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2025 Fall Meeting
Hudson Mohawk AVS Chapter
Thursday, November 13, 2025
2:50 – 7:20 PM

University at Albany, SUNY
ETEC building, Room B010
1220 Washington Ave, Albany, NY 12203

Meeting Agenda

2:50 - 3:20 Reception *(coffee and cookies served)*

3:20 - 3:30 Welcoming Remarks by Vincent Smentkowski

Keynote Presentation

3:30 - 4:00 "*Material Innovation Shaping the Future of Logic and Memory Devices*"
Dr. Dina Triyoso, Tokyo Electron Technology Center

Oral Presentations, moderated by Steven Consiglio

4:00 - 4:15 *"Catalytic Oxygen Dissociation for Area-Selective HfO_2 Deposition on Cobalt Through Selective PMMA Etching"*
Enzo Novoselic (UAlbany CNSE, Graduate Student)

4:15 - 4:30 *"Potential Interconnect Material: Topological Semimetal ZrB_2"*
Sanzida Rahman (RPI, MSE, Graduate Student)

4:30 - 4:45 *"Machine Learning Assisted Electronic Nose for VOC Detection and Classification in Room Air"*
Md Delowar Hossain (UCONN, CBE, Graduate Student)

4:45 - 5:00 *"Van der Waals Epitaxy of Millimeter-Domain Bi_2Se_3"*
Skye Williams (RPI, MSE, Graduate Student)

5:00 - 5:15 *"Negative-Tone Organotin Resists with Alkenyl and Alkynyl Ligands"*
Moira Niluxsshun (UAlbany CNSE, Graduate Student)

5:15 - 5:30 *"Epitaxial $Ti_2AlN(0001)/Al_2O_3(0001)$ Films: Process Window and Resistivity Scaling"*
Mehedi Hasan Prince (RPI, MSE, Graduate Student)

5:30 - 7:00 **Poster Presentations** *(pizza and refreshments served)*

7:00 - 7:20 **Student Awards Ceremony**

Poster Presentations

P01. **DEVELOPMENT OF A HIGH VACUUM BASED ANALYSIS SYSTEM FOR DETERMINING THE RELIABILITY OF MEMS DEVICES**
Alvar Garza (UAlbany, CNSE, Graduate Student)

P02. **EFFECTS OF THICKNESS AND TEMPERATURE ON THE GROWTH OF TOPOLOGICAL SEMIMETAL PtAl THIN FILMS**
Oishy Roy (RPI, MSE, Graduate Student)

P03. **WHICH INSTRUMENT SHOULD YOU USE FOR HIGH LATERAL RESOLUTION CHEMICAL ANALYSIS - SEM/EDS OR TOF-SIMS?**
Vincent Smentkowski (GE Vernova Advanced Research Center)

P04. **ELECTRICAL CHARACTERIZATION OF FERROELECTRIC $Hf_{0.5}Zr_{0.5}O_2$ FILMS**
Jarron Maguire (TEL Technology Center America, Undergraduate Student)

P05. **SHELF-LIFE AND CRYSTALLINITY OF NEGATIVE-TONE ORGANOTIN RESISTS**
Moira Niluxsshun (UAlbany, CNSE, Graduate Student)

P06. **HYPULSE XPS FEMTOSECOND LASER ABLATION XPS DEPTH PROFILING**
Drew Griffin, James Lallo (Thermo Fisher Scientific)

P07. **DETERMINING EFFECT OF ENCAPSULATION ENVIRONMENT ON RESISTANCE OF MEMS SWITCHES**
Meghan Herbert (UAlbany, CNSE, Undergraduate Student)

UAlbany ETEC Driving Directions

The ETEC building is in the Harriman State Office Complex, which is adjacent to the University at Albany (UAlbany, or SUNY Albany) campus.
The address is ETEC, 1220 Washington Avenue, Albany, NY 12203.
It is important that you include "ETEC" in your search if you are using a mapping program; otherwise, the search will send you to the state police barracks.

*From **UAlbany Campus**:*

There is no direct street access to the ETEC building from the UAlbany campus. You must first drive to either Washington Avenue or Western Avenue and go east towards downtown Albany.
Just after passing the UAlbany campus, there will be an entrance to the Harriman State Office Complex (State Offices).

- If entering Campus Access Road from Washington Avenue, you will see the ETEC building on your left. After passing the building, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building. The parking lot is on the north side of the building.
- If entering Campus Access Road from Western Avenue, you will also need to take a U-turn so that you are driving towards the ETEC building, not away from it. Again, the parking lot is on the north side of the ETEC building.

*From the **North**:*

Take the Northway (I-87) south to Exit 1E. Merge onto I-90 east (toward Albany/Boston). Then take Exit 3 (State Office Buildings), which will put you on Campus Access Road. After passing the ETEC building, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

*From the **South**:*

Take the Thruway (I-87) north to Exit 24. Merge onto I-90 east (toward Albany/Boston). Then take Exit 3 (State Office Buildings), which will put you on Campus Access Road. After passing the ETEC building, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

*From the **West**:*

Take the Thruway (I-87) east to Exit 24. Merge onto I-90 east (toward Albany/Boston). Then take Exit 3 (State Office Buildings), which will put you on Campus Access Road. After passing the ETEC building, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

*From the **East**:*

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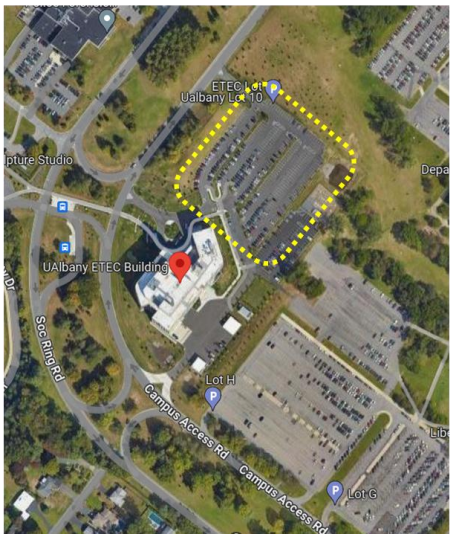
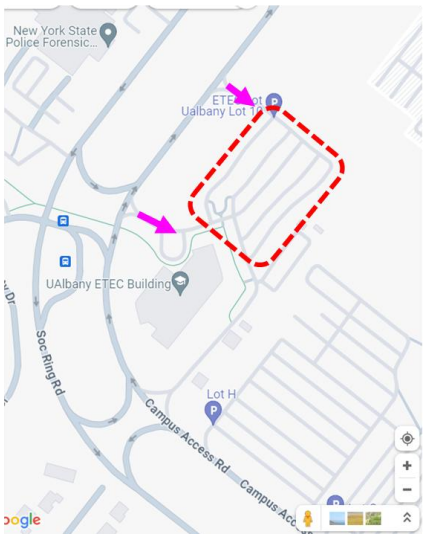
Print the parking permit and display it on your dashboard when parking in the ETEC lot. (Unless you have an active UAlbany permit)
Otherwise you will have to pay 5$ at UAlbany parking kiosk as a visitor, or risk getting a ticket.

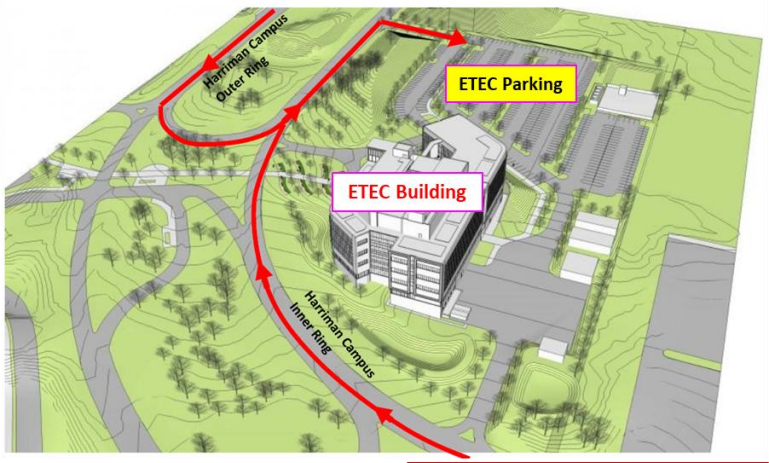
HMAVS meeting location is in ETEC Room B010 (Basement level).

Enter ETEC Lot from Campus Access Road (inner ring road, one-way)
(Purple Arrows)





From Washington Ave (North)



From Western Ave (US-20, South)

MATERIAL INNOVATION SHAPING THE FUTURE OF LOGIC AND MEMORY DEVICES

Dina H. Triyoso

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Over the past 50 years, the semiconductor industry has experienced remarkable growth, primarily driven by transistor dimensional scaling. However, recent advancements have been propelled by emerging data-centric and connectivity-driven applications such as IoT, 5G/6G, and AI. Consequently, research focus has expanded from merely discovering new materials to support continued scaling, to identifying materials tailored for these novel applications. In this presentation, we will explore two key examples of material innovations that are shaping the future of logic and memory devices: ruthenium (Ru) as a post-copper (Cu) interconnect material, and hafnium (Hf)-based high-k materials as ferroelectric films. We will review the latest progress and discuss the challenges related to their manufacturing implementation, highlighting their potential impact on next-generation semiconductor technologies.

Keynote Presentation

CATALYTIC OXYGEN DISSOCIATION FOR AREA-SELECTIVE HfO_2 DEPOSITION ON COBALT THROUGH SELECTIVE PMMA ETCHING

Enzo Novoselic, Christophe Vallee, Natalya Tokranova

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Area-selective deposition (ASD) of thin films is critical for advanced semiconductor manufacturing, yet conventional methods often suffer from "mushrooming" defects due to poor selectivity at feature edges and lateral expansion of the isotropic growth. This work presents an alternative approach to ASD on cobalt (Co) substrates while avoiding mushrooming, leveraging catalytic dissociation for both polymer etching and selective deposition. The use of selective catalytic dissociation has been demonstrated for the etching and deposition steps. As an example, Zhang et al. [1] demonstrated selective etching on Pt/Ru/Cu/Ti, while Joseph et al. [2] demonstrated selective deposition on Pt.

In this work, a polymethyl methacrylate (PMMA) material is non-selectively deposited on all exposed surfaces (Co and silicon). Through catalytic O_2 dissociation, PMMA atop Co is selectively etched in an atomic layer deposition (ALD) tool, while PMMA on silicon remains intact. Subsequently, the ALD step is performed in the same chamber at the same surface temperature, and under catalytic conditions, enabling selective growth on Co while suppressing nucleation on PMMA. Finally, PMMA is stripped, yielding structures exclusively on Co with sub-nanometer precision and vertical sidewalls.

The results show that the catalytic processes achieve near-complete selectivity. Vertical growth blocking remains an issue due to polymer reflow. The use of catalytic dissociation for both etching and deposition steps simplifies integration into existing fabrication workflows. This approach offers a scalable pathway for advanced node patterning, particularly in back-end-of-line (BEOL) metallization and gate oxide applications where material selectivity and feature definition are paramount.

[1] Zhang, C.; Leskelä, M.; Ritala, M. Self-Aligned Thin-Film Patterning by Area-Selective Etching of Polymers. Coatings 2021, 11, 1124. https://doi.org/10.3390/coatings11091124
[2] Joseph A. Singh, Nick F. W. Thissen, Woo-Hee Kim, Hannah Johnson, Wilhelmus M. M. Kessels, Ageeth A. Bol, Stacey F. Bent, and Adriaan J. M. Mackus. Chemistry of Materials 2018 30 (3), 663-670. https://doi.org/10.1021/acs.chemmater.7b03818

Graduate Student, Oral Presentation

POTENTIAL INTERCONNECT MATERIAL: TOPOLOGICAL SEMIMETAL ZrB_2

Sanzida Rahman, Rui Shu, and Daniel Gall

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Rensselaer Polytechnic Institute, Troy, NY 12180, USA

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ZrB_2 is predicted to be a topological nodal line semimetal with band crossings and arcs at the Fermi level which indicate potential surface conductance benefits for the $ZrB_2(0001)$ surface. In this study, we deposit $ZrB_2(0001)$ on $Al_2O_3(0001)$ using combined d.c. and r.f. sputtering of elemental zirconium and boron targets, respectively. The growth temperature is varied from T_s = 700 to 1100 °C to maximize the crystallinity and minimize the resistivity. Raising T_s to 1100 °C increases the ZrB_2 0001 x-ray diffraction peak intensity by a factor of 3.3 and decreases the resistivity ρ from 860 to 220 μΩcm. Varying the power to the Zr source between P_{Zr} = 25 and 33 W while keeping P_B fixed at 45 W is used to deposit a series of layers with different composition. A stoichiometric composition leads to a maximum XRD ZrB_2 0001 peak intensity and a minimum ρ, but causes lower crystalline quality and higher resistivity for deviations from stoichiometry. This is attributed to boron vacancies or segregation of excess boron. Epitaxial $ZrB_2(0001)/Al_2O_3(0001)$ films are deposited with P_{Zr} = 27 W and P_B = 45 W at 1100 °C. They show Laue fringes and a narrow 0.02° FWHM rocking curve width, indicating an excellent crystalline quality. XRD phi scans show an in-plane epitaxial relationship with ZrB_2 $[10\bar{1}0] \| Al_2O_3$ $[11\bar{2}0]$. Resistivity vs thickness d measurements for films grown at T_s = 1100 °C indicate an increasing ρ = 106-224 μΩcm with decreasing d = 24.8 to 7.9 nm. This is attributed to defect scattering. Thin films with d = 2.9 - 8.6 nm grown at T_s = 700 °C followed by annealing at T_s = 1000 °C demonstrate an increasing ρ = 620 to 1850 μΩcm with decreasing d. The high resistivity in thinner films is likely due to discontinuous microstructure. Despite theoretical predictions, no evidence of a surface conductance benefit has been demonstrated yet.

Graduate Student, Oral Presentation

MACHINE LEARNING ASSISTED ELECTRONIC NOSE FOR VOC DETECTION AND CLASSIFICATION IN ROOM AIR

Md Delowar Hossain, Brian G. Willis

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University of Connecticut, Storrs, CT, USA

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Detecting volatile organic compounds (VOCs), biomarkers, explosives, pollutants, toxic compounds, and other informative chemicals in the presence of moisture is a major challenge for new gas sensing technologies. The combination of diverse detector chemistries with machine learning is promising to overcome moisture interference by generating unique odor prints for signature chemicals. In this study, we incorporated multiple organic-ligand-capped gold nanoparticles (AuNP) into arrays of microfabricated electrodes using state-of-the-art pico-drop technology with micron level precision to fabricate sensor chips. Optimum fabrication conditions were obtained by varying deposition conditions including AuNP mass per device, layers of AuNPs, droplet volumes, spot placements, ligand and solvent types, solvent evaporation rates, and relative humidity to improve sensor performance in terms of reproducibility, response magnitudes, variability, and selectivity. A range of 0.25 – 1.0 P/Psat VOCs in room air (760 torr, 22-25℃, 0 – 55% RH) were sampled by sensor chips mounted in a 3D-printed flow cell with an electrically connected socket and multiplexed multimeter to measure responses of the sensor arrays. Sensor data were processed with machine learning for conventional multi-class classification as well as a new approach based on image analysis of radar plots (Fig. 1a). A classification accuracy of 98–100% was achieved for 15 VOCs at vapor pressures ranging from P/Psat = 0.25 to saturation using conventional machine learning models including RF, NNN, LDA, SVM, and KNN (Fig 1b). We achieved similar classification accuracy using image analysis based on a convolutional neural network model. Results are promising for fabricating low cost sensors for VOC detection and related applications.

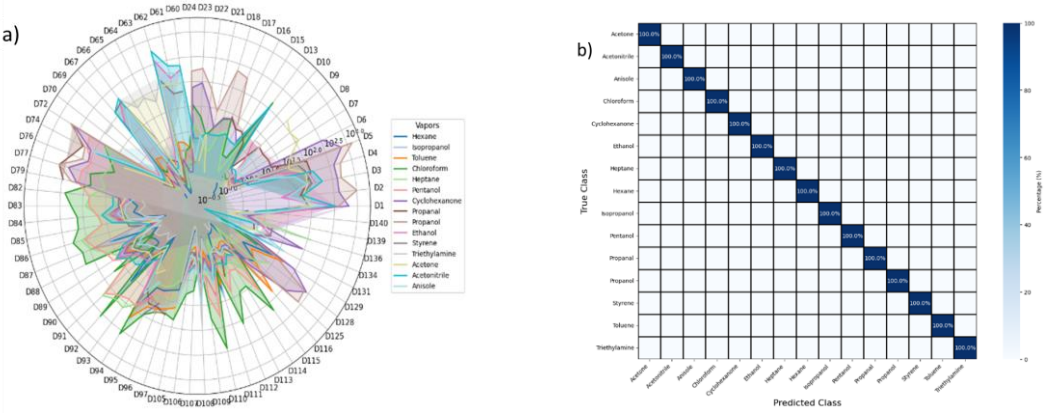

Figure 1: a) Odor-prints, b) Test confusion matrix of 0.25 P/Psat VOCs in room air

Graduate Student, Oral Presentation

VAN DER WAALS EPITAXY OF MILLIMETER-DOMAIN Bi_2Se_3

Skye Williams[1], Edwin Fohtung[1,2], Jian Shi[1,2]

[1]Department of Materials Science and Engineering, Rensselaer Polytechnic Institute, New York, USA
[2]Department of Physics, Rensselaer Polytechnic Institute, New York, USA

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The unique electronic structure of Bi_2Se_3 makes it appealing not only for studying fundamental topological physics but also for pursuing technological applications that include future electronics, spintronics, and quantum computing. This work uses a chemical vapor deposition approach to synthesize sub-millimeter domain continuous epitaxial thin films as well as continuous films with preferred orientation and domain sizes ranging up to a millimeter. Atomic force microscopy imaging reveals a terraced pyramid structure with step sizes down to one quintuple layer. We observe that large amounts of deposition on the tube walls from previous growths negatively affect the quality of epitaxy but positively affect grain size due to re-vaporization of previous growth. Transport measurements and Hikami-Larkin-Nagaoka fits of conductivity vs magnetic field indicate a bulk conducting nature to the film. This work pushes forward the domain size Bi_2Se_3 films by an order of magnitude, while maintaining the regularly reported doping problems of topological insulators.

Graduate Student, Oral Presentation

NEGATIVE-TONE ORGANOTIN RESISTS WITH ALKENYL AND ALKYNYL LIGANDS

Moira Niluxsshun,[a] Munsaf Ali,[a] Stephen Smith,[a] Ricardo Burke,[a] Jordan Greenough,[a] Ryan Chae,[b] Greg Denbeaux[a] and Robert L. Brainard[a]*

[a] *Department of Nanoscale Science and Engineering, University at Albany, Albany, NY 12203*
[b] *SAMSUNG SDI Co., Ltd., Gyeonggi, 16678, South Korea*

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The **Molecular Organometallic Resists for EUV (MORE)** project, initiated in 2011, aims to develop metal-based photoresists with strong EUV absorption and tunable solubility-switching mechanisms. By incorporating metals such as tin, antimony, bismuth, cobalt, palladium, and tellurium, the program has investigated thousands of compounds to understand structure property relationships at the molecular level. While our early efforts focused on antimony olefinic ligands, due to their high speed and radical-based mechanisms, these systems often suffered from linear contrast curves and poor SEM stability. Alkynes were initially avoided due to concerns over reactivity, but recent research has revealed that alkynyl ligands are synthetically accessible and produce well-formed films with excellent EUV and e-beam performance.

Here, we report the development of two novel organotin-based negative-tone resists MA-257 and MA-258 as part of the MORE program. Both compounds have two benzylic ligands. Additionally, MA-257 has two alkynyl groups, while MA-258 has two alkenyl groups. Thin films were exposed to EUV radiation (2–200 mJ/cm²) and developed. MA-257 produces excellent non-linear high contrast curves, whereas MA-258 produces relatively low contrast curves. E-beam lithography at 100 kV further confirmed its enhanced contrast and image fidelity, resolving features down to 20 nm. These results highlight the critical role of ligand design in optimizing metal-based photoresists and reveal the promising potential of alkynyl-tin complexes for next-generation EUV and e-beam patterning.

* The authors gratefully acknowledge financial support from Samsung-SDI and Cornell Nanoscale Facility for technical support.

Graduate Student, Oral Presentation

EPITAXIAL $Ti_2AlN(0001)/Al_2O_3(0001)$ FILMS: PROCESS WINDOW AND RESISTIVITY SCALING

Mehedi Hasan Prince and Daniel Gall

Department of Materials Science and Engineering,
Rensselaer Polytechnic Institute, Troy, NY 12180

princm3@rpi.edu

Nitrogen-based MAX-phase materials are promising as conductor for interconnects in future integrated circuits due to their high cohesive energy, anisotropic Fermi surface, and potential for low resistivity at small (~10 nm) dimensions. Ti_2AlN is used as a model system to explore epitaxial growth and thickness-dependent transport. Initial attempts to deposit Ti_2AlN on c-plane sapphire by reactive magnetron co-sputtering yields rock-salt structure TiN and $Ti_{1-x}Al_xN$. This is attributed to target poisoning, which results in a high nitrogen content in the deposited film. Sputter deposition in a constant 3 mTorr Ar atmosphere with a pulsed N_2 flux enables control of the nitrogen content in the film as deposition alternately switches between poisoned and metallic target mode, as quantified by an oscillating target voltage. An optimized pulse time of 1.9 and 4.1 s with and without N_2, deposition temperature T_s = 850 °C, and d.c. power to the deposition sources P_{Ti} = 150 W and P_{Al} = 35 W results in single-phase, epitaxial $Ti_2AlN(0001)/Al_2O_3(0001)$ layers. This is confirmed by strong x-ray diffraction 000ℓ reflections, a low ω-rocking-curve full width at half maximum of 0.65°, and pole figures and φ-scans which indicate an in-plane epitaxial alignment with Ti_2AlN [$11\bar{2}0$] || Al_2O_3 [$10\bar{1}0$]. The resistivity ρ = 44 and 22 μΩ.cm at 295 and 77 K, respectively. It remains nearly constant for layer thicknesses d = 32-111 nm but increases by 20-49% as d is reduced to 12 nm, which is attributed to an increased defect density and/or surface roughness at small thicknesses. The overall transport data indicate electron scattering at residual crystalline defects, but a low resistivity scaling which is promising for the envisioned interconnect applications.

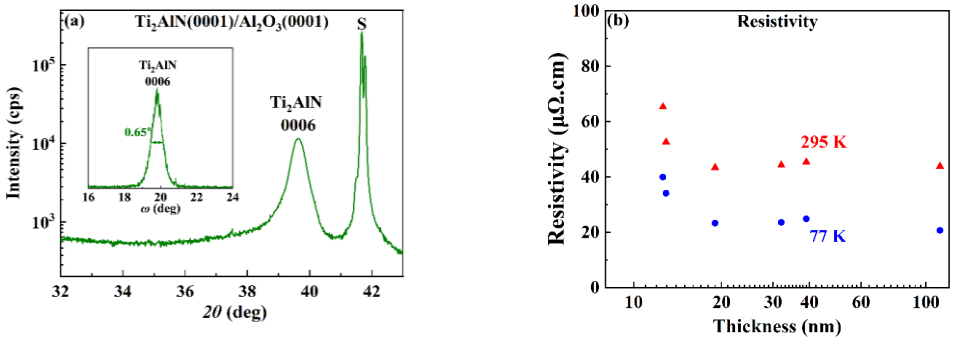

Figure 1: (a) X-ray diffraction θ-2θ scan from a $Ti_2AlN(0001)/Al_2O_3(0001)$ layer including a rocking curve from the Ti_2AlN 0006 reflection in the inset. (b) The resistivity measured at 295 and 77 K of epitaxial $Ti_2AlN(0001)$ layers vs thickness.

Graduate Student, Oral Presentation

P01. DEVELOPMENT OF A HIGH VACUUM BASED ANALYSIS SYSTEM FOR DETERMINING THE RELIABILITY OF MEMS DEVICES

Alvar Garza[1], Anthony Valenti[1], Matthew Strohmayer[2], Joleyn Brewer[2], Christopher Nassar[2], Christopher Keimel[2], and Carl A. Ventrice, Jr.[1]

[1]*Dept. of Nanoscale Science & Engineering, University at Albany, Albany, NY 12203*
[2]*Menlo Microsystems, Inc., Albany, NY 12203*

agarza@albany.edu

Microelectromechanical systems (MEMS) are micron scale devices with moving parts. In particular, Menlo Micro produces MEMS-based switches for radio frequency signal propagation. Their MEMS devices have higher switching speeds and lower power consumption than conventional semiconductor-based switches. The MEMS switches use an electrostatically controlled cantilever that is made from a Au-Ni alloy. The electrical contacts of the switch are coated with ruthenium. The MEMS devices are encapsulated in a proprietary gas mixture that includes nitrogen and oxygen. Repeated high-velocity impacts from the cantilever's motion can wear down the protective layer over time. The goal of this project was to design and build a vacuum compatible MEMS test station. A vacuum chamber was modified so that electrical signals could be sent to and from the MEMS device through high vacuum electrical feedthroughs. Variable leak valves were used to introduce nitrogen, argon, oxygen, and compressed dry air into the chamber, which allowed testing under different gas mixtures at various pressures. A compound pressure gauge was used to monitor of the gas pressure during testing. Measurements of resistivity were made over each cycling period to evaluate the longevity of the MEMS device at different pressures and different gas mixtures.

Graduate Student, Poster Presentation

P02. EFFECTS OF THICKNESS AND TEMPERATURE ON THE GROWTH OF TOPOLOGICAL SEMIMETAL PtAl THIN FILMS

Oishy Roy[1], Ching-Tzu Chen[2], Atharv Jog[3], Nargess Arabchi[3], Daniel Gall[1]

[1] Materials Science and Engineering, Rensselaer Polytechnic Institute, Troy, 12180,
[2] Tomas J Watson Research Center, IBM Research, Yorktown Heights, 10598
[3] Advanced Logic Technology, IBM Research, Albany, 12203

royo@rpi.edu

In the quest of next-generation interconnect alternates, chiral topological semimetals such as PtAl are predicted to be promising candidates. PtAl has a cubic chiral structure with $P2_13$ space group, lacks any mirror and inversion symmetry, and is predicted to demonstrate scatter-free conduction through topologically protected surface states at ultrathin dimensions.

This collaborative research explores the growth of epitaxial PtAl by ultra-high vacuum magnetron sputtering as a function of substrate, deposition temperature and layer thickness. Pt_xAl thin films with thickness d = 55 nm are deposited onto single crystal substrates $Al_2O_3(0001)$, $Al_2O_3(1\bar{1}02)$, $Al_2O_3(11\bar{2}0)$ and $MgO(001)$ at T_s = 20-1000 °C. Growth on $Al_2O_3(1\bar{1}02)$ yields epitaxial PtAl(001) for T_s ≥ 600 °C. The resistivity ρ decreases for deviations from stoichiometry due to the formation of Pt_5Al_3 and Pt_2Al_3 impurity phases for Pt and Al rich conditions, respectively. Continuous PtAl layers with d = 13 – 57 nm for T_s = 700 °C show thickness dependent crystalline orientation with epitaxial PtAl(001) for d ≥ 26 nm and misoriented PtAl(102) for d ≤ 13 nm and a decreasing ρ = 140 – 92 μΩ·cm with increasing d. Growth at T_s = 1000 °C leads to thickness independent epitaxial PtAl(001) layers with a decreasing ρ from 115 - 67 μΩ·cm with increasing d = 13 – 109 nm. Layers deposited at T_s = 400 °C followed by *in situ* vacuum annealing at T_a = 700, 850 and 1000 °C indicate a transition from 102 to 001 oriented films for T_a ≥ 850 °C. Film continuity and resistivity are improved for T_a = 850 °C with ρ = 220 μΩ·cm for d = 3 nm.

Graduate Student, Poster Presentation

P03. WHICH INSTRUMENT SHOULD YOU USE FOR HIGH LATERAL RESOLUTION CHEMICAL ANALYSIS - SEM/EDS OR TOF-SIMS?

Vincent S. Smentkowski[1*], Deliang Guo[1], and Felix Kollmer[2]

[1]GE Vernova Advanced Research Center, Niskayuna, NY, 12065, United States
[2]IONTOF GmbH, Heisenbergstraße 15, 48149 Münster, Germany

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Scanning electron microscopy (SEM) coupled with energy dispersive spectroscopy (EDS) is often the instrument of choice when researchers desire rapid high lateral resolution chemical analysis. Time of flight secondary ion mass spectroscopy (ToF-SIMS) instrumentation has matured over the past few decades – state of the art instruments can now perform rapid high lateral resolution chemical analysis of all elements (including H and Li), however its use as a microscopy technique is often overlooked.

BAM-L200, is a certified reference material prepared from a cross-sectioned epitaxially grown layer stack of $Al_{(0.70)}Ga_{(0.3)}As$ and $In_{(0.2)}$ $Ga_{(0.8)}As$ on a GaAs substrate [1,2]. The surface of the cross sectional BAM-L200 sample provides a flat pattern with layer widths down to 1 nm. Calibration distances, grating periods and layer widths have been certified by TEM with traceability to the length unit. The combination of gratings, isolated narrow lines and sharp edges of wide lines offers plenty of options for the determination of lateral resolution, sharpness and calibration of length scale for analytical instruments.

A region of the BAM L200 sample was analyzed using EDS/SEM and ToF-SIMS. We will show that ToF-SIMS has better lateral resolution. In addition to being faster and providing higher lateral resolution imaging, ToF-SIMS also allows for the collection of a full mass spectrum (all elements from H to U, and high mass molecular fragments) at every volume element; ToF-SIMS also has much higher chemical sensitivity (detection limit for most elements is in the ppm to ppb range); and ToF-SIMS does not require the deposition of a thin conductive coating [3,4].

References:

1. CERTIFIED REFERENCE MATERIAL
2. https://rrr.bam.de/RRR/Content/DE/Downloads/RM-Zertifikate/RM-Oberflaechen-Schicht-Mat/bam_l200repe.pdf?__blob=publicationFile
3. Kollmer F *et al. Surface and Interface Analysis* (2012) **45**, 312-314.
4. Senoner M *et al. J. Anal. At. Spectrom* (2012) **27**, 1050.

Poster Presentation

P04. ELECTRICAL CHARACTERIZATION OF FERROELECTRIC $Hf_{0.5}Zr_{0.5}O_2$ FILMS

Jarron Maguire, Dina Triyoso, *David O'Meara, Sara Aoki, Sarah Lynch, Rinus Lee

*TEL Technology Center America, LLC, *Tokyo Electron America, Inc.*

jarron.x.maguire@us.tel.com

Ferroelectric materials exhibit a spontaneous polarization that can be switched by an external electric field. $Hf_{0.5}Zr_{0.5}O_2$ based ferroelectrics are promising for the "next generation" of memory devices due to their non-volatility, fast read/write speeds, and low power consumption[1]. One important figure of merit for ferroelectric device is the hysteresis (polarization vs. voltage) curve (Fig. 1), which displays the memory window and coercive voltages of the device.

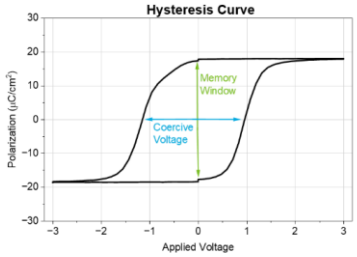

Fig. 1. Ideal hysteresis loop with sharp ends (defined switching), observable memory window and coercive voltage.

To measure this curve, we apply voltage pulses and measure the output current and polarization. A PUND (positive up, negative down) technique is used to test the ferroelectric capacitors (Fig 2). In this work, we optimized the pulse slope, width, and base time based on capacitor size and film thickness. The goal of using a PUND measurement method applies a pair of pulses and a non-switching pulse, so we can isolate the polarization value from non-ferroelectric effects like parasitic capacitance and other dielectric effects[2]. The number of pulse cycles at which the ideal hysteresis loop is maintained is known as the "endurance" of the device, a factor that correlates with the number of read/write cycles for a completed device. Once we observe a non-ideal hysterisis curve, we note that the device has broken down. Through pulse-time optimization, we can characterize our device structures to compare with literature and internal results and further optimize our films.

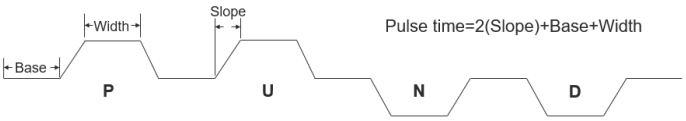

Figure 2: PUND pulse schematic, including a positive and negative variation of a switching and non-switching pulse.

[1] Faizan, M et al.Emerging Ferroelectric Materials for High-Performance Next-Generation Memory Devices. *ACS Applied Electronic Materials* **2025**, *7* (16), 7473–7502. https://doi.org/10.1021/acsaelm.5c01058.
[2] Magagnin, G. et al. An Original Positive-Up-Negative-down Protocol for Electrical Characterization of Antiferroelectric Materials. *Nano Letters* **2025**, *25* (16), 6686–6692. https://doi.org/10.1021/acs.nanolett.5c00851.

Undergraduate Student, Poster Presentation

P05. SHELF-LIFE AND CRYSTALLINITY OF NEGATIVE-TONE ORGANOTIN RESISTS

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Since 2011, our group has developed EUV photoresists composed of amorphous thin films of compounds containing tin, cobalt, platinum, palladium, bismuth, and antimony, as part of our ongoing project **Molecular Organometallic Resists for EUV (MORE).** In our Oral presentation, "Negative Tone Organotin Resist with Alkenyl and Alkynyl Ligands," we report on the EUV lithographic performance of MA-257 and MA-258. These resists were exposed to EUV radiation and developed in a solvent system of 2-heptanone and hexanoic acid. Notably, MA-257 exhibits exceptional lithographic characteristics, including a nonlinear high contrast curve, and high-resolution imaging at an effective dose of 31 mJ/cm².

Here, we report a surprising behavior of MA-257: freshly prepared solutions form crystalline coatings unsuitable for high-resolution patterning, but after aging for 4–5 weeks under ambient conditions, the same solutions produce high-quality amorphous films with excellent lithographic performance. To understand this transformation, we systematically studied the aging effect, aiming to identify strategies to improve tin-based EUV resists. We tested water and other small molecule additives to accelerate or replicate aging, with two main goals: (1) to uncover the chemical and physical changes behind aging, and (2) to achieve high-performance films from fresh solutions. However, none of the additive approaches matched the lithographic quality of naturally aged samples. This suggests that aging may involve slow, complex chemical or structural changes that are not yet fully understood. Ongoing work is focused on elucidating these mechanisms to gain predictive control over resist performance.

❖ The authors gratefully acknowledge financial support from Samsung-SDI and Cornell Nanoscale Facility for technical support.

Graduate Student, Poster Presentation

P06. HYPULSE XPS FEMTOSECOND LASER ABLATION XPS DEPTH PROFILING

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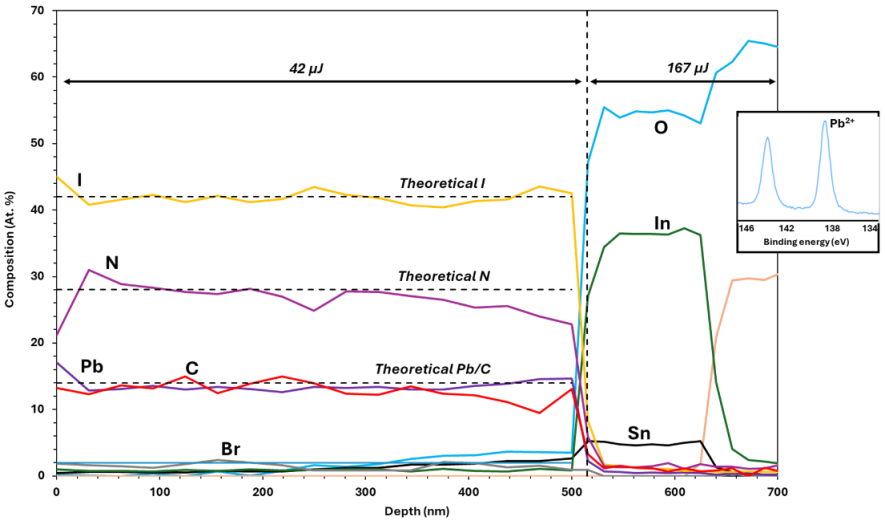
The stability of novel perovskite photovoltaic devices is investigated via X-ray Photoelectron Spectroscopy. As XPS is a very surface sensitive technique, the experiment method involves depth profiling the material by interleaving analysis with removal steps, to characterize changes to the chemistry of these materials. XPS depth profiling is traditionally done using monatomic and gas cluster ion beam (GCIB) bombardment. However, ion beam methods induce changes in the material chemistry and morphology, affecting the validity of the results. By using Femtosecond laser ablation for XPS depth profiling it has been shown that analysis of thin film perovskite solar cell devices can be achieved without changing the chemistry.

Femtosecond laser Ablation XPS depth profiling has been performed here and compared with the traditional ion beam methods on different spin-coated formamidinium lead Iodide (CH5N2PbI3) based perovskite thin film solar cells, both pristine and following environmental testing. Fs-LA XPS depth profiles fully retained the true chemical composition of the 500 nm thick perovskite layer.

A femtosecond laser with a 1030 nm peak wavelength and a pulse duration of 160 fs was employed. The monatomic and cluster ion sputtering depth profiles exhibited chemical damage due to preferential sputtering of C, N and I.
Pb0 was also observed in the Pb 4f spectrum as a preferential sputtering artefact.



Poster Presentation

P07. DETERMINING EFFECT OF ENCAPSULATION ENVIRONMENT ON RESISTANCE OF MEMS SWITCHES

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Microelectromechanical systems (MEMS) are micron scale devices with moving parts. In particular, Menlo Micro produces radio frequency MEMS-based switches that have higher switching speeds and lower power consumption than conventional semiconductor-based switches. The MEMS switches use an electrostatically controlled cantilever that is made from a metal alloy. The electrical contacts of the switch are coated with ruthenium because of its resistance to oxidation. In addition, the most stable stoichiometry of ruthenium oxide is RuO_2, which is an electrically conductive oxide. The MEMS devices are encapsulated in a proprietary gas mixture. This gas mixture helps maintain the stability of the contacts.

The primary goal of this project was to experimentally determine the effect that different gas environments have on the cycling resistance of the MEMS devices. The devices are tested in a high vacuum chamber. The chamber has leak valves that allow the introduction of ultra-high purity N_2, Ar, O_2, and compressed dry air to allow testing of the devices in different custom gas mixtures up to just under 1 atm (absolute) of pressure. Several similar MEMS devices have been tested in various gas mixtures and pressures. The data show that the introduction of oxygen into the gas results in an increase in resistance, which implies a change in the Ru contact.

Another aspect of this research project was to design a custom vacuum chamber to allow testing of devices at pressures of up to 2 atm (absolute) and at temperatures up to 100 °C. The chamber has been machined and welded but has not been attached to the existing test chamber yet.

Undergraduate Student, Poster Presentation

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