
Nimel D. Theodore

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EDUCATION

College of William and Mary, Williamsburg, VA

Ph.D. Applied Science, May 2006 (anticipated)
Thesis Title: "Silicon Oxynitride: A Field Emission Suppression Coating"
M.S. in Applied Science, College of William and Mary, August 2002

Drew University, Madison, NJ

B.A. Chemistry and Physics, Mathematics Minor, May 2000

RESEARCH EXPERIENCE

- **Graduate Research Student, College of William and Mary, Fall 2000 – present**
Conducting research on plasma immersion ion implantation and reactive sputtering as a technique to modify surface properties of metals
 - Discovered silicon oxynitride deposition procedure using reactive sputtering
 - Developed coating procedure to suppress field emission from large, contoured stainless steel substrates
 - Characterized composition and bonding of deposited silicon oxynitride using XPS, FTIR, AES, VASE, RBS, and ERDA
 - Calculated nitrogen implantation profile into silicon dioxide
 - Developed procedure to form refractory metal carbides by using PIII
 - Characterized metal nitride and carbide formation using XPS
 - Calculated and designed RF-inductively-coupled matching network for maximum power transfer to the plasma

- **Research Student, Drew University, Fall 1999 – Spring 2000**
Researched organic chromophores for information storage devices
 - Developed chemical procedure to create organic chromophores

- **REU Student, University of Nevada at Las Vegas, Summer 1999**

Researched metal quinolates as organic light-emitting devices (OLED)

- Determined melting points and reactivity of novel materials
- Characterized metal quinolates using XPS at the Advanced Light Source at Lawrence Livermore National Laboratory in Berkeley, CA

SKILLS AND QUALIFICATIONS

- Proficient in plasma immersion ion implantation (PIII) to create metal nitrides and carbides and in plasma-based reactive sputtering to deposit high-purity silicon oxynitride coatings
- Expertise and understanding in control of field emission (both enhancement and suppression), RF-plasmas, matching networks, and vacuum technology
- Extensive practice in using XPS, FTIR, profilometry, micro-indentation, optical microscopy, and SEM/EDS
- Experience in using AFM, STM, TofSIMS, AES, AA, NMR, UV-vis, and other material characterization techniques

TEACHING EXPERIENCE

- **Teaching Assistant, Drew University, Fall 1997 – Spring 1999**

Assisted teaching Chemistry I and II, and Physics I (Mechanics) labs to college students

- Taught students proper use of laboratory instruments and equipment such as FTIR, pH meters, mass spectrometers, UV-vis, DSC, computer-assisted sensors, etc.
- Guided students in the learning process through experimentation
- Trained students how to properly handle hazardous chemicals including corrosives, acids, and bases
- Monitored overall lab safety

- **Tutor, Drew University, Spring 1997 – Spring 2000**

Tutored undergraduate students in calculus, physics, and chemistry

- Worked in both groups and individual settings
- Created practice and review worksheets

- **Mentor, Summer Institute for the Gifted, Summer 1998**

Supervised 5th-12th grade students in a live-in academic camp

- Taught chemistry and electronics courses to 5th graders and 8th graders, respectively

- Tutored students in all areas (i.e. Math, Science, History, Ultimate Frisbee, etc.)
- Counseled students and mediated conflicts between students
- See also **SUPERVISION OF UNDERGRADUATE STUDENTS**

HONORS, PRIZES, AND AWARDS

- Virginia Space Grant Consortium Research Fellowship, Aug 2001- May 2004
- 2nd place poster, Applied Surface Science Division, 49th AVS Conference, Nov. 2002
- Pi Mu Epsilon – National Math Honor Society, inducted April 1998
- Sigma Pi Sigma – National Physics Honor Society, inducted April 1999
- Hardin Prize – given to the person whose participation in academic and community life exemplifies that of former President Paul Hardin, Drew University, April 2000
- Marshall C. Harrington Prize in Physics and Astronomy – given to one physics student for outstanding research, Drew University, April 2000
- The Gold-D Award – given to those who have provided significant contributions to academic and community life, Drew University, April 2000
- National Merit Scholar, March 1996

PUBLICATIONS

Peer-Reviewed Publications

1. N.D. Theodore, C. Hendricks, M. Bagge-Hansen, B.C. Holloway, D.M. Manos, C. Hernandez, H.F. Dylla. “Comparison of SiO_xN_y Produced by PIII/D and Reactive Sputtering.” *In preparation.*
2. N.D. Theodore, B.C. Holloway, D.M. Manos, R. Moore, C. Hernandez, T. Wang, H.F. Dylla. “Nitrogen-Implanted Silicon Oxynitride: A Coating for Suppressing Field Emission from Stainless Steel Used in High Voltage Applications.” *IEEE Transactions on Plasma Science*, 2006. *In press.*
3. C. Hernandez, T. Wang, T. Siggins, H. F. Dylla, N. D. Theodore, and D. M. Manos. “DC Field Emission Analysis of GaAs and Plasma-Source Ion-Implanted Stainless Steel.” *Journal of Vacuum Science & Technology A*, **12**, 2003.

Unrefereed Publications

1. N.D. Theodore, D.M. Manos. “The Effectiveness of Kelvin Probe Microscopy to Determine the Work Function of Ion-implanted Materials.” *Proceedings of the Virginia Space Grant Consortium*, 2004.

2. N.D. Theodore, D.M. Manos, C. Hernandez, T. Wang, H.F. Dylla, R. Moore. "Plasma Surface Implantation of Electron Source Structures." *Proceedings of the Virginia Space Grant Consortium*, 2003.
3. N.D. Theodore, L.L. Wu, D.M. Manos. "Surface Processing Using Plasma Source Ion Implantation." *Proceedings of the Virginia Space Grant Consortium*, 2002.
4. N.D. Theodore, L.L. Wu, C.K. Sinclair, T. Siggins, D.M. Manos. "Micro-Processing Using Plasma Source Ion Implantation." *Proceedings of the 14th Biennial University/Government/Industry Microelectronics Symposium*, 2001.

CONTRIBUTED PRESENTATIONS

"Comparison of SiO_xN_y Produced by PIII/D and Reactive Sputtering." N.D. Theodore, D.M. Manos, B.C. Holloway, C. Hernandez, H.F. Dylla. *2005 International AVS Science and Technology Symposium*, Boston, MA, Nov. 2005.

"Fabrication of Mo₂C Using Plasma Immersion Ion Implantation for Field Emission Applications." N.D. Theodore, X. Zhao, B.C. Holloway, D.M. Manos. *2004 International AVS Science and Technology Symposium*, Anaheim, CA, Nov. 2004. (poster)

"The Effectiveness of Kelvin Probe Microscopy to Determine the Work Function of Ion-implanted Materials." N.D. Theodore, D.M. Manos. *Virginia Space Grant Consortium Symposium*, Hampton VA, April 2004.

"The Effect of Surface Finish on Field Emission in Nitrogen-Implanted, Silicon Dioxide-Coated Stainless Steel." N.D. Theodore, B.C. Holloway, D.M. Manos, C. Hernandez, T. Wang, T. Siggins, C. Reece, H.F. Dylla. *2003 International AVS Science and Technology Symposium*, Baltimore, MD, Nov. 2003.

"Plasma Surface Implantation of Electron Source Structures." N.D. Theodore, D.M. Manos, C. Hernandez, T. Wang, H.F. Dylla, R. Moore. *Virginia Space Grant Consortium Symposium*, Hampton VA, April 2003.

"Characterization of Plasma Source Ion Implanted Stainless Steel for High Voltage Applications." N.D. Theodore, C. Hernandez, D.M. Manos, H.F. Dylla, T. Wang, C. Reece, T. Siggins. *2002 International AVS Science and Technology Symposium*, Denver, CO, Nov. 2002. (2nd place poster)

"DC Field Emission Analysis of GaAs and Plasma-Source Ion-Implanted Stainless Steel." C. Hernandez, T. Wang, T. Siggins, H.F. Dylla, N.D. Theodore, and D.M. Manos. *2002 International AVS Science and Technology Symposium*, Denver, CO, Nov. 2002.

"Surface Processing Using Plasma Source Ion Implantation." N.D. Theodore, L.L. Wu, D.M. Manos. *Virginia Space Grant Consortium Symposium*, Hampton, VA, April 2002.

“Suppression Field Emission From DC Electron Gun Structures.” N.D. Theodore, C. Hernandez, T. Siggins, D.M. Manos, H.F. Dylla. *Workshop on Thin Films, Surfaces, and Material Processing*, Newport News, VA, June 2002. (poster)

“Micro-Processing Using Plasma Source Ion Implantation.” N.D. Theodore, L.L. Wu, C.K. Sinclair, T. Siggins, D.M. Manos. *Proceedings of the 2001 University / Government / Industry / Microelectronics Symposium*, Richmond, VA, June 2001.

SUPERVISION OF UNDERGRADUATE STUDENTS

1. Christopher Hendricks, Laboratory Research Student, Summer 2005 – present

Chris uses AFM, profilometry, VASE, and FTIR to characterize the plasma deposition parameters of reactively sputtered silicon oxynitride coatings deposited onto stainless steel and silicon. I directly supervised his research and instrument training. Our efforts will produce a publication.

2. Michael Bagge-Hansen, Laboratory Research Student, Summer 2003 – present

Michael has developed a semi-automated polishing procedure for flat stainless steel, has built two 5 kV DC power supplies, has built an UHV chamber for our Kelvin Probe Microscope. Using profilometry and XPS, he is studying the composition and bonding of refractory metal nitrides and carbides and silicon oxynitride coatings. I directly supervise his research and instrument training. Our efforts will produce a publication.

3. Olivia Penrose, Visiting Research Student, Summer 2004

Olivia compared the field emission characteristics of Ta to carbon-implanted Ta using STM and AFM. Her work, “Field Emission Characteristics of Ta and TaC,” was presented at Norfolk State University’s summer research symposium in Norfolk, VA. Dr. Kang Seo was her adviser, and I directly supervised her day-to-day research.

4. Scott Wight, Virginia Microelectronics Consortium (VMEC) Student, Summer 2004

Scott studied unipolar arc formation in the RF-inductively coupled plasma. He determined that flakes of silicon dioxide dust would instigate arcs when they landed on an immersed sample. I directly supervised his research efforts.

5. Jack Simonson, Senior Physics Student, Fall 2003 – Spring 2004

Jack used STM to study the field emission properties of carbon-implanted Group Vb metals (V, Nb, and Ta). This work was the subject of his Senior Thesis, “Field Emission Enhancements in C-implanted Group Vb Metals,” which was awarded Honors. Dr. Dennis Manos was his adviser, and I supervised his day-to-day research efforts.

6. Laurel Averett, Research Student, Summer 2003

Laurel used XPS to confirm nitride and carbide formation in metals (Ta, Mo, W, Al, Cu, Ni, Nb, Ti, Hf, Zr) implanted with nitrogen and diluted methane, respectively. I supervised her research progress.

7. Donald Bitner, VMEC Student, Summer 2003

Don used p-spice to model the pulse-forming network that generates high voltage negative pulses for plasma immersion ion implantation. I directly supervised his research efforts.

8. Kendra Letchworth, Research Student, Summer 2003

Kendra used optical emission spectroscopy to see whether the concentration of silicon dioxide could be determined as a function of height. Dr. Dennis Manos was her advisor, and I directly supervised her day-to-day research.

9. Timothy Scheffler, VMEC Student, Summer 2002

Tim studied the RF-matching network our inductively-coupled plasma source. He used p-spice and a Smith chart to determine the specifications of each capacitor during an upgrade to a 2 kW RF power supply. I directly supervised his research progress.

10. Sarah Myers, Laboratory Assistant, Summer 2002

Sarah hand-polished stainless steel disks and characterized them using AFM and profilometry. Her efforts were acknowledged in several poster presentations. I directly supervised her training and laboratory efforts.

11. Timothy van Drew, VMEC Student, Summer 2001

Tim compared hardness and resistivity differences in nitrogen-implanted refractory metals using a micro-indenter and a 4-point probe. I directly supervised his research progress.

12. Emily Chapman, REU Student, Summer 2001

Emily used ultraviolet optical emission spectroscopy to study the plasma properties of our RF-inductively coupled nitrogen plasma. Dr. Dennis Manos was her REU adviser, and I directly supervised her day-to-day research efforts.

PROFESSIONAL SOCIETIES

- AVS Science and Technology of Materials, Interfaces, and Processing
- American Institute of Physics
- American Physical Society
- Institute of Electrical and Electronics Engineers

REFERENCES

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