

Self-Assembled Monolayers

June 11, 2015

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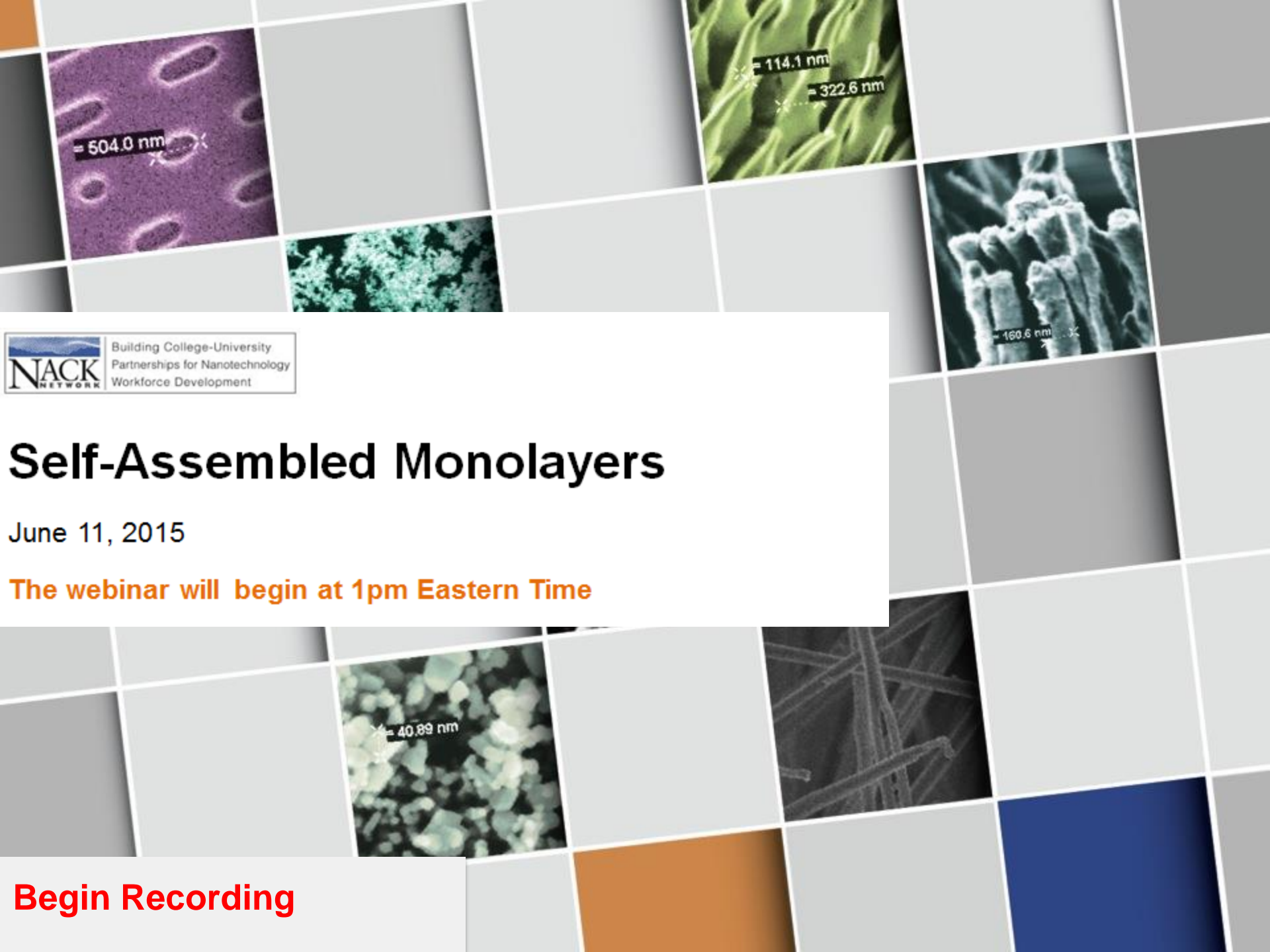


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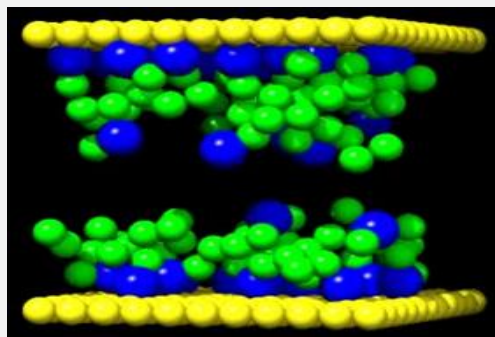
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Today's Presenter



Christina Arisio, Ivy Tech Community College of Indiana

Since 2013, I have been an assistant professor of Nanotechnology at Ivy Tech Community College of Indiana, South Bend campus. I am currently working to finish a Ph.D. in Chemistry with Dr. Marya Lieberman. My research focuses on the functionalization of Si and GaN semiconductors and III-V (nitride) high electron mobility transistors with silane self-assembled monolayers for biosensor applications. My undergraduate work was done at SUNY Stony Brook (B.S. in Chemistry) with Dr. Stanislaus S. Wong. This research involved the synthesis and characterization of strontium titanate nanocubes. Portions of my undergraduate work were carried out at Brookhaven National Laboratory.



Host: Roxanna Montoya
MATEC



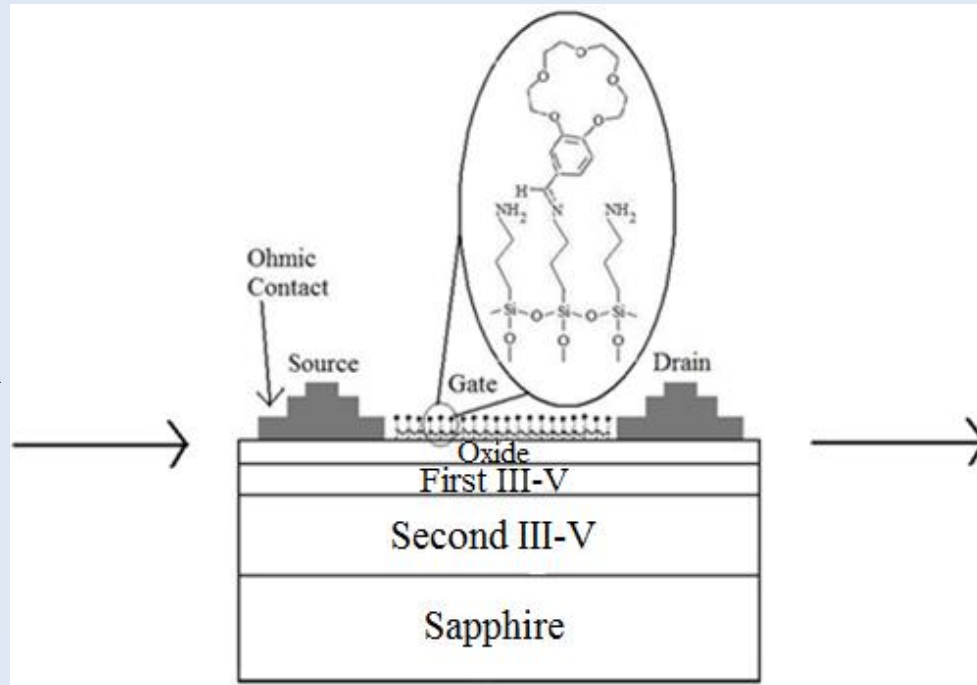
Moderator: Sam Agdasi
Assistant Professor and
Chair, Nanotechnology, Ivy
Tech Community College

Self-Assembled Monolayers

Silane SAM's for Bioapplications

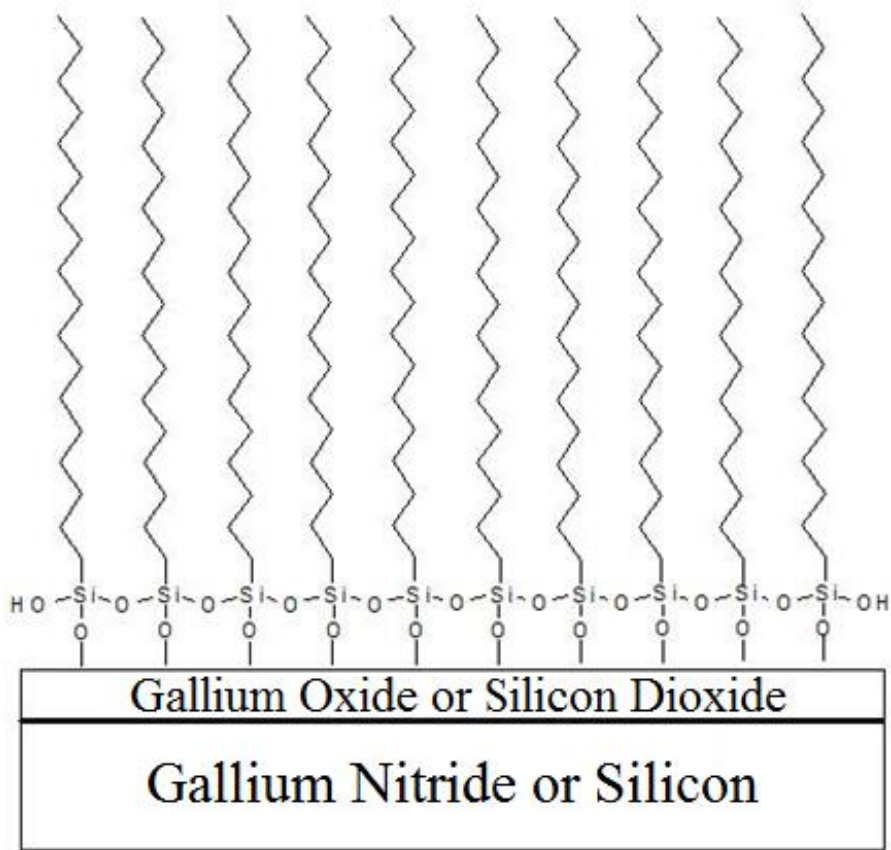
Christina Arisio
Ivy Tech Community College

Surface Functionalization and Characterization

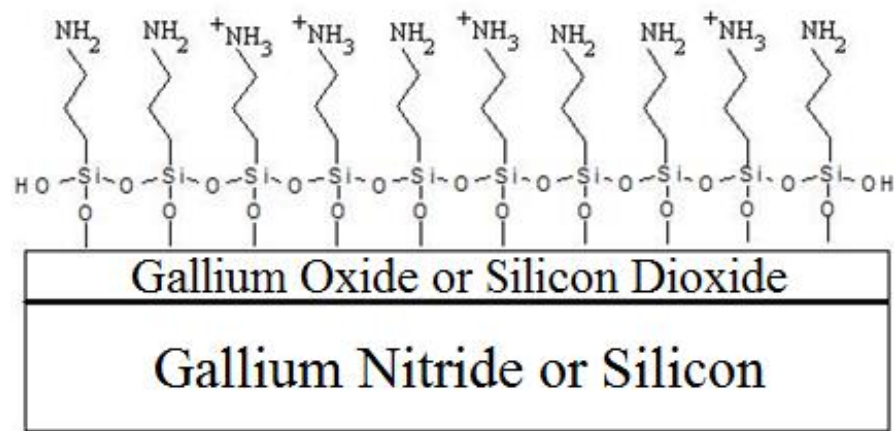


Analyze Sensor Response to Target

Siloxane SAM's on GaN and on Si



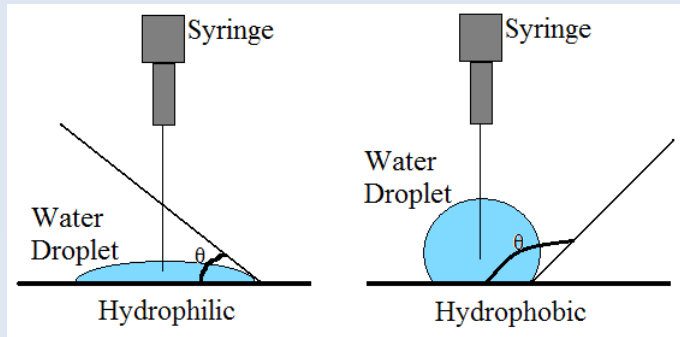
OTS -
Octadecyltrichlorosilane



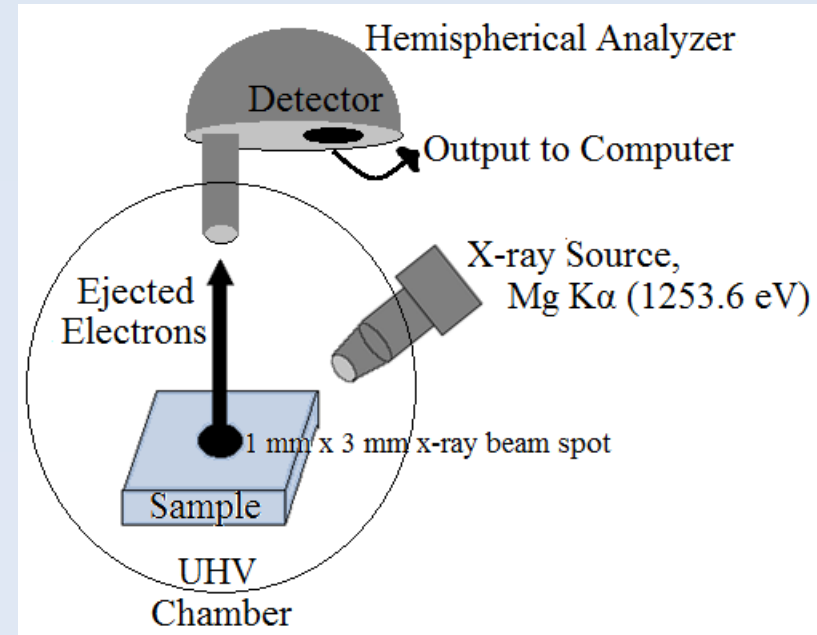
APTES - Aminopropyltriethoxysilane

Surface Analysis Techniques

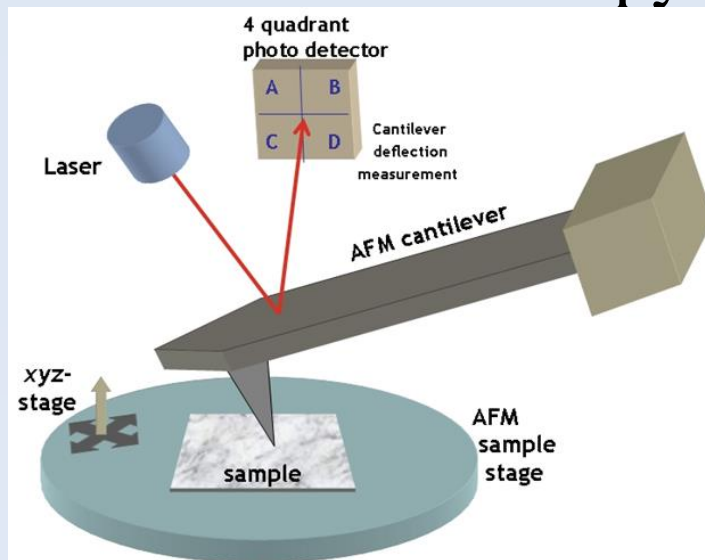
Water Contact Angle



X-Ray Photoelectron Spectroscopy (XPS)

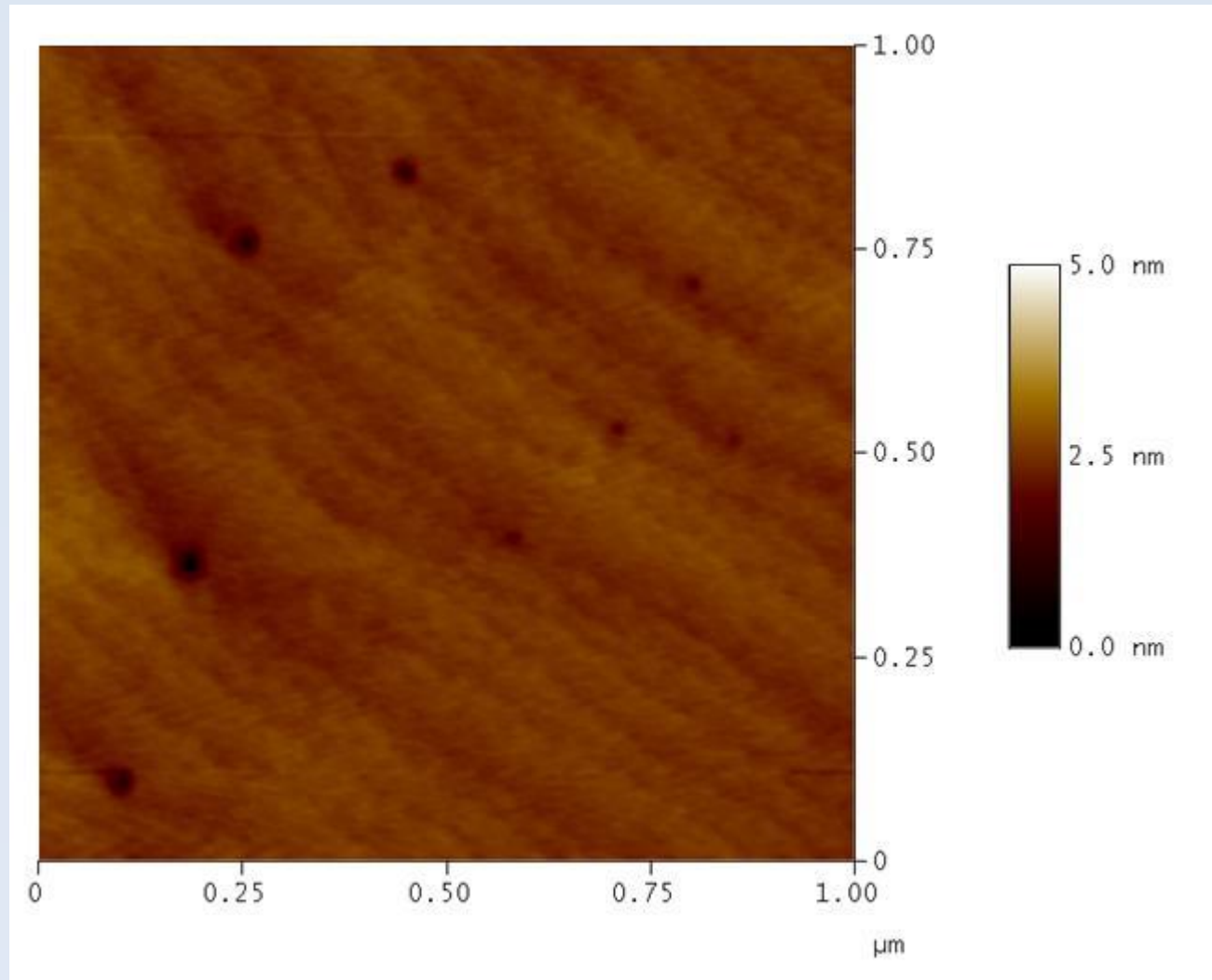


Atomic Force Microscopy (AFM)

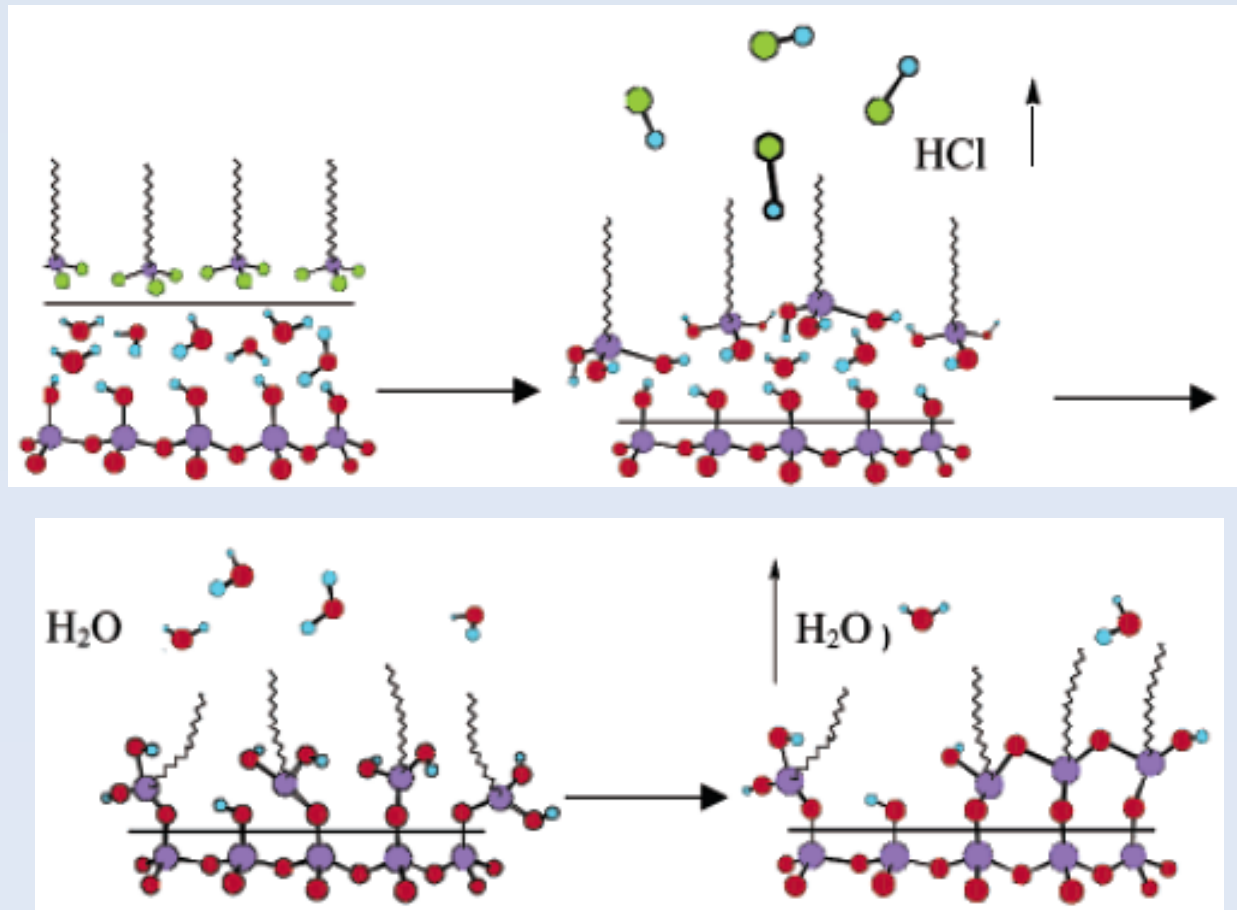


Unfunctionalized Clean GaN Surface

Surface
preparation/
treatment is
critical!

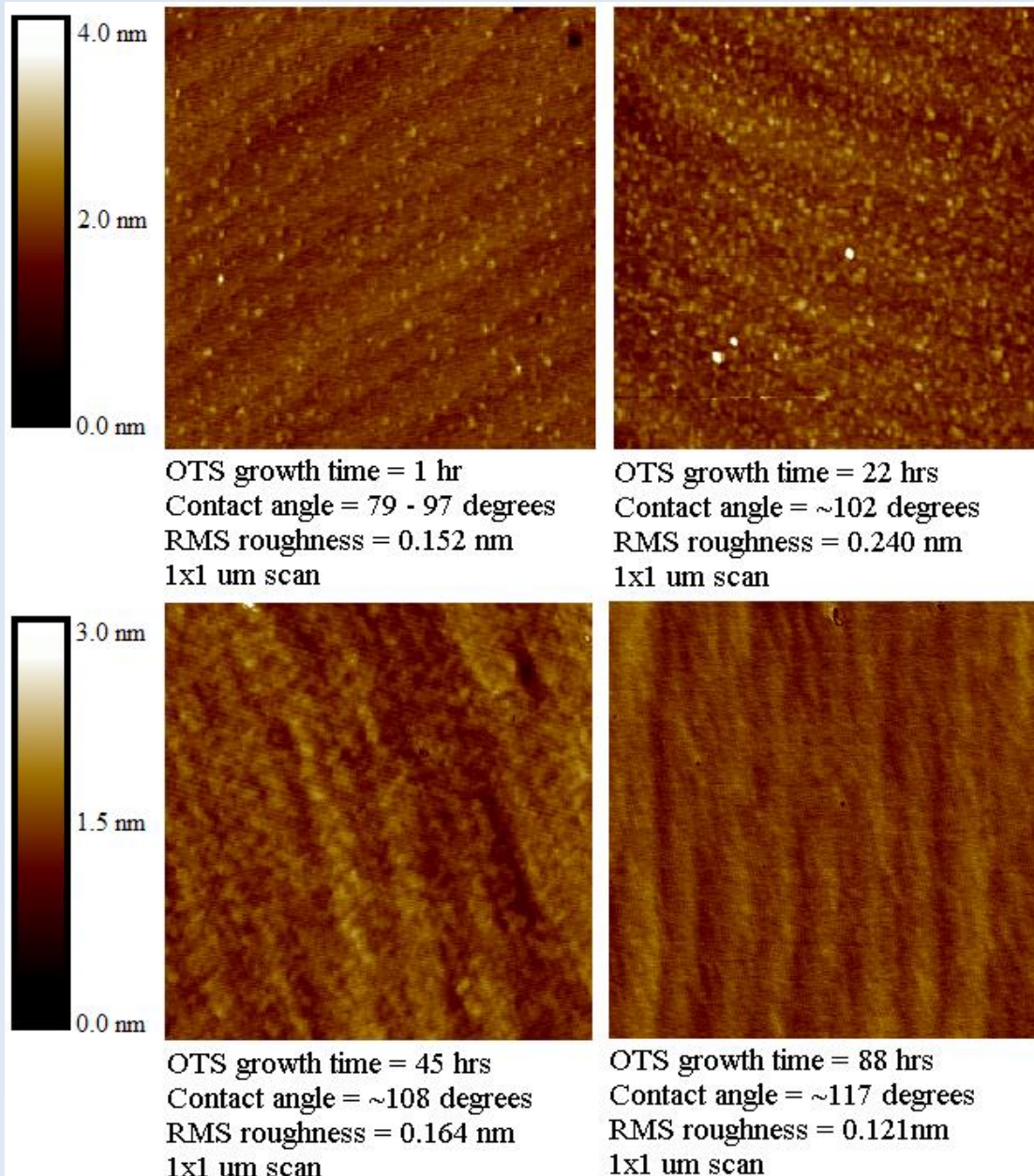


Monolayer Growth Deposition in Solution

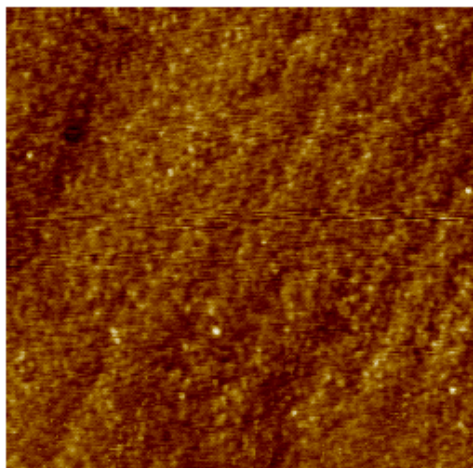


Wang and Lieberman; Langmuir, Vol. 19, No. 4, (2003)

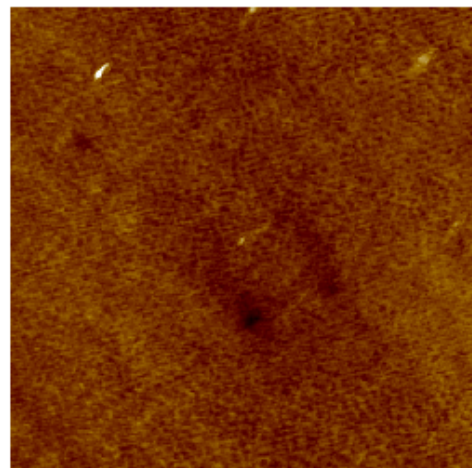
OTS Functionalized GaN Surface



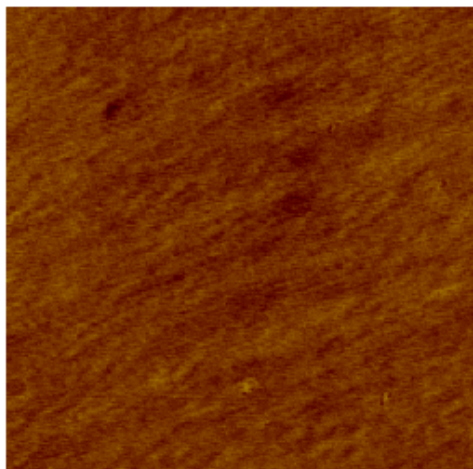
APTES Functionalized GaN Surface



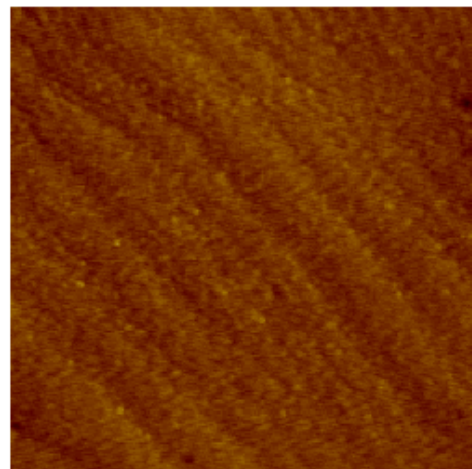
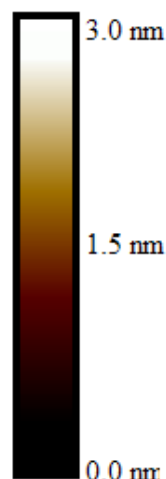
APTES growth time = 15 min
Contact angle = low 60's
RMS roughness = 0.255 nm
1x1 um scan



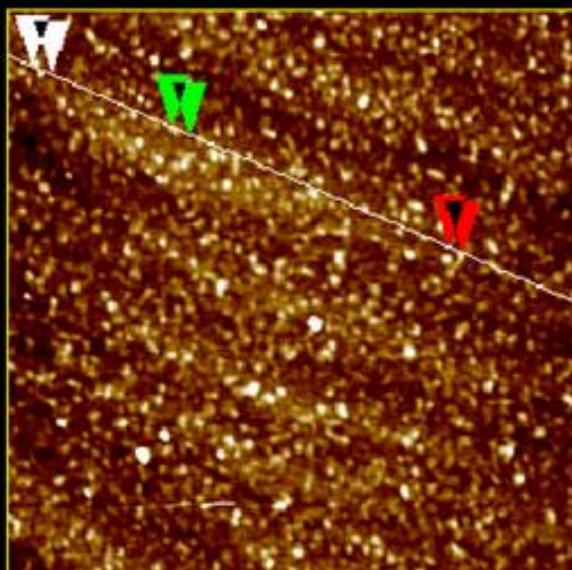
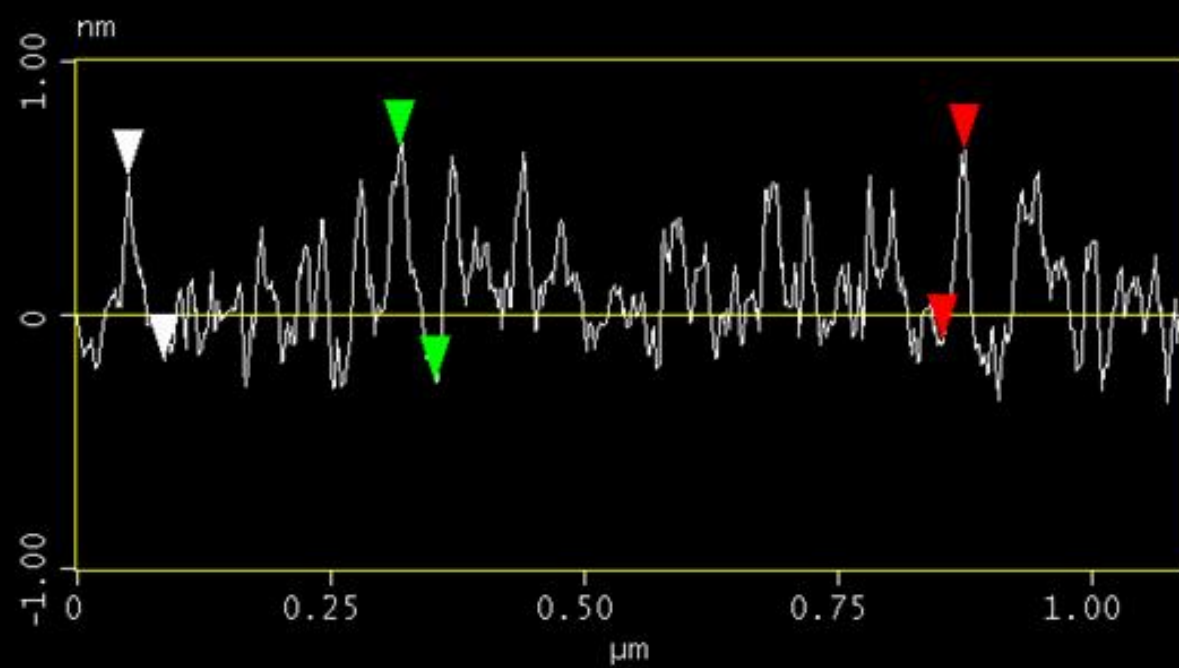
APTES growth time = 25 min
Contact angle = low 60's
RMS roughness = 0.229 nm
1x1 um scan



APTES growth time = 45 min
Contact angle = low 70's
RMS roughness = 0.182 nm
1x1 um scan



APTES growth time = 1hr
Contact angle = low 80's
RMS roughness = 0.186 nm
1x1 um scan

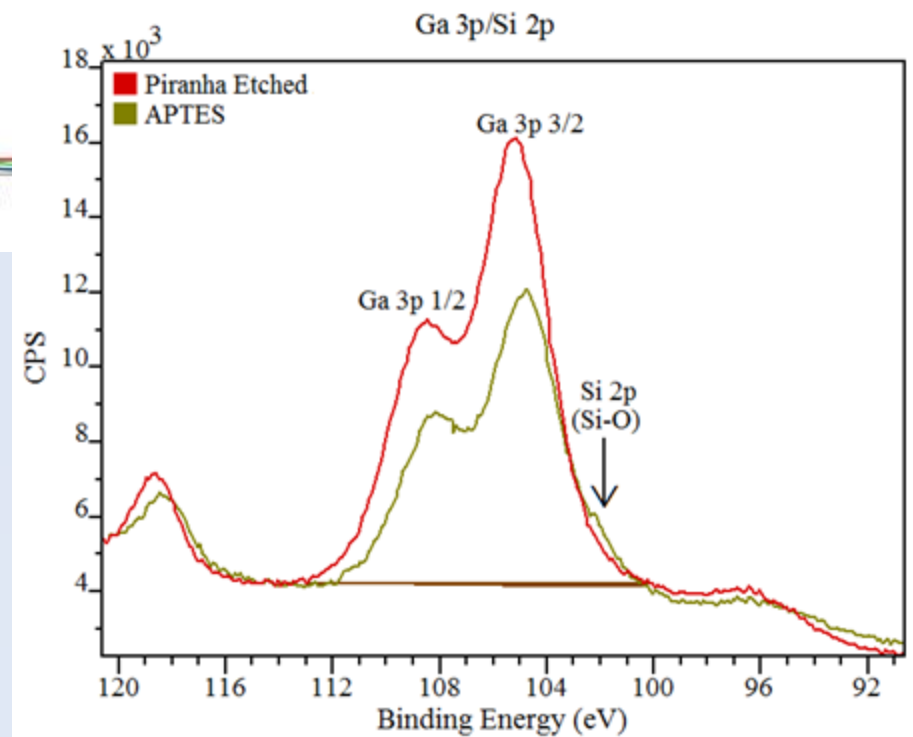
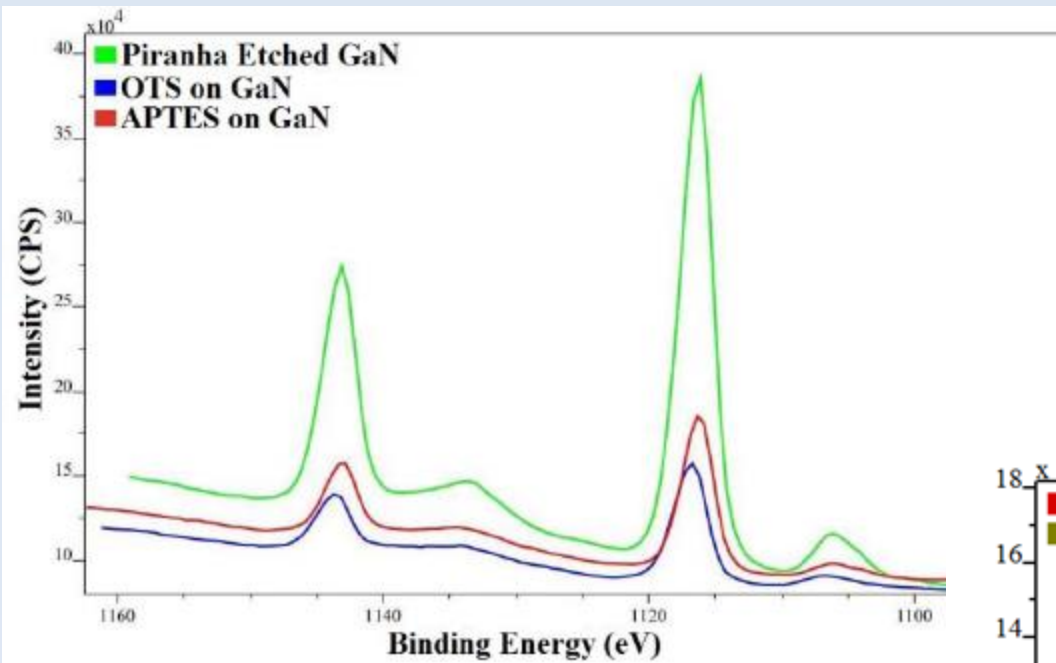


Vertical Distance **0.722 nm**

Vertical Distance **0.936 nm**

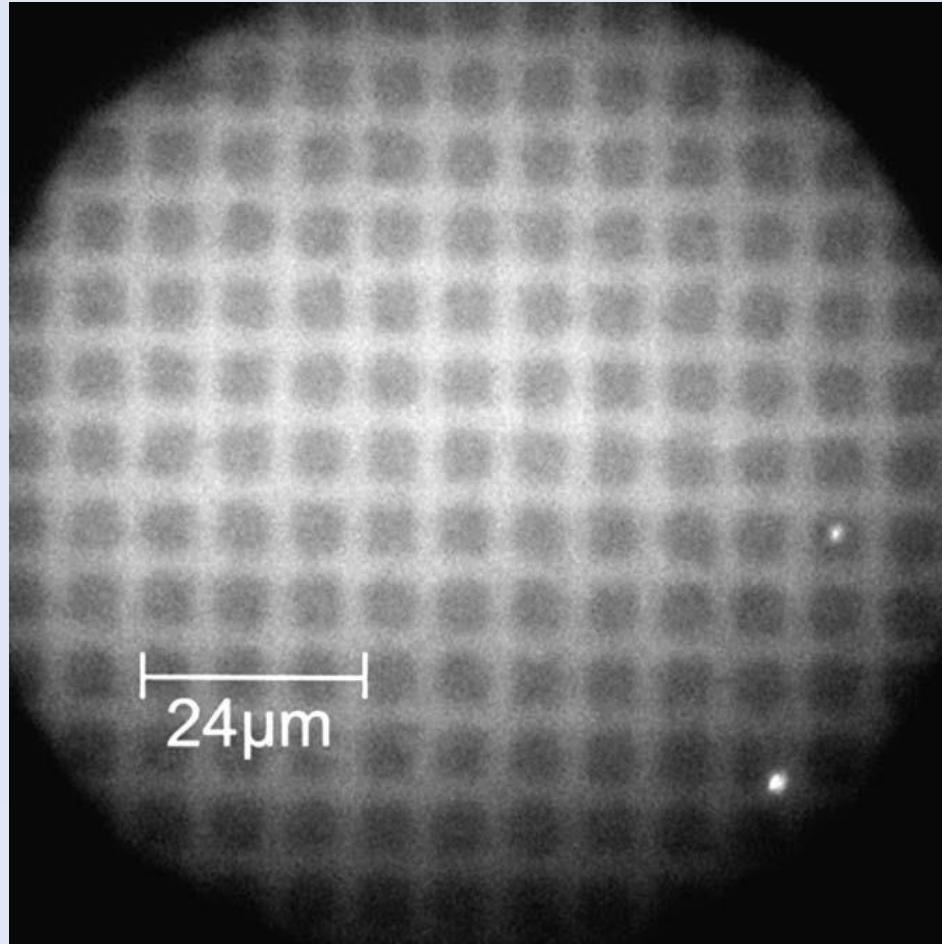
Vertical Distance **0.749 nm**

XPS

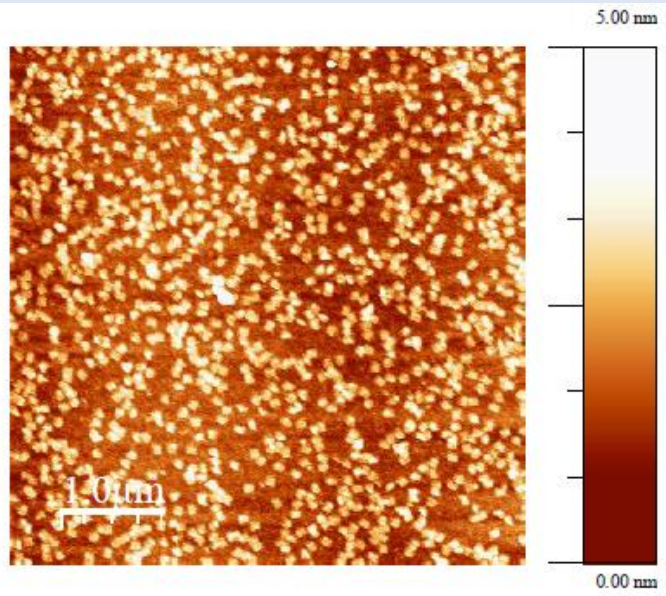


Questions?

DNA Immobilization on APTES

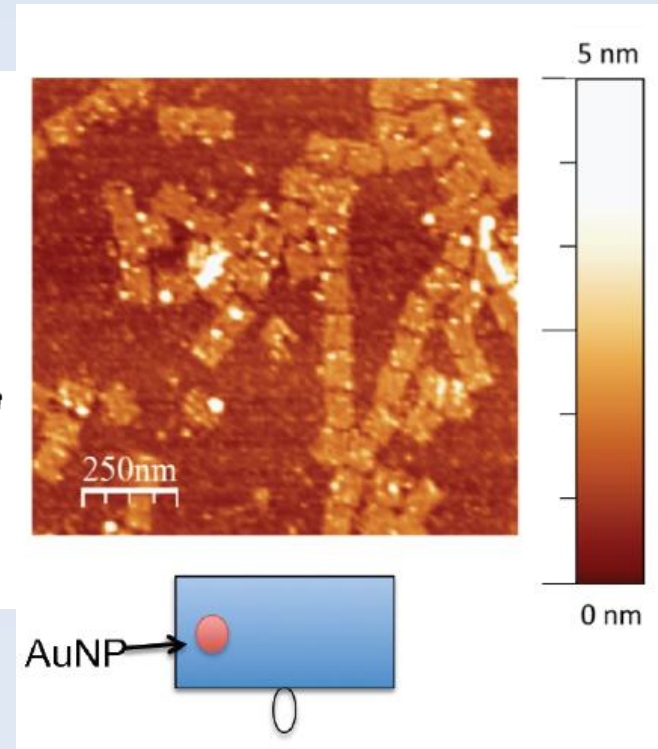
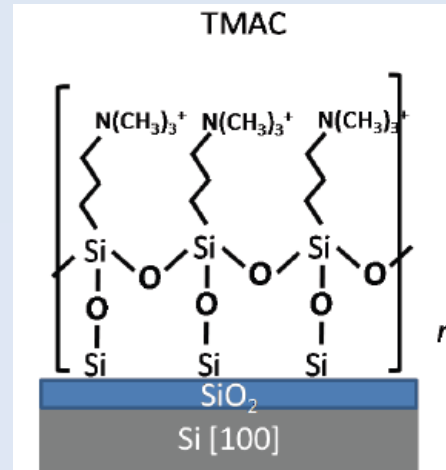


DNA Origami Immobilization onto APTES and TMAC



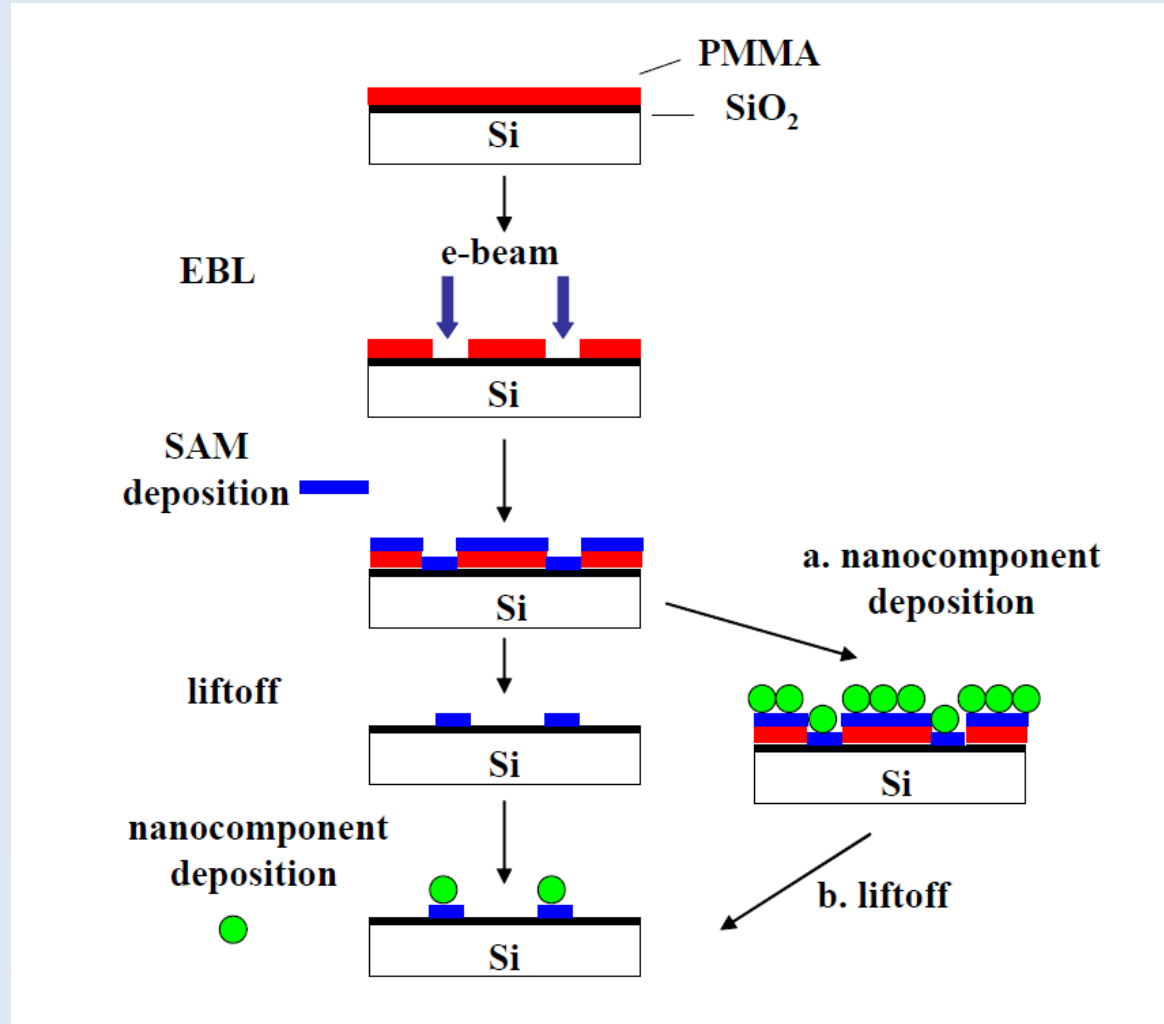
Goss, V. *Adsorbing, Desorbing, Jamming, and Burning DNA Origami* (2012)

Kim, K. *Self-aligned DNA Oligomer and the Deposition of DNA Oligomers on EBL Patterned Cationic SAMs on SiO₂/Si [1001]* (2012)



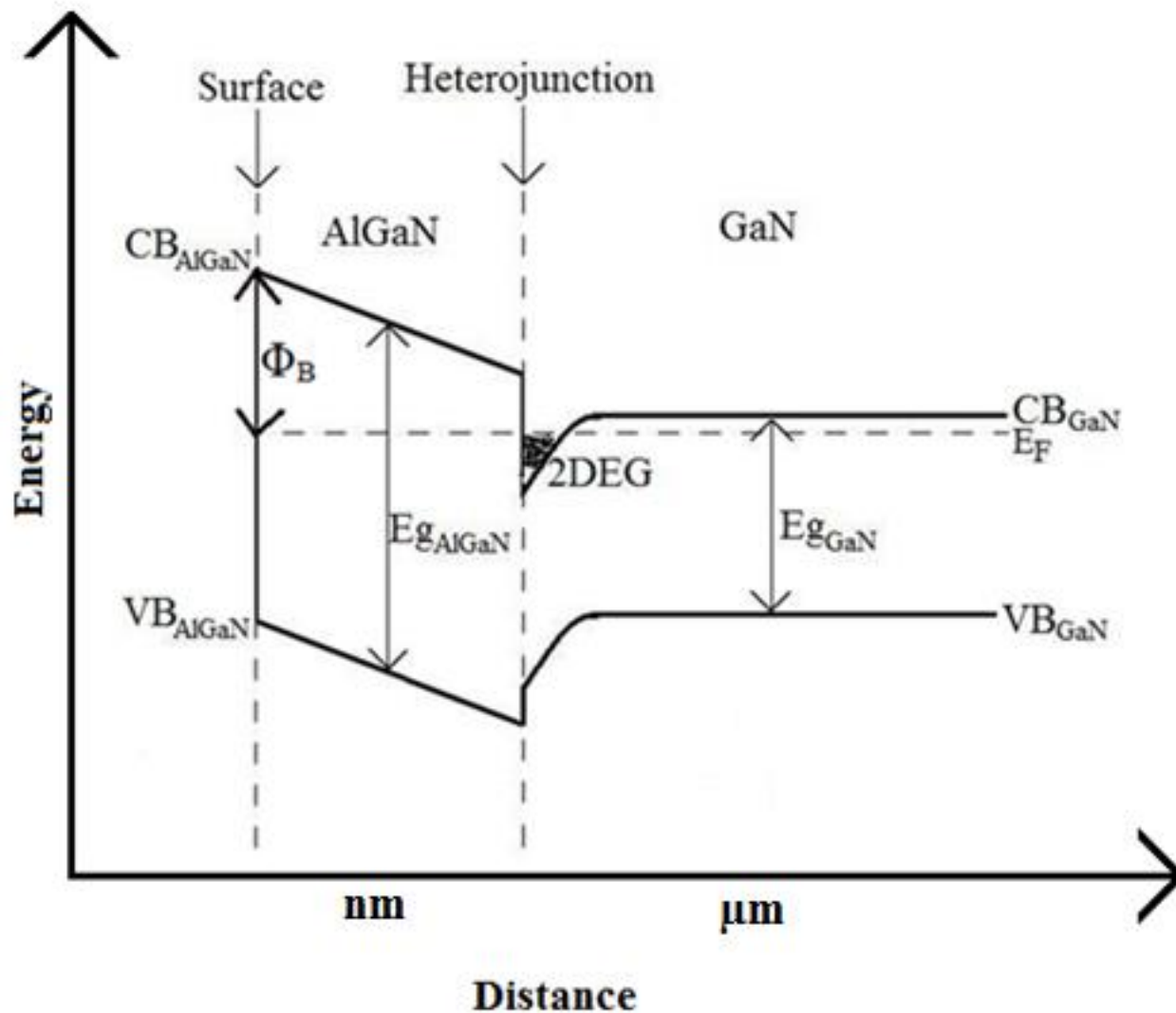
TMAC - Trimethyl[(trimethoxysilyl)propyl]ammonium chloride

Patterned DNA Origami Immobilization on APTES



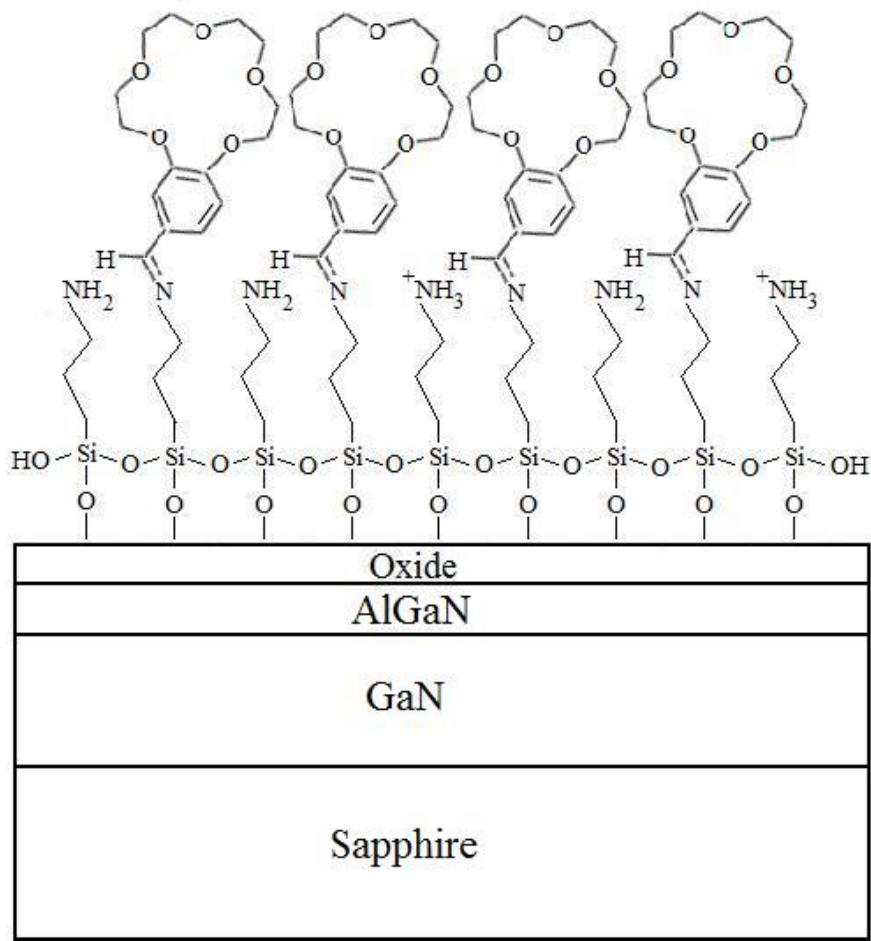
Gao, B. *PATTERNING BIOMOLECULES AT SUB-30 NM RESOLUTION BY ELECTRON BEAM LITHOGRAPHY* (2009)

HEMT Structures for Sensor Applications

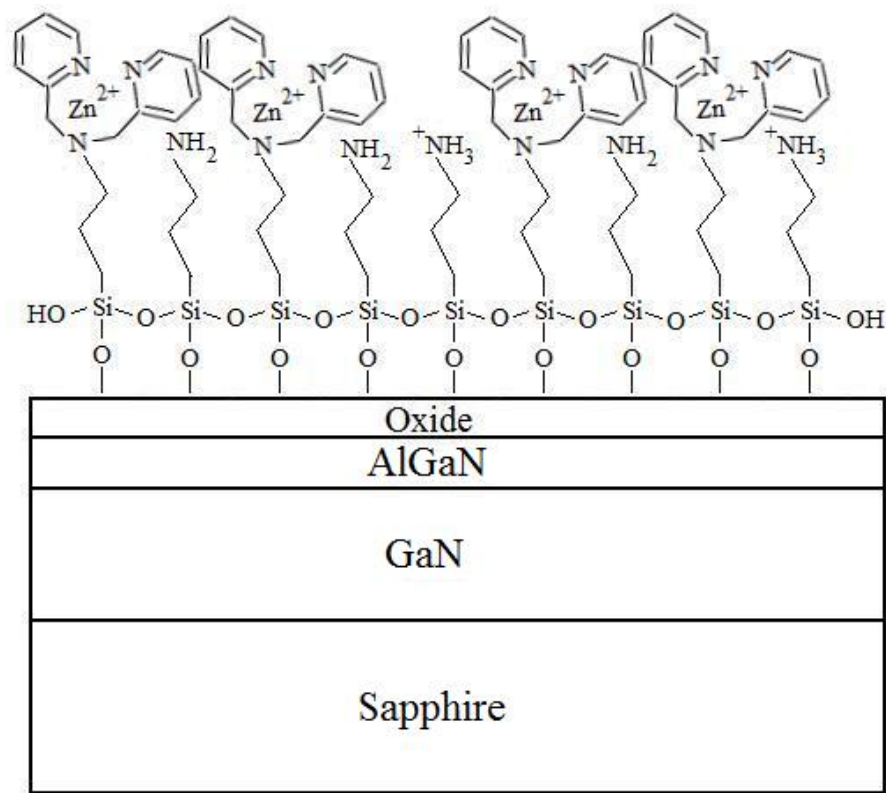


HEMT -
High
Electron
Mobility
Transistor

Ion Sensing SAM's on HEMT's

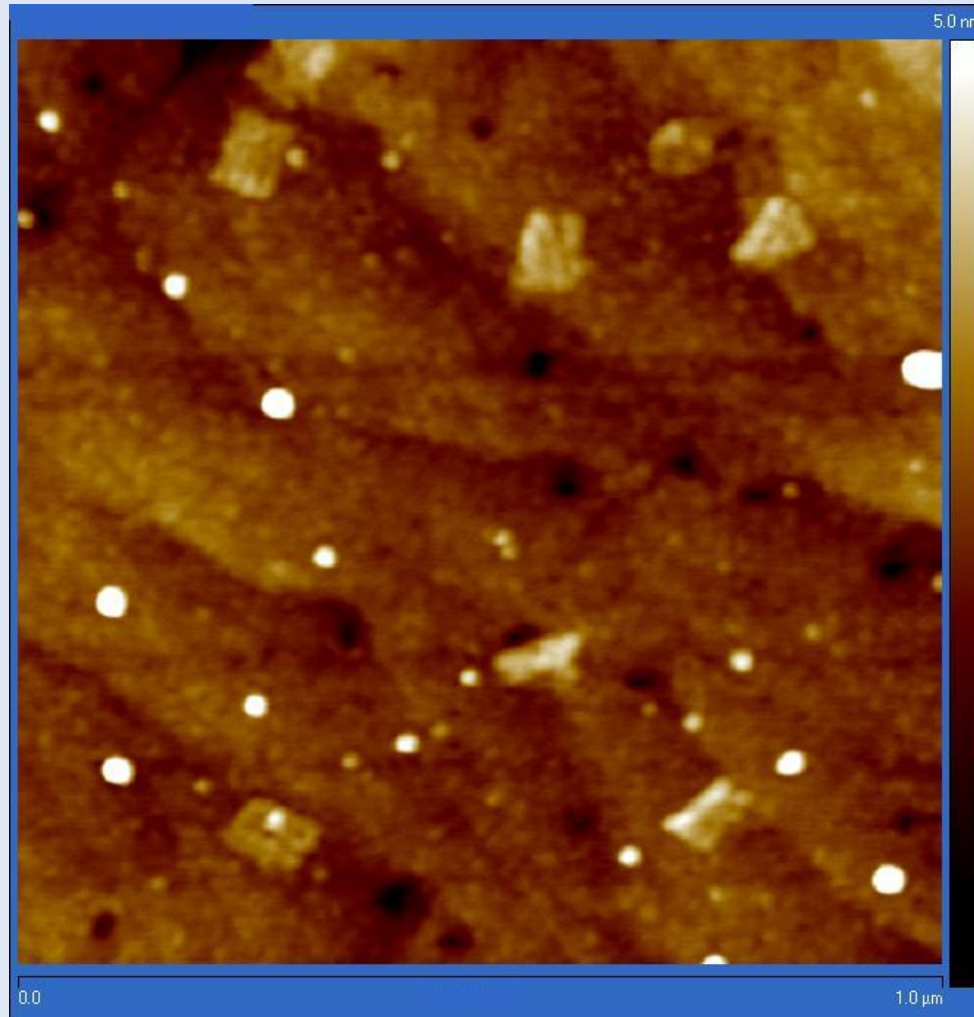


Formylbenzyl-15-crown-5



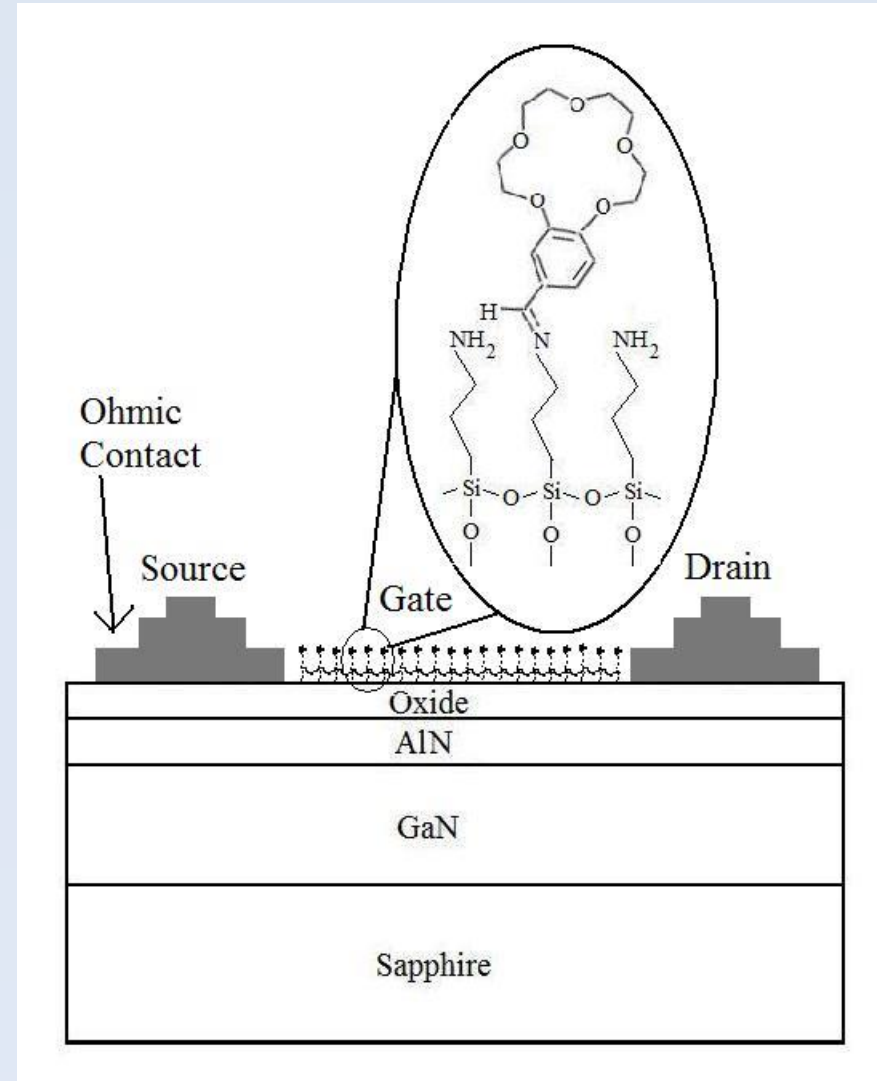
DPA - Dipicolylamine

DNA Origami on DPA-Zn-APTES

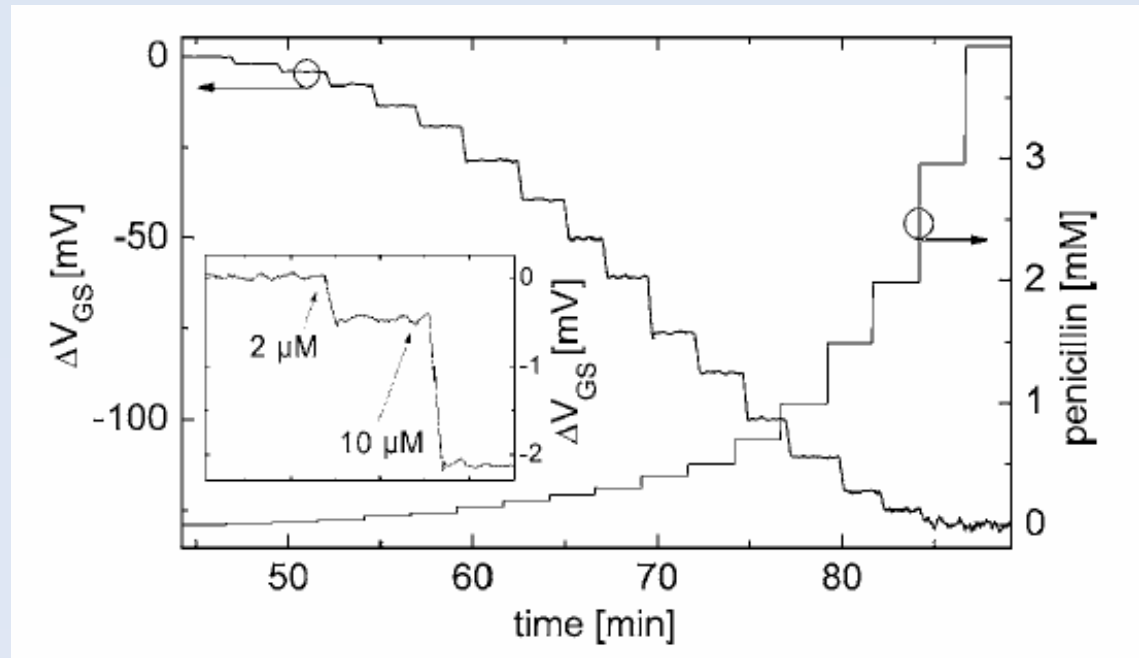
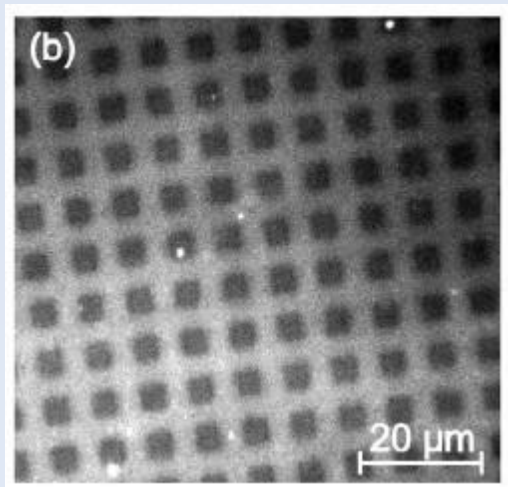
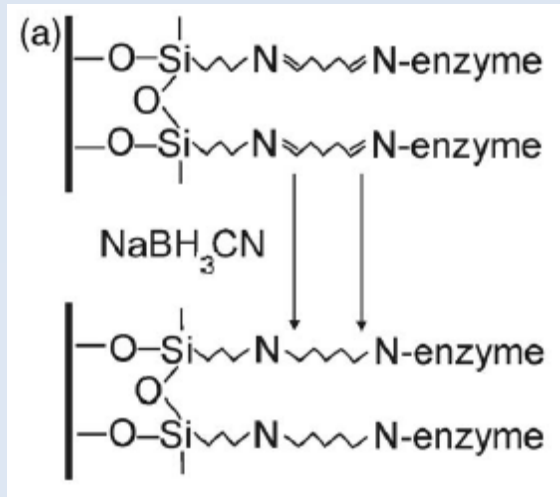


Functionalized Device (HEMT) Structure

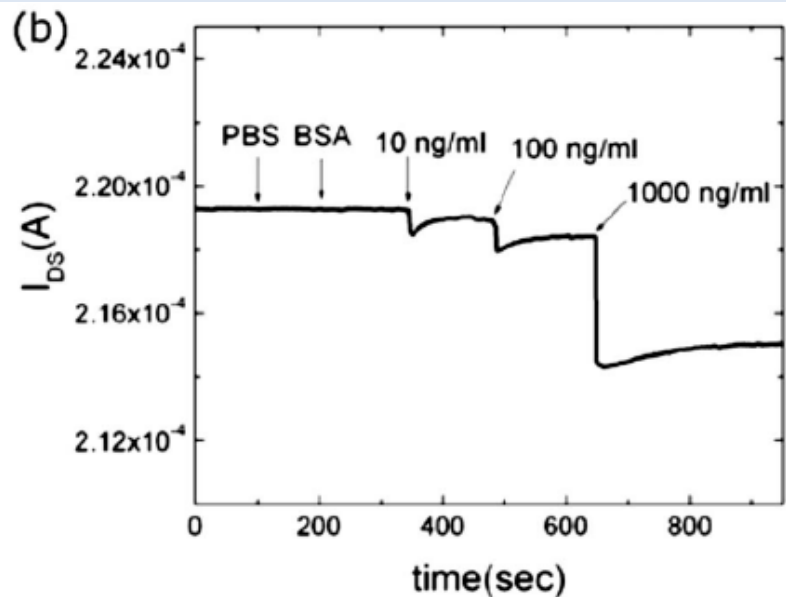
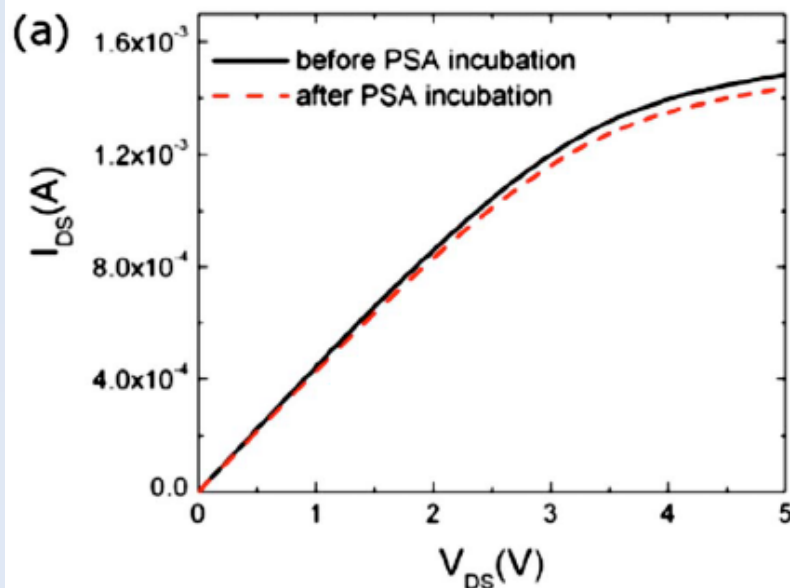
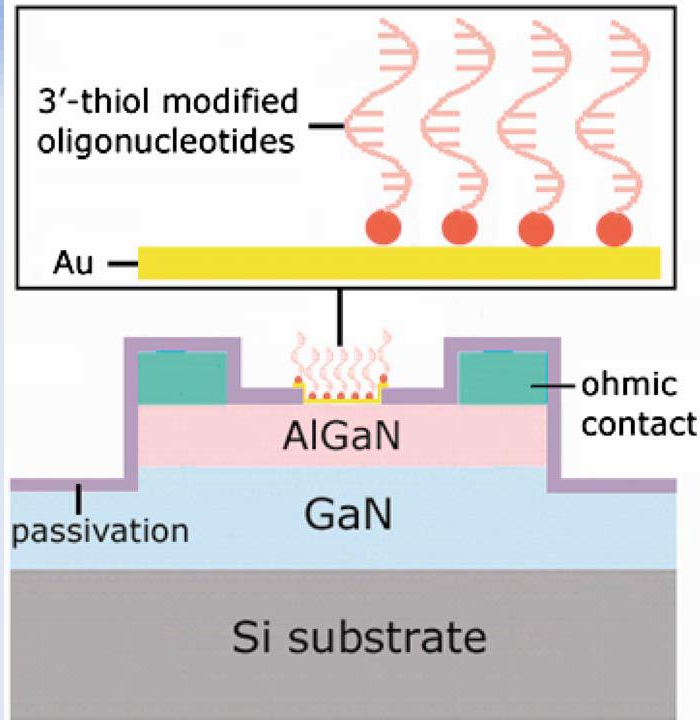
- Deposit metal Ohmic contacts on surface for source and drain
- APTES functionalization as gate region
- APTES modification w. crowns or DPA's
- Expose to solutions of target ions
- Measure sensor function



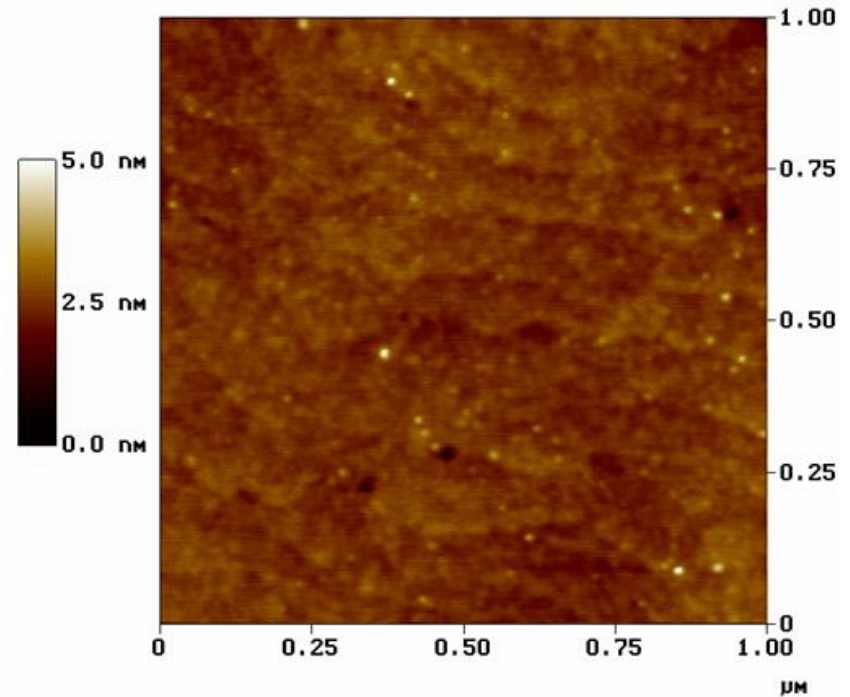
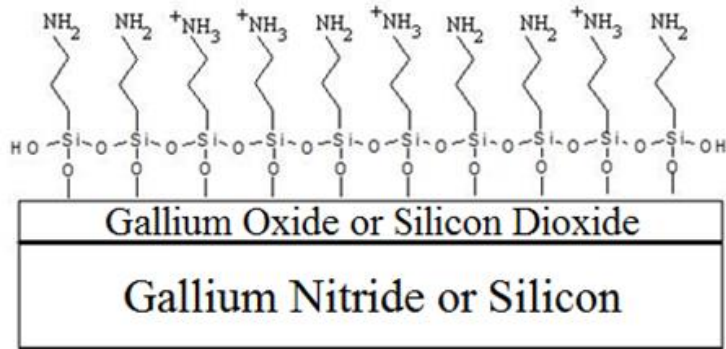
Enzyme Activity Sensor



Functioning Sensor with another SAM/Surface Combination



Conclusions



Acknowledgements

- Dr. Marya Lieberman and the Lieberman Group (University of Notre Dame, Dept. of Chemistry)
 - Dr. Bo Gao
 - Dr. Valerie Goss
 - Dr. Kyoung Nan Kim
- Dr. Huili Grace Xing (University of Notre Dame, Dept. of Electrical Engineering)
- The University of Notre Dame
 - The non-referenced research presented was performed at the University of Notre Dame, Dept. of Chemistry.



Questions?



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*Nanotechnology Course Resources II:
Patterning, Characterization, and Applications*

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Educators, Workshop

Hands-on Introduction to Nanotechnology for

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