoparticles have the potential to perform tumor selective delivery and thus function as a superior biocompatible drug-delivery platform with great potential for cancer theranostics [6].

References:


Anton V. Naumov, Md. Tanvir Hasan, Elizabeth Sizemore, Roberto Gonzalez Rodriguez, Giridhar Akkaraju

Email: a.naumov@tcu.edu

Carbon nanomaterials including single-walled carbon nanotubes (SWCNTs) serve as a basis of multiple molecular imaging and biological sensing device applications. However, those applications are still mainly centered on a single analyte sensing or the delivery of one particular therapeutic. Structure-dependent band gap configuration of SWCNTs was shown provides a promise of multiwavelength imaging in near-infrared or visible spectral regions. We utilize these structural characteristics of SWCNTs to provide multidrug delivery and multicolor imaging for complex medical conditions requiring combination therapies such as nonalcoholic steatohepatitis (NASH). It is so far, a non-curable condition present in 6-8% of adults in the US. The progression of NASH is mediated mainly via fibrosis and inflammation interlinked through the production of cytokines. The treatment of this complex condition requires targeting of several factors at once. We utilize (6,5) and (7,5) SWCNT samples chirality-separated by aqueous two-phase extraction for the delivery and drug-specific in-vitro imaging of drug and gene therapeutics targeting inflammation and fibrosis. These active agents, each bound non-covalently to SWCNT sample enriched in a specific chirality and purified from the sorting surfactants, are delivered to HepG2 cells and imaged via characteristic SWCNT emission in the near-IR. Hyperspectral microscopy imaging at select wavelengths corresponding to resonant transitions of (6,5) and (7,5) SWCNTs allows to preferentially track the presence of SWCNTs bound to each specific therapeutic. Furthermore, therapeutic effects of each formulation are assessed separately via protein and cytotoxicity assays allowing to utilize remarkable properties of SWCNTs for multimodal imaging and multidrug/gene delivery for NASH therapeutics.
August 1st, 2018
Posters
Electroless Deposition of Copper on Self-Assembled Monolayers
Monitored Using QCM-D

Tania Estrada¹, and Amy V. Walker¹,²

¹ Department of Chemistry and Biochemistry, University of Texas at Dallas, 800 W Campbell Rd, Richardson, TX, 75080
² Department of Materials Science and Engineering, University of Texas at Dallas, 800 W Campbell Rd, Richardson, TX, 75080

Email: Tania.Estrada@utdallas.edu

Electroless deposition (ELD) has many applications in electronics, healthcare, and energy storage. However, ELD is sensitive to bath conditions including temperature, pH, and reagent concentrations. In this poster we investigate the little explored effect of flow conditions on Cu ELD using quartz crystal microbalance with dissipation (QCM-D). We employ, as model organic substrates, -CH₃, -OH and -COOH terminated alkanethiolate self-assembled monolayers (SAMs) on gold. In QCM-D the change in frequency of a quartz crystal is used to monitor the deposited film mass. In addition, surface interactions such as swelling, phase changes, viscoelasticity, and surface adsorption can be further explored using dissipation monitoring. Preliminary results suggest that the impact of flow rate is different for each terminal group as well as for bare gold surfaces. Rates between 10µl/min to 90µl/min have been observed in increments of 10µl/min. Initial data on -COOH indicates that flow influences the uniformity and amount of surface coverage. The largest, most uniform coverage is seen at 50µl/min. At the highest flow rates studied, uniformity is lost while maintaining wide surface coverage. The lowest flow rates studied display low quantities of uneven Cu films.
Fabrication of a Micro Secondary Electron Detection System

Zhengyang Wang¹, M. Goeckner¹ and L. Overzet¹

¹Department of Electrical & Computer Engineering, the University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080

Email: zxw130130@utdallas.edu

The poster is about the fabrication of a micro-scale secondary electron detection system that should have the capability of imposing a variable surface electric field [1]. To our knowledge, no experiments have been done to measure the ion induced secondary electron emission (IIEE) yield as a function of the surface electric fields. This is a critical factor in the operation of microplasmas since strong electric fields are present on all surfaces due to the plasma sheath.

In our design, an electric field of at least 1V/µm will be applied on an atomic clean Si surface to simulate the E-field in a plasma sheath. Then low energy ions are directed onto the Si surface and produce IIEE. A collector layer is used to collect the secondary electron current (Fig.1). The secondary electron current is at the pA level, and requires the leakage current between the collector and Si substrate to be less than or equal to a few pAs. This is the main challenge of the fabrication. We have made several tests to find the right materials and gathered experience in reducing the leakage current. We believe we are on the verge of a working device now.

![Fig.1](image-url)

References:

Drug delivery and degradation behavior of nanostructured porous silicon-polycaprolactone composites

Nelli K. Bodiford¹, Steven J.P. McInnes², Nicolas H. Voelcker³, and Jeffery L. Coffer¹

¹Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX 76129
²University of South Australia, GPO Box 2471 South Australia 5001, Australia
³Monash Institute of Pharmaceutical Sciences, Monash University, Australia

*Corresponding author e-mail address: j.coffer@tcu.edu

The combination of porous silicon (pSi) and flexible biocompatible polymers has been shown to yield more beneficial hybrid scaffolds for tissue engineering, with a concomitant ability of the material to release a useful therapeutic moiety. PSi has a variety of tunable properties, including pore size, pore volume and non-toxic degradation.¹ Adding a flexible polymer component such as polycaprolactone (PCL) can not only provide easy molding into various shapes and forms, but also opportunities for designing two-stage drug delivery vehicles.

In this work, novel designs of pSi-PCL thin films and pSi-porous PCL fibers composites are presented. A thin PCL film base provides a very secure anchoring of pSi particles without completely encapsulating them, whereas porous PCL fibers partially cover pSi. These composite materials were evaluated as a drug delivery system using the cytotoxic topoisomerase inhibitor camptothecin (CPT).²

In addition, the degradation behavior of the composites in vitro is examined as a function of PCL morphology and in the presence of pSi by means of gravimetry, field emission scanning microscopy (FESEM), and thermal analysis-differential scanning calorimetry (DSC). Specifically, the evolution of the polymer component during the solution exposure is evaluated with a focus on changes in crystalline and amorphous domains as well as any morphological changes.

References:

Thermal Pathways of Hybrid Oxo-Cluster EUV Resists with \textit{in situ} IR Spectroscopy

Y. Cabrera$^1$, E.C. Mattson$^1$, Y. Wang$^1$, K. Oyekan$^1$, and Y.J. Chabal$^1$

$^1$Department of Material Science and Engineering, University of Texas at Dallas, 800 W Campbell Rd, RL 10, Richardson, TX

Email: yasiel.cabrera@utdallas.edu

The role of thermal reactivity in organic-inorganic hybrid resist materials is characterized using infrared (IR) spectroscopy. The material presented is comprised of a small HfOx core, surrounded by methacrylic acid ligands (HfMAA) and have proven to be a promising material for newly emerging advances in extreme ultraviolet (EUV) photolithography. Both IR of the crystals and spin-coated films suggest a significant amount of extrinsic hydroxyl groups, not previously reported in the calculated x-ray crystal structure of HfMAA-12 clusters. We find by adding excess ligands to the HfMAA solution, we can better control the amount of extrinsic water molecules observed in our films. To understand the role of hydroxyls on the film, post-application bake (PAB) is studied. Upon heating we find a condensation reaction pathway between hydroxyl groups on which new bridging Hf-O bonds are formed with adjacent clusters decreasing the solubility sensitivity of the film.
Graphene Quantum Dots as Imaging, Sensing, and Delivery Agents

Elizabeth Sizemore¹, Md. Tanvir Hasan¹, Roberto Gonzalez¹ and A. Naumov¹

¹Department of Physics and Astronomy, Texas Christian University, TCU Sid Richardson Building TCU Box 298840, Fort Worth, TX, 76129

Email: e.sizemore@tcu.edu

Graphene quantum dots (GQDs) are novel materials with a number of unique properties that can be applied in electronics, sensing and biotechnology. GQDs possess physical properties that are critical for biomedical applications, including small size (3-5 nm), high quantum yield, and pH-dependent fluorescence emission in the visible/near-infrared, providing a possibility of molecular imaging and pH-sensing. They show very low cytotoxicity suggesting high potential for multiple biomedical applications. GQDs can also be doped to form nitrogen based quantum dots (NQDs), sulfur based quantum dots (SQDs) and boron nitrate quantum dots (BNQDs), which allow these optical properties to be adjusted. We utilize and modify these properties to yield a multifunctional delivery/imaging/sensing platform geared toward the analysis of cancer therapeutics delivery in vitro. In our work, we outline how GQDs can serve as potential drug transport agents and as molecular markers for imaging the delivery pathways. Optimal emission and excitation are selected for each quantum dot to minimize the autofluorescence of cells, allowing them to be imaged in-vitro. Emission in healthy (HEK-293) and cancer (HeLa) cells is quantified for a variety of pH environments to identify the ideal conditions for cellular internalization and pH-sensing of acidic cancerous environments. In addition, in-vitro fluorescence microscopy analysis provide quantitative assessment of the drug delivery and accumulation in cells. The results of this work suggest GQDs as innovative and effective multifunctional platforms for cancer therapeutics.
Tunable Self-Healing Thermal Barrier Coatings

J.J. Gu, S.S. Joshi, Y.-S. Ho, B.W. Wei, T.Y. Hung, Y.Y. Liu, N.B Dahotre, S.M. Aouadi

Department of Materials Science and Engineering, University of North Texas, Denton, TX 76207, USA

Email: TingyuHuang@my.unt.edu

Oxide ceramics exhibit a wide spectrum of unique properties, but can suffer from unpredictable and often catastrophic crack propagation and fracture, which limits their use in some applications. One possible solution to overcoming this limitation is to leverage the ability of oxides to repair their inherent flaws and cracks, i.e. to self-heal. The aim of the work is to gain new insights into self-healing mechanisms of a subset of ceramic surfaces, namely thermal barrier coatings, in response to thermal stimuli. TBCs are extensively used to protect metallic blades in gas-turbine engines against harsh operating conditions that include elevated temperatures and corrosive environments. Model systems that were investigated include YSZ-Al₂O₃-SiC and YSZ-Al₂O₃-TiC laser processed coatings. The healing process occurs when the carbide phase oxidizes and the resulting oxide flows to the crack site and bonds to the YSZ matrix. The formation of the oxide phase was observed using X-Ray diffraction its formation in the crack site was confirmed using cross-section scanning electron microscopy. The optimum process to create a self-healing composite was determined. Finally, the mechanisms responsible for how the self-healing process impacts deformation and failure resistance as well as corrosion resistance at elevated temperatures was investigated.

References:

Towards Optimization of Copper Nanowire Transfer and Crossbar Synthesis

J.S. Vienes¹ and A.V. Walker¹,²

¹Department of Chemistry and Biochemistry, The University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080

²Department of Material Science and Engineering, The University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080

Email: Jevalyne.Vienes@utdallas.edu

Nanowires and crossbar nanowire structures have applications in electronics as interconnects and in memory and logic applications. Recently the Walker group has demonstrated a new method by which to in situ synthesize and precisely place nano-objects – electroless nanowire deposition on micropatterned substrates (ENDOM). In ENDOM nano-objects, such as nanowires, are formed at the junction of two dissimilar materials using electroless deposition. Here we report on progress towards the transfer of copper nanowires (CuNWs) to other substrates to fabricate electronic devices. We demonstrate that deposited CuNWs can be transferred to insulating substrates using heat transfer tape (HTT). The transfer process is controlled by the concentration of triethanolamine, an additive in the electroless deposition bath, and by optimizing the applied pressure during the liftoff and re-deposition processes. We show that complex structures, such as a crossbar, can also be formed. Crossbar structures are formed using repeated application of the ENDOM process which is a much faster and easier method than current technologies used to form crossbar architectures.
Silicon Nanotubes as A Platform for Platinum Nanocrystal Deposition

N. T. Le¹, J. L. Coffer¹

¹Department of Chemistry and Biochemistry, Texas Christian University, Fort Worth, TX, 76129, USA.

Email:nguyen.t.le@tcu.edu

Porous silicon (pSi) is a unique nanostructured form of the elemental semiconductor Si. Due to its useful properties governed by its surface chemistry and porous morphology, pSi has been studied in the last few decades in diverse fields extending from electronic device technology to bio-relevant applications.¹ Recently, one-dimensional porous nanotubes based on elemental Si (pSiNTs) with a tunable structure (sidewalls, inner void space and lengths) have been successfully synthesized.² The well-defined structure of pSiNTs offers ample opportunities to study newly emerging properties of this material and innovative applications in multiple areas. For example, recent reports have revealed the use of SiNTs as an efficient template for loading superparamagnetic nanoparticles (Fe₃O₄), lithium storage and cycling, as well as acting as a template for formation of organometal perovskite nanostructures.³⁵

Platinum (Pt) nanoparticles, both free-standing as well as anchored on various surfaces, have attracted widespread attention in nanocatalysis, electronics, and chemotherapeutics.⁶ In this work, it is suggested that pSiNTs after being functionalized with 3-(aminopropyl)trimethoxysilane (APTES) can serve as a platform for Pt nanocrystal (Pt NC) formation. Particularly, incubation of APTES-functionalized SiNTs in potassium tetrachloroplatinate (II) (K₂PtCl₄) solution under ambient conditions subsequently yields Pt nanoclusters with sizes ranging from 1-3 nm on SiNTs. From high-resolution transmission electron microscopy (HRTEM), nanocrystals with characteristic lattice spacings associated with Pt (d = 0.21 nm) are observed on the nanotubes. The amount of Pt deposited on SiNTs can be sensitively tuned from 20-60 wt% (characterized by TEM Energy Dispersive X-ray Analysis, EDX) by varying concentration of K₂PtCl₄ and immersion time in this Pt salt precursor.

These findings suggest a new approach to prepare Pt NCs that are of potential benefit to a broad number of applications by using pSiNTs as a template. Further investigations into the properties of the newly discovered Pt NCs-SiNT composites are imperative to evaluate useful applications of this material.

References
Self-healing properties of Nb-Ag-O coating

Asghar Shirani1, Jingjing Gu1, Samir Aouadi1, Diana Berman1

1Department of Materials Science Engineering, University of North Texas, TX, 1155 Union Circle, Denton, 76203

Email: Diana.Berman@unt.edu

Self-healing coatings have ability to form a second phase to heal the scratches or cracks at the surface of ceramic materials. In this study a multi-layer coating of Nb2O5-Ag was deposited with the sputtering technique. The produced ceramic coatings were tested in tribological tests at elevated temperature around 650 °C. Reaction of oxides always requires high amount of energy and extremely high temperature. The idea of using tribometer was selected to provide thermo-mechanical conditions to facilitate ternary oxide formation at much lower temperatures when applied load and sliding-induced heating provide favorable conditions for the self-healing reaction to proceed. After tribology test at of 200 MPa contact load and 650 °C, the wear track was analyzed by EDS and Raman spectroscopy to trace formation of Nb-Ag-O ternary oxide. The EDS mapping clearly shows the reaction of Ag with Nb2O5 coating. Also, the Raman analysis confirms the reaction of Nb2O5 and Ag to form ternary oxide.

References:
Heteroatoms-doped Graphene Quantum Dots Synthesized via Bottom-up Approach for Multi-color Bioimaging Applications

Md. Tanvir Hasan¹, Roberto Gonzalez-Rodriguez¹, Elizabeth Sizemore¹, Giridhar Akkaraju² and Anton V. Naumov¹

¹Department of Physics and Astronomy, Texas Christian University, TCU Sid Richardson Building, Fort Worth, TX, 76129

²Department of Biology, Texas Christian University, Winton Scott Building, 2955 South University Drive, Fort Worth, TX, 76129

Email: tanvir.hasan@tcu.edu

Since a number of medical conditions require simultaneous treatment and diagnostics, the field of molecular therapeutics has recently turned to multifunctional approaches allowing for both therapy and biomedical imaging. A number of such molecular and nanoformulations are combined with fluorophores that allow for imaging of the delivery pathways of the drug in the visible. This is optimal for in-vitro or ex-vivo work, however, cannot be utilized well in-vivo. Thus, there is a need in nanoformulations optimized for both in-vitro and in-vivo studies. Graphene quantum dots, possessing intrinsic stable fluorescence in the visible and near-IR stand out as candidates for such complex application.

In this work, we for the first time produce biocompatible graphene quantum dots (GQDs) synthesized via bottom-up approach that exhibit multi-color emission both in visible and NIR possess a capability for biological pH sensing. These GQDs show the crystalline graphitic structure in TEM and average sizes of c.a. 5 nm beneficial for cellular internalization. They show no cytotoxicity even at high doses of 1 mg/mL that are used for imaging. As opposed to related structures such as graphene oxide and other graphene derivatives GQDs show high quantum yield in green (~500 nm) of ~50%. Near-IR emission at ~860 nm is located in the water window with reduced absorption and lower autofluorescence backgrounds providing a promising potential route for in-vivo studies. Emission of GQDs also depends on pH of the surrounding medium. The change in pH of as-prepared GQDs from 2.70 to 8.0 yields an increase of fluorescence intensity up to ~60%. Additionally, pH dependent shifts of the spectral features allow differentiating between acidic cancerous and neutral healthy exocellular environments allowing to use GQDs for cancer detection. Therefore, our results indicate that GQDs have a significant potential in bio-applications because of their capacity for multi-color green/near-IR imaging for in-vitro/in-vivo studies, pH sensitivity, water solubility, low cytotoxicity and high capacity for cellular internalization.
PrMn$_2$O$_5$ Mullite-type Oxide as a Superior Catalyst over SmMn$_2$O$_5$ for Low-Temperature NO Oxidation

S. Thampy$^1$, N. Ashburn$^1$, S. Dillon$^1$, Y. Zheng$^1$, C. Liu$^2$, K. Xiong$^2$, Y. Chabal$^1$, K. Cho$^1$, and J. W. P. Hsu$^1$

$^1$Department of Materials Science & Engineering, University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080

$^2$Dongguan Innovative New Materials Co. Ltd, Incubation Park for SciTech SMEs, Songshan Lake, Dongguan, Guangdong China 523808

Email: sxt120130@utdallas.edu

Catalytic oxidation of NO to NO$_2$ is critical to mitigate NO$_x$ and particulate matter from diesel exhaust, a reaction that currently uses expensive platinum (Pt) catalysts. A novel catalyst based on SmMn$_2$O$_5$ mullite is shown to exhibit higher NO activity than Pt and perovskite [1,2]. Here we compare PrMn$_2$O$_5$ and SmMn$_2$O$_5$ to investigate the superior catalytic performance of PrMn$_2$O$_5$ for low temperature NO oxidation. The catalysts are synthesized by hydrothermal method. The crystalline phase, surface area, and composition are determined using X-ray diffraction, N$_2$ physisorption, and X-ray photoelectron spectroscopy, respectively. The O$_2$ Temperature-programmed desorption (TPD), in-situ Fourier-transform infrared spectroscopy, and NO TPD studies show that lattice oxygen desorption and nitrate dissociation on PrMn$_2$O$_5$ is easier compared to SmMn$_2$O$_5$. Consequently, PrMn$_2$O$_5$ shows 50% conversion at low temperature (230 °C vs. 275 °C) with a higher maximum conversion efficiency compared to SmMn$_2$O$_5$ (81 % at 282 °C vs. 68% at 314 °C). Density functional theory calculations are employed to explain the difference observed experimentally and to elucidate the NO oxidation reaction pathway. The insight gained through this study should pave way to design better NO oxidation catalysts based on Earth-abundant materials.

References:


Rapid Synthesis of Nanoporous Conformal Coatings via Plasma-Enhanced Sequential Infiltration of a Polymer Template

Yunlong She¹, Jihyung Lee¹, Benjamin Diroll², Byeongdu Lee³, Elena Shevchenko²,*, Diana Berman¹,*

¹Materials Science and Engineering Department, University of North Texas, Denton, TX, 76203
²Center for Nanoscale Materials, Argonne National Laboratory, Argonne, IL, 60439
³Advanced Photon Source, Argonne National Laboratory, Argonne, IL, 60439

Email: YunlongShe@my.unt.edu, Diana.Berman@unt.edu

Nanoporous conformal coating plays an important role in electrocatalysis, water purification, antireflective coatings, etc. Common synthesis methods of porous films often require harsh conditions (high temperature and high plasma power) or specific substrate materials [1-2]. Here, we report a plasma-enhanced sequential infiltration synthesis (PE SIS) as a new platform toward deposition of nanoporous inorganic films [3]. PE SIS is conducted under gentle conditions, and can be applied to a broad range of substrates, including water-sensitive surfaces which most common synthesis methods cannot. PE SIS is based on oxygen-plasma-induced rapid conversion of metal precursors selectively adsorbed in a block-copolymer template. Porosity and thickness of resulting materials can be easily controlled by characteristics of the template. PE SIS offers adventurous rapid infiltration with improved ability to, full infiltration of the polar domain of the polymer template can be achieved upon initial exposure to TMA, followed by its oxygen-plasma-induced conversion into a functional material. We show that up to 5 μm highly interconnected porous alumina films can be achieved by PE SIS. PE SIS opens a new approach for synthesis of highly porous materials with various elemental compositions and stoichiometries with different types of plasma (such as oxygen, nitrogen, hydrogen, etc.) induce conversion of different metal precursors.

References:

Photophysical characterization of oligopeptide linked FRET system in PVA matrix and buffer to detect levels of MMP-9.

S. Shah\textsuperscript{1}, W. Mandecki\textsuperscript{2}, J. Li\textsuperscript{2}, Z. Gryczynski\textsuperscript{3}, J. Borejdo\textsuperscript{1}, I. Gryczynski\textsuperscript{1}, and R. Fudala\textsuperscript{1}

1: Department of Microbiology, Immunology and Genetics, Center for Fluorescence Technologies and Nanomedicine, University of North Texas Health Science Center, Fort Worth, Texas 76107

2: PharmaSeq, Inc., 11 Deer Park Dr., Suite 104, Monmouth Junction, New Jersey 08852

3: Department of Physics and Astronomy, Texas Christian University, Fort Worth, Texas 76129

Email: Rafal.Fudala@unthsc.edu

Matrix metalloproteinases (MMP’s) are a group of zinc dependent peptidases which can be classified based on their structural differences. So far, over 26 MMP’s have been identified. Out of these, MMP-9 is of particular interest in many biomedical applications. MMP-9, also known as gelatinase B, plays an important role in degrading the basement membrane of the extracellular matrix (ECM). Levels of MMP-9 have been found to be up-regulated in several types of cancer, including breast, bladder, colon, ovarian etc. and are generally associated with poor prognosis. Thus, there is a need to develop applications for detecting MMP-9 enzyme levels. This would result in rapid, non-invasive detection, and possibly early treatment for several cancers. We can use Forster resonance energy transfer (FRET) to come up with a custom peptide that is cleaved by MMP-9 enzyme, leading to easy detection and diagnosis. FRET is a well-known phenomenon being used today in studying molecular interactions. Briefly; FRET is the energy transfer between two fluorophores when they are within 1-10nms of each other. The fluorophore with emission at the shorter wavelength acts as the donor, and instead of emitting florescence, transfers its energy to an acceptor molecule, whose emission is generally at a longer wavelength. It is a very sensitive technique which can be used as a precise measurement and detection tool. We were able to successfully demonstrate FRET with a custom peptide whose partial sequence was recognized and selectively cleaved by MMP-9 enzyme. The probe uses 5,6 TAMRA and HiLyte 647 as a donor and acceptor respectively. The target peptide sequence is Lys-Gly-Pro-Arg-Ser-Leu-Ser-Gly-Lys-NH\textsubscript{2}. The probe and donor control were dissolved in 10\% (w/w) poly-vinyl alcohol, and dried on glass slides. This produced films 200 microns in thickness. Absorption spectra and other steady state measurements indicate successful energy transfer between donor and acceptor fluorophores. Furthermore, the probe was dissolved in buffer and upon addition of MMP-9 enzyme, showed a gradual decrease in energy transfer over time. These measurements were done by using a 1cmx1cm quartz cuvette and a square geometry set-up with 470nm as the excitation wavelength. This showed that the peptide is functional, being recognized and cleaved by MMP-9 enzyme.

Acknowledgements: This work was supported by an NIH SBIR grant, 1R43CA193087-01 (W.M, R.F), and an NSF grant, CBET-1264608 (I.G).
August 2\textsuperscript{nd}, 2018
Abstracts
Resilient High Temperature UHV Sealing

J. Young

1 Sr. Business Development Specialist, Technetics Group, Columbia, SC 29209 USA
Email: Jacob.Young@technetics.com

Ultra-High Vacuum applications typically require all metal sealing due to outgassing and permeation concerns. Many of these systems are baked at a high temperature in order to reach the lowest base pressure and required cleanliness levels. However, high temperature bake outs can be problematic for traditional metals seals due to thermal expansion and the occasional need to have a shaped or non-circular configuration. Other critical sealing applications such as etching or thin film deposition also require a metal seal that has low outgassing and permeability – but must also be compatible with the process gasses or plasma.

This presentation will discuss a unique type of metal seal that utilizes a helical wound spring with layered metal jackets to address these issues. Presentation topics will include the metal-to-metal sealing concept along with design factors such as seating load, seal function, seal material selection, leak rate, and required seating load, groove configuration and finish.
Temporally Resolved Optical Emission Spectroscopy for Studies of Level-to-Level Discharges.

University of Texas at Dallas, Richardson, TX USA

Phase Resolved Optical Emission Spectroscopy (PROES) is a powerful tool for the study of radio frequency (rf) discharges. In continuous wave discharges, one needs to accurately trigger against the rf cycle so as to measure the temporal variation of the emission intensity. With modern high-speed cameras, this can result in excellent time resolution within the rf cycle. Such studies become more difficult in level-to-level discharges. This is because the trigger needs to be in reference to both the rf cycle and the level-to-level transitions. In this paper we will examine some of the experimental techniques that need to be employed in order to attain temporally resolved PROES (TR-PROES) in our m-GEC system. We show that the excitation function derived from TR-PROES for the Ar 750.4 nm line is approximately a single pulse (~10 ns) within the 80 ns rf cycle (12.5 MHz). Initial results indicate that essentially only the strength of this excitation function increases during the plasma transition from low to high power.

This work is supported by the National Science Foundation under Grant No. NSF IIP1338917. In addition, support from the industrial partners to the I/UCRC for Laser and Plasma Advanced Manufacturing, specifically Applied Materials and Lam Research.
Multilayer nanostructures for highly-sensitive surface plasmon resonance sensors

H. Akafzade¹, S. C. Sharma¹, * and N. Hozhabri²

¹Department of Physics, University of Texas at Arlington, Arlington, TX, 76019
²Schimadzu Institute: Nanotechnology Research Center, University of Texas at Arlington, Arlington, TX, 76019
E-mail: sharma@uta.edu

This presentation provides an overview of the research being carried out by our group on the design and fabrication of surface plasmon resonance (SPR) sensors [1,5]. Among the nanostructures investigated recently are waveguide-coupled Ag/Si3N4/Au, Ag/HfO2/Au, and metal/dielectric gratings structures. Through computer simulations and optical measurements, we have optimized the nanostructure parameters for fabricating SPR sensors with high sensitivity (52°/RIU), good resolution (FWHM ≤ 0.28°), and strong evanescent fields (penetration depths, δ ≥ 305nm). The Si3N4 and HfO2 dielectrics are preferred because of high dielectric constants, good optical transparency over wide range of wavelengths, high density in the solid state, chemical stability, and high melting points. The hafnium-dioxide dielectric is particularly attractive because of high refractive index (2.042 @ λ = 630 nm), optical transparency over 250-2000 nm, chemical stability, and high melting point 2750°C. We will present results on computer simulations, sensor architecture, and SPR measurements for variety of sensor platforms. The SPR measurements are made by using the traditional high-index prism Kretschmann configuration system and a novel fixed-detector Kretschmann optical system recently developed in our laboratories [6].

Nanosecond Scale, Corrected RF-IV Measurements of Pulsed Plasmas

A. Press¹, K. Hernandez¹, M. Gockner² and L. Overzet¹

¹Department of Electrical Engineering, The University of Texas at Dallas, 800 W. Campbell Road, Dallas, TX, 75252

²Department of Natural Sciences and Mathematics, The University of Texas at Dallas, 800 W. Campbell Road, Dallas, TX, 75252

Email: alex.press@utdallas.edu

Pulsed plasma environments have been shown to improve plasma processing in a variety of ways; improved critical dimension control, improved material selectivity, reduced plasma induced damage, etc. However, introducing new control parameters increases process design complexity. Therefore, characterization of pulsed plasmas is vital for efficient process optimization. Electrical characterization of plasma can be non-invasive and gives an understanding of the voltage across the plasma, current flowing through the plasma (including the sheaths) as well as the electrical impedance of the plasma (related to the plasma parameters) and power being delivered to the plasma. It can be an extremely powerful diagnostic, especially when combined with Langmuir Probe measurements of the plasma parameters: plasma density, electron temperature and/or electron energy distribution function.

A major contributor to the difficulty experienced in process repeatability is how electrical power to the plasma is measured. Often, a power meter is set before the matching network (MN), measuring forward and reflected power. This is useful in finding a good match, but the forward power measured here is generally very different than the power deposited in the system. Measuring the power after the MN gives a slightly better measurement as it accounts for losses in the MN and power reflections between the MN and electrode. However this measurement is still not a measurement of the power deposited into the plasma as there are parasitic impedances between the measurement point and the plasma-electrode boundary. As an example the capacitance to ground between the powered electrode and grounded surfaces (electrode shield, chamber wall...), can provide a large current path bypassing the plasma. This large current can cause even seemingly insignificant real impedances in the conductor between the MN and electrode to become important. Taking these effects into account, along with chamber dimensions, gives a more universal measurement of power deposition density.

In this talk I will briefly explain the measurement system, and then discuss measured results.
Photoreactions of Monolayer MoS$_2$ in Ambient Conditions

Zhenrong Zhang

Department of Physics, Baylor University, Waco, TX, 76798

Email: Zhenrong_zhang@baylor.edu

MoS$_2$ has a variety of applications including photovoltaics, energy storage, optoelectronics, and catalysis. Chemical vapor deposition-grown and mechanically-exfoliated MoS$_2$ monolayers have been modified by chemical treatment and doping to improve their light-matter interactions for optoelectronic devices. The performance of ideal MoS$_2$ devices could change under realistic conditions. Correlation of the chemistry of MoS$_2$ under ambient environment is critical to its various applications. Here the effect of laser irradiation on the optical properties of MoS$_2$ in ambient conditions has been studied using in situ Raman micro-spectroscopy equipped with an environment-controlled reaction cell. The results show that there are photo-induced reactions of molecules with the MoS$_2$ monolayer in the ambient conditions and the reactions strongly affect the photoluminescence of MoS$_2$. The mapping of the flakes shows that the reaction depends on the spatial location. We study the effect of the phase of the chemical dopant (liquid and gaseous) on the optical properties of monolayer MoS$_2$. Interestingly, gaseous n-dopant is significantly more effective in charge transfer than liquid phase.
Photoactivated CVD of Dimethyl(1,5-cyclooctadiene)platinum(II) on Functionalized Self-Assembled Monolayers

Bryan G. Salazar¹, Hanwen Liu², Lisa Mcelwee-White², Amy V. Walker³

¹. Department of Chemistry and Biochemistry, University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX 75080
². Department of Chemistry, University of Florida, Gainesville, Fl 32611
³. Department of Materials Science and Engineering, University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX 75080

Email: bryan.salazar@utdallas.edu

Chemical vapor deposition (CVD) is widely employed to deposit a variety of materials. However, CVD is generally unsuitable for use on organic substrates because it often requires high deposition temperatures (≥200°C). Here an alternative to thermal activation, photolysis, is investigated for CVD processes on organic surfaces. We employ self-assembled monolayers (SAMs) as model surfaces because they have a known uniform density of functional terminal groups and are synthetically flexible. In this study, the precursor used is dimethyl(1,5-cyclo-octadiene)platinum(II) (COD)Pt(CH₃)₂. To study the role of substrate chemistry on the CVD process, three different SAMs, carboxylic acid-, hydroxyl-, and methyl- terminated monolayers, were used. The resulting deposition was then investigated using time-of-flight secondary ion mass spectrometry (TOF SIMS) and X-ray photoelectron spectroscopy (XPS). The data indicates that the deposition is highly dependent on the wavelength and the SAM terminal group. In agreement with previous studies, the data also shows that the neutral polyhapto ligand, COD, is more difficult to remove than the alkyl ligand. Density functional theory (DFT) calculations provide insights into how the precursor decomposes and thus into the deposition mechanisms observed. These studies will therefore aid in the rational design for new precursors for photoactivated CVD on organic substrates.
Semiconducting boron carbide films are of interest in neutron detection and other applications. However, films made from boron carbide have high levels of defects and low charge carrier mobilities making them poor semiconducting materials. Boron carbide films alloyed with aniline moieties have been deposited by plasma-enhanced chemical vapor co-deposition (PECVD) from aniline (C₆H₅NH₂) and orthocarborane (ortho-B₁₀C₂H₁₂) precursors to obtain tunable and repeatable aniline/orthocarborane film stoichiometries and are found to exhibit composition-dependent drift carrier lifetimes as derived from I(V) and C(V)) measurements. For a film with an aniline/carborane ratio of 5:1, the effective drift carrier lifetimes are ~ 80 micro seconds, at low bias voltage, but quickly drop to a few microseconds with increasing bias. A film with a 10:1 aniline/carborane ratio, however, exhibited lifetimes of ~ 6 microseconds, or less, at 1 kHz, and much smaller values at 10 kHz. These lifetimes are orders of magnitude longer than in polyaniline films, and comparable to PECVD carborane films without aromatic content but compared to other aromatic/boron carbide films, the effective drift carrier life times are shorter. The chemical and electronic structures of these materials were characterized by x-ray photoemission spectroscopy (XPS), FTIR, variable angled spectroscopic ellipsometry (VASE). The results combined with density functional theory (DFT) calculations indicate that aniline and orthocarborane moieties are largely intact within the films with bonding occurring primarily between aniline C sites and carborane B sites, and the aniline coordination number per carborane icosahedron is ~ 2 as the aniline/carborane ratio is increased from 3:1 to 10:1. This aniline/carborane coordination ratio independent of aniline/orthocarborane stoichiometry is consistent with the dependence of charge transport properties on aniline film content at high bias voltage. The aniline bonding to carborane yields aniline-like states near the valence band maximum and a combination of aniline and carborane-like states at the conduction band minimum, with an indirect band gap (~1.3 eV) over a range of aniline/orthocarborane stoichiometries compared with films of pure boron carbide without aniline which showed energy (indirect band gap) of 3.0 eV [1,2].

References:
The combination of solar energy and water represents the most attractive and fundamentally viable solution to our energy needs. Water splitting, the sum of water oxidation and hydrogen evolution half-reactions, remains a formidable challenge since it requires the concerted transfer of four electrons and four protons. The 2H polymorph of MoS2, a semiconducting transition metal dichalcogenide, has gained prominence as a catalyst for the hydrogen evolution reaction (HER) but requires a much greater overpotential as compared to Pt. Specifically, the edges of MoS2 nanostructures are known to be the active sites for the hydrogen evolution reaction. Several studies of MoS2 catalysts indicate that only one in four atoms on edge sites of MoS2 are active in catalysis, requiring substantial effort to maximize the density of edge sites and implying that a large volume fraction of catalytic particles are essentially catalytically inert. However, modification of edge sites to reduce the enthalpy of hydrogen adsorption has been stymied by the absence of a precise understanding of the atomistic and electronic structure of active sites. First-principles density functional theory calculations along with element-specific X-ray absorption spectroscopy and imaging have been used to probe edge electronic structure, which has further been correlated to catalytic performance [1]. Modeling of excited state spectra allows for assignment of X-ray absorption features to specific structural and bonding motifs. The incorporation of dopants and interfacial modification with nC60 [2] provide a powerful means to modulate edge electronic structure and reactivity.

References:

Figure 1. (A) False color map showing the relative spatial localization of the two spectral features, the bulk region and the early-pre-edge region of the x-ray absorption spectra of MoS2 shown in (B). The interfacial modification of MoS2 with nC60 is shown in (C).
Synthesis and Exploration of Electronic Properties in Monolayers of Molybdenum Disulfide

Y. Jiang and U. Philipose

1Department of Physics, University of North Texas, Denton, TX, 76207

Email: yanjiang@my.unt.edu

Two dimensional semiconductors are of great interest for next-generation electronic devices. Among them, monolayers of molybdenum disulfide (MoS$_2$) exhibit excellent properties that make them suitable for several applications. Large areas of high-quality monolayers of MoS$_2$ is desired for these applications. But, the synthesis routes lack reproducibility and the growth parameters in most techniques are interconnected.

In this talk, I will present results of MoS$_2$ monolayer growth by strategically placing water droplets on the growth substrate and/or in the source prior to its loading in the growth chamber. Characterized by scanning electron microscopy (SEM), Raman microscopy, photoluminescence spectroscopy (PL) and atomic force microscopy (AFM), the number and size of MoS$_2$ layers, as well as its distribution on the growth substrate were found to have a strong dependence on the positioning of the water droplet. This study on MoS$_2$ monolayer growth using water droplets as a promoter, provides a simple and reproducible experimental technique enabling growth with high reliability.

The electronic properties of monolayers of MoS$_2$ were studied by using them in a field effect transistor device configuration. Two-terminal and three-terminal devices were fabricated and electrical transport was tested under ambient condition. The measured charge carrier mobility and current ON/OFF ratios indicate defects in as-grown monolayers of MoS$_2$. An in-depth study of defects is expected in the future.
Application of Gas Cluster Ion Source Etching to Inorganic Materials: LiPON

C. Moffitt\textsuperscript{1} and J. Counsell\textsuperscript{2}

\textsuperscript{1}Kratos Analytical, Inc., 100 Red Schoolhouse Rd., Chestnut Ridge, NY, 10977

\textsuperscript{2}Kratos Analytical, Wharfside, Trafford Wharf Road, Manchester, M17 1GP, UK

Email: cmoffitt@kratos.com

The development of gas cluster ion sources has made possible the depth profiling of organic materials that could not previously be sputter etched. This advance has allowed for the characterization of organic multilayer structures not previously practical, opening up whole new research avenues in many applications.

While the use for analysis of organic material films has been revolutionary, these same cluster sources are bringing new insight to the characterization of inorganic structures. The ability to etch without imbedding sputter ions into the material, which causes mixing of matrix elements being etched, allows improved analysis and understanding of a host of inorganic chemical structures, retaining chemical relationships.

A brief overview of organic and recent inorganic uses will be presented, followed by discussion of critical new insight in the application to lithium ion battery technology. LiPON structures are prevalent in the wide application of light battery technology, and understanding the chemistry involved is critical to the development of cells with longer functional lives\textsuperscript{1}. The use of gas cluster sources in practical application to real structures will be shown to remove artifacts inherent to traditional sputter etching, revealing new insight and methodologies for analyzing these structures.

Chemical Bath Deposition of Substrate Selective Molybdenum Disulfide

J. K. Hedlund\textsuperscript{1}, A.V Walker\textsuperscript{1,2}

\textsuperscript{1}Department of Chemistry & Biochemistry, University of Texas at Dallas, 800 W. Campbell Rd., Richardson, TX, 75080

\textsuperscript{2}Department of Materials Science & Engineering, University of Texas at Dallas, 800 W. Campbell Rd., Richardson, TX, 75080

Email: jkh140130@utdallas.edu

Molybdenum disulfide (MoS\textsubscript{2}) thin films have been extensively studied due to the material's tunable optical, mechanical, and electronic properties making it an ideal candidate for flexible nanoelectronics. While properties of few-layered MoS\textsubscript{2} are well understood, controlled uniform growth of large-area MoS\textsubscript{2} thin films remains a challenge. Chemical bath deposition (CBD) is a robust method used to grow thin films and nanostructures, and offers many advantages including low reaction temperatures (\(\leq 50^\circ\text{C}\)), and flexible solution phase chemistry. In this work, CBD is employed to deposit large-area MoS\textsubscript{2} thin films onto a variety of substrates ranging in surface chemistry and energy. SEM images show that polycrystalline flakes are grown on highly oriented pyrolytic graphite with a diameter on the order of \(~100\ \mu\text{m}\). Deposition of smooth thin films were also deposited on self-assembled monolayers with different terminal groups. XPS results confirm deposition of MoS\textsubscript{2}. Notably, layered MoS\textsubscript{2} can be made as one of two different polymorphs, each of which possess distinct electronic properties. Bulk and synthesized MoS\textsubscript{2} is commonly identified as the 2H polymorph, which maintains a trigonal prismatic geometry and behaves as a semiconductor. MoS\textsubscript{2} can also be synthesized with octahedral metal coordination geometry, the 1T polymorph, and has semi-metallic properties. Using Raman spectroscopy measurements, we further demonstrate that the rate of deposition and film polymorph is dependent on the substrate surface chemistry.
Atomic layer deposition of hexagonal boron nitride on transition metal substrates

J. Jones, A. Pilli, V. Lee, N. Chung, B. Beauclair and J. A. Kelber

Department of Chemistry, University of North Texas, 1508 W Mulberry St., Denton, TX, 76201

Email: Jessica.jones1725@gmail.com

Hexagonal boron nitride (h-BN) and graphene are 2D materials proposed for beyond-CMOS devices. Epitaxial, multilayer deposition of h-BN can be used in various device structures for applications as a dielectric, spin filter, or tunnel junction. Direct, epitaxial growth of h-BN has been demonstrated on Ni (111), RuO$_2$ (110)/Ru(0001), and graphene/Ru using ALD. The thicknesses of h-BN were linearly proportional to the number of ALD cycles on this variety of substrates. Growth was accomplished alternating cycles of BCl$_3$/NH$_3$ at substrate temperature of 600K. This yielded stoichiometric BN layers, and Cl impurities levels of < 5 at. %. A monolayer of RuO$_2$ (100) on Ru (0001) is sufficient to disrupt the strong orbital hybridization observed between h-BN and Ru (0001).

Graphene/h-BN/Ni (111) has been proposed as a possible schematic for a 2D magnetic spin filter, and this heterostructure was grown in situ. Using ALD, h-BN was deposited on a monolayer of graphene on a Ru (0001) substrate. H-BN grew epitaxially on graphene while preserving the graphene underlayer. The ordering of the substrate, as demonstrated by LEED, increased with increasing thickness of h-BN. The above experiments show that ALD using BCl$_3$ and NH$_3$ precursors is a practical route towards h-BN(0001) growth for device applications.

Acknowledgements: This work was supported in part by the National Science Foundation under grant no. ECCS-1508991

References:

Ordered Three-Fold Symmetric Graphene Oxide/Buckled Graphene/Graphene Heterostructures On MgO(111) By Carbon Molecular Beam Epitaxy

Chad Ladewig¹, Tao Cheng², Michael D. Randle³, Jonathan Bird³, Opeyemi Olanipekun¹, Fatima Anwar¹, Peter A. Dowben⁴, Jeffry Kelber¹ and William A. Goddard III²

¹ Department of Chemistry, University of North Texas, 1155 Union Circle #305070, Denton, TX, USA.

² Materials and Process Simulation Center, California Institute of Technology, Pasadena, California 91125, USA.

³ Department of Electrical Engineering, University at Buffalo, The State University of New York, Buffalo, NY 14260-1900, USA

⁴ Department of Physics and Astronomy, University of Nebraska-Lincoln, Lincoln, NE 68588-0299, USA

Email: chadladewig@my.unt.edu

Limitations have become evident in the use of silicon based CMOS devices, prompting research into the development of graphene-based electronic and spintronic devices as an alternative approach. This work probes the direct growth of graphene on MgO(111) by molecular beam epitaxy (MBE) in order to investigate the mechanism by which graphene accommodates itself to the dissimilar oxide substrate. X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), electron energy loss spectroscopy (EELS), low energy electron diffraction (LEED), and Raman spectroscopy [Buffalo] were used along with first-principles density functional theory (DFT) calculations [Caltech] which produced results indicating a complex three layer interface of graphene oxide/buckled graphene/graphene. XPS and LEED demonstrate that the first C layer is commensurate with the hydroxylated MgO(111) surface resulting in a “bowed” graphene oxide layer exhibiting $C_{3v}$ symmetry which is further explained by DFT calculations suggesting the presence of O vacancies to accommodate O–C bond formation at the MgO(111) surface. Continued graphene growth results in a “buckled” second layer in an attempt to conform and maintain the structure of the first layer as seen in the LEED and again confirmed by the DFT calculations. Upon growth of a third layer, the data resembles that of planar graphene with appropriate lattice spacing and a $\pi \rightarrow \pi^*$ loss feature in the EELS spectra that is however, slightly shifted to 5.6 eV. Graphene grown on the sputtered MgO(111) film shows similar results. The $sp^3$ character in the first two layers suggest substantial spin-orbit coupling and the potential for a significant spin Hall effect, both of which may have significant device implications.
Atomic layer deposition (ALD) of boron oxide (B$_2$O$_3$) on silicon (Si(100)) substrate is the subject of extensive investigation for ultra-shallow B doping applications. Although little research has been done on the deposition of B$_2$O$_3$ as a source of B dopant, the need for a continuous, conformal dopant source layer is essential in high aspect ratio (AR) 3D transistor units such as FinFET devices. Here we explore room temperature, thermal and free-radical assisted ALD of B$_2$O$_3$ on Si(100) using BCl$_3$, trimethyl borate (TMB), H$_2$O, O$_2$ and atomic O precursors. The deposited films were characterized in situ using XPS. Room temperature ALD-type growth of B$_2$O$_3$ was obtained using BCl$_3$/H$_2$O precursors with a linear B$_2$O$_3$ growth rate of ~ 2.4 Å/cycle and negligible Cl contamination due to initial Cl-Si bond formation at the interface. Cl was not incorporated in the growing oxide film during subsequent ALD cycles. The role of Cl in the inhibition of B$_2$O$_3$ growth was further investigated by the ALD of BCl$_3$/O$_2$ on SiO$_2$ at room temperature and 650 K. Although negligible B$_2$O$_3$ growth was observed at room temperature, increasing B$_2$O$_3$ thicknesses, but with a monotonically decreasing growth rate, corresponding to an increase in Cl contamination was observed at 650 K. Free-radical assisted ALD of B$_2$O$_3$ was also investigated using non-corrosive trimethyl borate (TMB) precursor. Average B$_2$O$_3$ growth rate of ~ 0.85 Å/cycle was obtained when TMB was used in conjunction with atomic O at room temperature.

The deposited B$_2$O$_3$ films are extremely unstable in ambient resulting in boric acid formation upon air exposure. Here, we investigate, thermally stable BN as a novel capping barrier for B$_2$O$_3$. BN is of particular interest as a compatible passivation barrier as such films may not be prone to upward B diffusion through the cap at temperatures generally used for shallow B doping applications. BN cap was deposited by ALD using BCl$_3$/NH$_3$ precursors at 600 K and ~ 13 Å of nanothin BN was sufficient to passivate ~ 26 Å of B$_2$O$_3$ from boric acid formation upon exposure to ambient.

The above findings indicate that low temperature ALD of B$_2$O$_3$ is possible using both corrosive and non-corrosive precursors and is a potential route towards the formation of uniform, stoichiometric B$_2$O$_3$ films for shallow Si doping applications. The data also indicate that ultrathin BN cap acts as a novel passivating barrier for B$_2$O$_3$ from boric acid formation and can be deposited by ALD.

References:

Geometrical factors affecting fluorescence experiments: A correction for high absorption at the excitation wavelength

J. Kimball¹, Z. Nurekeyev¹, J. L. Chavez¹, L. Ceresa¹, H. Doan¹, Harris To, Sunil Shah², I. Gryczynski² and Z. Gryczynski¹,²

¹Department of Physics and Astronomy, Texas Christian University, 2800 S University Drive, Fort Worth, TX, 76129
²Department of Molecular Immunology and Genetics, University of North Texas Health Science Center, Fort Worth, TX, 76107, USA

Email: j.d.kimball@tcu.edu

Fluorescence is the most sensitive technology available for detection and characterization of various compounds. Many high-end commercial instruments are used these days and fluorescence measurements becomes a simple routine for many scientists. However, many factors may affect fluorescence signals and lead to distorted or wrong results. In most fluorescence measurements, experimentalists should be alert to keep the sample’s absorption low (below 0.1) however in many occasions this may not be possible. In many experiments, technical or investigational conditions require certain concentrations and lowering the sample’s absorption is unfeasible. For compounds absorbing in UV, the intrinsic absorption of the solvent may lead to a problem. In addition, many biochemical studies involve fluorophore quenching (e.g. collisional quenching or FRET) in which a quencher may present significant absorption at the fluorophore’s excitation wavelength. So, even if the absorption of a fluorophore is below 0.1 an artificially decreased signal can be observed. The main factors leading to this artifact are the detection system’s narrow focus on the detection cone (the center of the sample holder) as well as a decreasing intensity of the excitation light as it propagates through the sample (cuvette).

We will present a method on how to test the sensitivity of the emission spot position of a standard spectrofluorometer system. We will demonstrate how significant this artifact can be using two different systems. First, using a solvent (toluene) that absorbs in UV (below 300 nm) and compounds that absorb in this range. Second, using a common tryptophan quencher - acrylamide in an increasing concentration and show how the artifact would affect a Stern-Volmer relationship.
August 2\textsuperscript{nd}, 2018

Posters
A photoelectron study of intrinsic and extrinsic p-type doping of pulsed laser deposited few layered WS₂ films.

Urmilaben P. Rathod¹, Jitendra Kumar Jha, Justin Egede¹, Andrey A. Voevodin¹, and Nigel D. Shepherd¹

¹ Department of Materials Science and Engineering, University of North Texas, Denton, TX 76203-5015, USA
Email: urmilabenrathod@my.unt.edu

Controlled doping of two dimensional transition dichalcogenides such as MoS₂ and WS₂ is essential for applications of these materials in a variety of electronic and optical devices. Pulsed laser deposition is a potentially attractive method for achieving targeted doping, because it is characterized by congruent evaporation of the ablation target. We report intrinsic p-type behavior associated with excess sulfur, as well as p-type conduction due to extrinsic doping with Nb. In this study, as-deposited, undoped few layer pulsed laser deposited WS₂ films were used as controls. These films exhibited S/W ratios of ~1.3, and were n-type due to electron donating sulfur vacancies. They exhibited a Hall mobility of 0.4 cm²/Vs, and were characterized by a Fermi level at 1.41 eV from the valence band edge. The latter was determined using ultraviolet photoelectron spectroscopy.

The intrinsic conductivity of the controls switched to p-type after annealing under sulfur, which increased the S/W ratio to 2.2, and improved the mobility to 28 cm²/Vs⁻¹. The increase in mobility is ascribed to improved stoichiometry and reduced incoherent scattering from point defects. The annealing induced n to p-type switch was confirmed by ultraviolet photoelectron spectroscopy which revealed a workfunction increase from 3.36 eV to 4.5 eV, a corresponding change in the Fermi level separation from the valence band edge, and a shift of the tungsten x-ray photoelectron spectrum to lower binding energy by ~1 eV. The intrinsic n and p-type conductivity can be described by:

\[ WS_2 \rightarrow S_2(g) + W^X_W + 2V^S_S + 4e' \]

and

\[ S_2(g) + 2V^S_S + W^X_W \rightarrow 2S^X_S + W^X_W + 4\hbar \]

Extrinsic p-type doping of few layered 2H WS₂ films with Nb by pulsed laser deposition using ablation targets fabricated from WS₂, S and Nb powders is also demonstrated. Films doped at 0.5 and 1.1 atomic percentages niobium were p-type, and characterized by Fermi levels at 0.31 eV and 0.18 eV from the valence band edge. X-ray photoelectron spectroscopy indicates that Nb substitutes on W lattice sites. With increased Nb doping, the hole sheet concentration increased from $3.9 \times 10^{12}$ to $8.6 \times 10^{13}$ cm⁻², while the mobility decreased from 7.2 to 2.6 cm²/Vs, presumably due to increased ionized impurity scattering. The approach demonstrates the potential of PLD for controlled doping of transition metal dichalcogenides.
Raman Spectroscopy Analysis of a New Copper-Cysteamine Complex


University of Texas at Arlington, TX, 76010
E-mail: akafzade@uta.edu

A recently synthesized copper-cysteamine complex with strong luminescence, Cu$_3$Cl(SR)$_2$, where R = CH$_2$CH$_2$NH$_2$, has been identified with potential applications in radiation detection and cancer treatment. In order to better understand the microstructure of this material, we have utilized Raman spectroscopy and several other characterization techniques to look into possible correlations between the microstructure and average crystal size in this material. The Raman spectroscopy and FTIR data identify numerous bonds having wavenumbers from 200 to 3500 cm$^{-1}$, SEM and EDS measurements reveal average crystal size (≤4 μm) and relative elemental composition (C = 48%, N=37.5%, S=5%, Cl = 2.6%, Cu = 7%), and XRD data identify the crystal structure. Additionally, there is evidence for much smaller crystals in the complex. Detailed data on the microstructure of the materials will be presented and discussed.

References:
Optimizing the Growth of WS\textsubscript{2} with Laser Annealing

C. L. Arnold, S. Bakkar and A. A. Voevodin

\textsuperscript{1}Department of Material Science and Engineering, University of North Texas – Discovery Park, 3940 N. Elm Street, Denton, TX, 76207

Email: Coreyarnold@myunt.edu

Over the years, two-dimensional (2D) transition metal dichalcogenides (TMDs) have gained support as graphene alternatives for semiconductor device applications due to their wide and tunable bandgap, temperature and field induced phase transitions, spin-orbit coupling, strong PL response, and high on/off ratios. The experimental obstacle of processing 2D TMDs in low temperature environments constrains the progress of a large-scale and low cost integration of these materials onto sensor and energy conversion packages on flexible polymer substrates. In this study, we show the progress in overcoming this obstacle via pulsed magnetron sputtering of amorphous ultrathin WS\textsubscript{2} at room temperatures, following by selected area crystallization of 2H tungsten disulfide (WS\textsubscript{2}) with a UV laser annealing on stretchable PDMS polymer and silicon wafer substrates. Both as-deposited and annealed WS\textsubscript{2} films were characterized by Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), and atomic force microscopy (AFM). This hybrid sputtering and laser annealing technique allows the production of semiconducting 2D WS\textsubscript{2} films directly on polymer or silicon wafers toward large-scale synthesis of 2D TMDs on both flexible and non-flexible substrates.

References:


Single Junction GaAs Thin Film Solar Cells on Flexible Epi-ready Metal Tape for Low Cost Photovoltaics

Devendra Khatiwada, Monika Rathi, Carlos Favela, Pavel Dutta, Sicong Sun, Yongkuan Li, Sara Pouladi, Jae-Hyun Ryou and Venkat Selvamanickam

Advanced Manufacturing Institute
Department of Mechanical Engineering
Texas Center for Superconductivity
University of Houston, Houston, TX 77204-4006, USA

Email:- khatiwada.devendra67@gmail.com

Thin film solar cells have increasing demand in photovoltaics industry due to their advantages including low cost, mechanical flexibility, light weight, wide range of applications and easy scalability.

III-V semiconductor materials like GaAs are a good candidate for thin films photovoltaics. These materials have a high absorption coefficient in the relevant energy range for photovoltaics and can absorb most of the sunlight within a few micrometer thickness, beneath their surface which can reduce the material cost. The highest efficiencies have been reported in III-V solar cells based on GaAs wafers however their application has been very limited due to high cost of these wafers. We have developed a technology to fabricate III-V solar cells on high quality epitaxial semiconductor thin films on low-cost flexible metal tapes to overcome the high wafer cost.

In our process, metal organic chemical vapor deposition (MOCVD) is used to epitaxially grow GaAs solar cell structure on single-crystalline-like germanium thin films grown on epi-ready flexible metal template. The grown device architecture is further processed for contact deposition via photolithography.

The fabricated thin film III-V solar cells show promising photovoltaic performance under A.M 1.5 (1 sun). Photon conversion efficiency greater than 11% was observed with open circuit voltage ($V_{oc}$) of 642mV, short circuit current density ($J_{sc}$) of 25mA/cm$^2$ and fill factor of 70%. Further improvement in device efficiency is pursued with new device architectures, optimization of film growth parameters and improvement of device fabrication processes.

This work is partially funded by the U.S. Department of Energy Sunshot Initiative award DE-EE0006711.
Synthesis and Characterization of Europium-Doped Cerium Oxide Nanotubes

A.E. D’Achille¹, J.L. Coffer¹

¹Department of Chemistry, Texas Christian University, Fort Worth, TX, 76132
Email: a.moffitt@tcu.edu

Cerium (IV) oxide, or CeO₂, nanomaterials have displayed antioxidant and enzyme mimetic activities due to the Ce³⁺/Ce⁴⁺ redox capability enhanced through oxygen vacancies and mobility. Trivalent, fluorescent ions such as Eu³⁺ increase the Ce³⁺/Ce⁴⁺ ratio and oxygen vacancy concentration, while contributing fluorescent properties to the nanomaterial.¹ The combinations of these attributes make europium doped cerium oxide (EuCeO₂) nanomaterials appealing candidates for various biological applications. This project presents a novel synthetic route to EuCeO₂ nanotubes with a clearly defined cavity and controllable dimensions.

The nanotubes are prepared via deposition and subsequent oxidation of Eu-doped Ce(OH)₃ to form a EuCeO₂ shell on sacrificial ZnO nanowires grown in arrays on silicon substrates. Previous synthetic routes to CeO₂ nanotubes have been reported featuring carbon nanotubes as sacrificial templates², the etching of cerium-based nanorods³, and other less-common methods⁴. These routes have struggled with clear evidence for distinct nanotube formation, as well as control over nanotube dimensions. Our use of a ZnO core allows for facile manipulation of the inner diameter and length of the nanotube following etching of the core.

The synthesized nanotubes were characterized using scanning and transmission microscopies (SEM and TEM) for morphology, energy dispersive x-ray (EDX) for elemental composition, and photoluminescence to track emissive europium centers. Synthesized nanotubes had inner diameters from 40 nm to 200 nm (based on the ZnO core). Following synthesis and characterization, the nanotubes will be tested for use as a drug delivery vector, using ibuprofen as a model.

References:
Electroless deposition (ELD) is an efficient and low-cost method to deposit metals on a wide range of surfaces. In this study we investigated the effect of triethanolamine (TEOA), an ELD additive on the adherence of copper film on -CH$_3$, -OH, and -COOH-terminated self-assembled monolayers (SAMs). The adherence of the deposited copper films strongly depends on the concentration of the TEOA and terminal group chemistry of the SAM. Using 0.3 M TEOA, Cu strongly adhered onto -COOH-terminated SAMs. Strong adherence was also observed using lower TEOA concentrations, but the film underwent removal at 0.08 M. At 0.3 M TEOA, the film on the -OH terminated SAM underwent partial removal. As the concentration of TEOA decreased, the deposited copper film on -OH-terminated SAMs was easily removed, and copper removal was observed in all -CH$_3$-terminated SAMs.
Effect of differing electrode metals on reactive species generation in humid N2/O2 atmospheric pressure dielectric barrier discharge plasmas

A. Gemsheim1, S. Patel1, L. Overzet and M. Goeckner

Department of Electrical Engineering, University of Texas at Dallas, 800 W Campbell Rd, Richardson, TX 75080

Email: alex.gemsheim@utdallas.edu
Email: smp090120@utdallas.edu

Atmospheric dielectric barrier discharge (DBD) plasma is rapidly expanding as a research field because of its applications in medical, industrial, and processing technologies. To form a DBD plasma, a strong dielectric is used to separate two metal electrodes. This plasma dissociates the surrounding gas, producing reactive oxygen and nitrogen species (RONS). Two RONS of interest include ozone and nitric acid because of the potential to use them in myriad applications. The RONS concentrations in a particular environment can be time dependent. Here we make use of a GEC Reference Cell to create and maintain a well-controlled environment. The Cell is first evacuated, and then refilled to atmospheric pressure with precise mixtures of N2, O2 and H2O. Using Fourier transform infrared spectroscopy we are able to monitor the time evolution of several RONS created in the Cell. By using differing electrode materials, with all other parameters held constant, we are able to examine the effect of differing metal surfaces on RONS generation. For example gold electrodes enabled the production of 30% more ozone and 3% more nitric acid than copper electrodes at essentially the same operating conditions and time.
Polysulfone is a stable and strong semitransparent thermoplastic material that is applicable in many industries due to its resistance to low and high temperatures, as well as unique hydrophobic properties. Hydrophobic films are frequently used in waterproofing devices and to improve the efficiency of water vessels. It was recently discovered that polysulfone has a unique behavior as it changes from being hydrophobic to hydrophilic after exposure to a UV radiation. In order to elucidate the mechanisms behind this phenomenon we are performing surface photovoltage (SPV) studies on polysulfone thin films, which is done for the first time, to the best of our knowledge. Whereas SPV is sensitive to buried interfaces, SPV spectral features contain contributions not only from the polysulfone films, but from the silicon wafer and the silicon oxide layer beneath the polymer films. Thereby, to identify the signal germane to the polysulfone properly, we employ in our studies polysulfone films of varying and controllable thicknesses. To establish controllable methods for producing such films by spin coating, we use different concentrations of polysulfone in solutions with different spin rates. We then scratch these films with a thin razor and use atomic force microscopy to measure the depth of the cuts. This allows us to quickly identify sample quality and thickness prior to performing SPV studies to investigate electronic transitions and mechanisms behind the hydrophobic ‘flipping’ of polysulfone.
Electric Field Induced Variation of the Optical Properties of Graphene Oxide

C. Ryan¹, T. Paz¹, F. Grote², and A. Naumov¹

¹Department of Physics and Astronomy, Texas Christian University, TCU Sid Richardson Building, TCU Box 298840, Fort Worth, Texas 76129

²Department of Chemistry, University of Würzburg, Sanderring 2, 97070, Würzburg, Germany

Email: c.a.ryan@tcu.edu

Graphene is a promising material, due to its various inherent properties that will lead to better, smaller, faster, or flexible electronics. Graphene doesn’t exhibit optical emission, limiting its potential use in optoelectronics. However, graphene’s functional derivative Graphene Oxide (GO) maintains many of graphene’s properties and exhibits optical fluorescence emission in the visible/near-infrared, which makes it a candidate for novel applications such as optoelectronic transistors, light emitting diodes (LEDs), and solar cells. Therefore, finding a way to alter optical and electronic properties of GO will lead to more versatility and control among the aforementioned applications.

In this work, we studied the potential use of GO for microelectronic applications by observing the fluorescence of this material under the electric field. A dried GO/PVP film was subject up to 1.6 V/µm in between transparent conductive ITO electrodes resulting in observable quenching of fluorescence emission as the field was applied. The emission was further partially restored at 0 field. Additionally, microscopic flakes of graphene oxide deposited onto interdigitated 10 µm electrodes were subject to 100V/µm with no breakdown current detected. The fluorescence of individual flakes, observed via visible fluorescence microscopy, experienced substantial field-dependent quenching. In aqueous suspensions GO flakes exhibited electrophoretic migration signifying of charge separation. As a result of this work we suggest the potential of varying electronic and optical properties of graphene oxide via the electric field for the advancement and control over its optoelectronic device applications.
Phosphonic acid self-assembled monolayers for wet thin film deposition

Milana C. Thomas¹ and Yves J. Chabal¹

¹Department of Materials Science and Engineering, University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080

Email: mcj140030@utdallas.edu

Developments have been made to allow spin coating of environmentally friendly precursor clusters for the deposition of thin metal oxide films. However, the properties of the resulting oxide films are highly dependent on the interface between the substrate and the film. For silicon substrates, the interface is its native or thermal oxide, which can be plagued with defect states and thus; degrades the electronic performance of the film. To mitigate this detriment, self-assembled monolayers can be grafted onto oxide-free silicon surfaces to stabilize the interface and provide a functional group for later processing, such as phosphonic head groups for Al-based oxides. Here, we explore the attachment of phosphonic acid-terminated self-assembled monolayers to oxide-free, H-terminated silicon surfaces. A two-step procedure is developed to graft an alkylphosphonic acid monolayer, starting with hydrosilylation of Si-H with 10-undecen-1-ol (under either thermal or UV activation), then transforming the hydroxyl functional group into a phosphonic acid group. A combination of FTIR, XPS, and contact angle measurements shows that the grafting involves a mixture of Si-C and Si-O-C bonds for thermally-activated samples and only Si-C bonds for UV-activated hydrosilylation. In both cases, the resulting SAM possesses high contact angles (> 70°), but remains thermally stable up to 250 °C and chemically stable (no increase in interfacial silicon oxide) when stored in inert atmospheres for several days. Grafting with a chemically similar but shorter molecule, vinylphosphonic acid, we observe issues with polymerization and long term instability. The resulting functionalization can accommodate aqueous precursors for spin coating (lower contact angle). For the longer chain molecule, methods to improve the surface hydrophilicity are presented.
Morphology-Dependent Optoelectronic Properties of Hydrothermally-Grown Nano- and Microscale ZnO

William Moss¹, John Reeks², Bao Thach³, Luc Le⁴, Rohan Maheshwari⁵, Hijun Ryu⁶, Alexander David⁶, Annie Zhi⁷, Yuri Strzhemechny²

¹Department of Chemistry and Biochemistry, Texas State University, 601 University Dr., San Marcos, TX, 78666
²Department of Physics and Astronomy, Texas Christian University, 2950 West Bowie, Fort Worth, TX, 76129
³Department of Engineering, Texas Christian University, 2840 West Bowie, Fort Worth, TX, 76129
⁴Keller Central High School, 9450 Ray White Rd, Keller, TX, 76244
⁵Coppell High School, 185 W Parkway Blvd, Coppell, TX, 75019
⁶Trinity Valley School, 7500 Dutch Branch Rd, Fort Worth, TX, 76132
⁷Clark High School, 523 W Spring Creek Pkwy, Plano, TX, 75023

Email: john.reeks@tcu.edu

Nanoscale materials and structures are becoming increasingly prevalent in applications including medicine, sensing devices, luminescent markers, and photovoltaics. Zinc Oxide nanostructures are already widely used for such applications due to a wide direct bandgap and ease of obtaining a variety of nano- and micro-scale morphologies. ZnO has an anisotropic crystal hexagonal wurtzite lattice which leads to two different types of surfaces at lattice termination: polar and nonpolar. This in turn yields a dependence of the optoelectronic behavior of nano- and micro-scale ZnO on the relative abundance of polar vs. non-polar surfaces. The morphology of nano-ZnO can be tuned using different fabrication methods. Some of these synthesis routes require high-temperature or/and expensive growth equipment. In this project we investigate and develop a low-temperature and inexpensive solution-based method for synthesizing ZnO nanoparticles with tunable morphology. We report on the hydrothermal synthesis of ZnO nanoparticles using varying zinc ion suppliers (zinc acetate dihydrate, or zinc chloride), hexamethylenetetramine, and ammonium hydroxide. In particular, we investigate the influence of the synthesis parameters (concentration of substrates, temperature/duration/type of heat treatment) on the morphology of the nanoparticles using scanning electron microscopy. Consequently, using this fabrication method and the photoluminescence spectroscopy, we study the correlation between the morphology of the obtained ZnO samples and their optoelectronic properties.
Geometrical factors affecting fluorescence experiments: the dangers of working with highly absorbing samples

J. L. Chavez¹, L. Ceresa¹, Z. Nurekeyev¹, J. Kimball¹, H. Doan¹, Harris To, Sunil Shah², I. Gryczynski², and Z. Gryczynski¹,²

¹ Department of Physics and Astronomy, Texas Christian University, 2800 S University Drive, Fort Worth, TX, 76129, USA
² Department of Molecular Immunology and Genetics, University of North Texas Health Science Center, Fort Worth, TX, 76107, USA

Email: JOSE.CHAVEZ@tcu.edu
Email: LUCA.CERESA@tcu.edu

Fluorescence is considered as one of the most sensitive methods for detection in various fields from solid state materials and chemistry, to biomedical assays. When performing fluorescence experiments aiming to identify characteristics of different substances, the absorption, excitation, and emission spectra are the most basic yet crucial. Many commercial instruments are available for a long time and making fluorescence measurements becomes a simple routine. However, many factors may affect the fluorescence signal and lead to distorted/wrong results.

It is intuitive that a higher amount of dye in solution should mean a higher emission signal. However, an increase in sample absorbance may lead to a significant distortion of the emission spot that consequently will strongly affect (decrease) the detected signal. This is due to two main factors. (1) The detection center of any spectrofluorometer is focused/limited to a very narrow cone in the center of the detection (cuvette). (2) The fact that excitation light intensity decreases as it penetrates the sample. In other words, the portion of sample closest to the cuvette’s wall facing the excitation light source will produce a high intensity emission light than the center and opposite side of the cuvette.

Herein we are presenting a method how to test detection sensitivity to the emission spot position and will give examples on how the overall fluorescence signal can be distorted by sample absorption. As examples we present the emission of Rhodamine B of increasing absorbance and an Anthracene emission signal observed with different excitation wavelength. Finally, we present a simple theoretical approach to correct for sample absorption and recover the true emission signal.
August 3\textsuperscript{rd}, 2018

Abstracts
Using FTIR to Study Surfaces –
My Path Crossings with Yves Chabal in the Past 27 Years

Julia W. P. Hsu

1Department of Materials Science and Engineering, University of Texas at Dallas, 800W Campbell Road, Richardson, TX, 75080

Email: jwhsu@utdallas.edu

In college chemistry class, we are taught that Fourier transformed infrared (FTIR) spectroscopy can identify molecules and compounds through the fingerprint of molecular vibrations, e.g. C-H stretch or H-O-H bending, and it is a bulk technique, i.e. the more a particular mode is present in the sample the higher the signal. Yves Chabal’s contribution to surface science was to apply FTIR to probe molecular adsorption, modification, and reaction on semiconductor surfaces. This talk is a personal account of the scientific and not-so-scientific experiences Yves and I shared over the past 27 years.
Infrared spectroscopy in academic research and industrial applications

K. Roodenko

Max-IR Labs, Dallas, TX

kroodenko@max-ir-labs.com

It is hard to underestimate the reliance on infrared (IR) technology in industrial, medical, defense and research environments. Positioned between the red limit of the visible spectrum and THz frequencies, infrared is most often associated with thermal radiation. Interaction of molecules with infrared radiation leads to absorption through resonant molecular vibrations at specific wavelengths. This provides unique possibility to identify particular units within complex organic and inorganic molecular structures. IR spectroscopy is therefore widely utilized in the development of novel materials, industrial process control, drug discovery, environmental sensing, and many other applications. Beyond spectroscopy, IR radiation is utilized in thermometry. The curves of the black-body radiation distribution peak at frequencies that are dependent on the temperature of the emitting body, thus mapping radiation emitted by biological bodies to the wavelength of about 10 mm, falling into the so-called long-wave infrared (LWIR) range. Thermal imaging is utilized for night vision and degraded visibility conditions such as fog; in non-contact temperature monitoring in industrial processes; as well as in medical and various research applications. This talk will describe uses of infrared radiation in academic research and industry, as guided, inspired and enabled by the outstanding mentor and innovative surface scientist, prof. Yves Chabal.
Probing Structure evolution and Charge Transport at Discrete Electrical Energy Storage Interfaces

Janice E. Reutt-Robey1 and Jonathan Larson2

1Department of Chemistry & Biochemistry, University of Maryland, College Park, MD 20742
2Department Physics, University of Maryland, College Park, MD 20742

Email: rrobey@umd.edu

Electrochemical Energy Storage (EES) devices with increased efficiency and reliability are in demand for sustainable technologies. Scan Probe Microscopy methods can help to fill in fundamental knowledge gaps on the spatiotemporal charge transport processes that govern EES operation and eventual failure. We present the application of classic STM methods to reveal complex formation and structure evolution at electrochemical interfaces, and introduce new SPM methods, based upon customized ½ cell nanobattery probe tips, to direct and monitor lithium transport in operational solid state batteries. In one approach, a multi-wall carbon nanotube (MW-CNT) appended to an AFM probe tip serves as a Lithium NanoPipette and structure probe. The NanoPipette is utilized to transfer attograms of Lithium to/from a Si (111) anode surface, and the electric potential fields that induce ionization and drive lithium ion transfer between the MW-CNT and Si (111) are quantified. The MW-CNT tip is further utilized to perform Li nanolithography, and extract lithium surface diffusion constants from the measured decay rates of surface Li features. In another measurement scheme, we utilize a conventional metallic (W or PtIr) probe tip clad in thin layers of metallic Lithium (cathode material) and solid electrolyte (lithium oxide). Nanobattery operation is demonstrated by cycling the Nano-half-battery probe tip against single crystalline anodes (Si (111), and HOPG), all under UHV conditions. Analysis of Li ion charge-discharge cycles against Si (111) reveals three characteristic charging timescales, reflecting processes for Li ion interface transfer, insertion, and bulk Li migration. To further probe Li ion transport, we develop a new stress-step pacalammetry technique, in which stress waveforms are applied to a solid-state electrochemical device and induced faradaic current transients are quantified. Measurements on operando microbattery probes (Li2O/Li/W) and Si cathodes, reveal stress-assisted Li+ diffusion through a non-Cotrellian current signature, described by an analytical solution to a diffusion/activation equation. This characteristic current signature for elevated stress in solid-state batteries offers a powerful new approach to study stress-related phenomena in solid-state electrochemical systems.

The work was supported by the Nanostructures for Electrical Energy Storage, an Energy Frontier Research Center funded by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under award no. DESC0001160.
Through the work of Yves Chabal and co-workers, significant progress has been made in expanding the application of in situ characterization techniques to the analysis and monitoring of semiconductor surfaces and processes. For example, in situ infrared (IR) spectroscopy can provide critical details of the local chemical structure at the surface of growing ALD films which in turn gives insight into the chemistry underlying the ALD process. First principles calculations have become a decisive tool in the interpretation of complex experimental spectra. Simulated vibrational modes and spectral intensities enable the reliable assignment of gas-phase precursor and surface adsorbate related bands. The agreement between observed and predicted spectral features for chemical species at various stages of the ALD process provides an important link between theory and experiment giving direct support to theoretical predictions of surface structures, reaction energetics and mechanisms of ALD nucleation and growth reactions. Illustrative examples from collaboration with the Chabal lab over the past 15 years are presented.