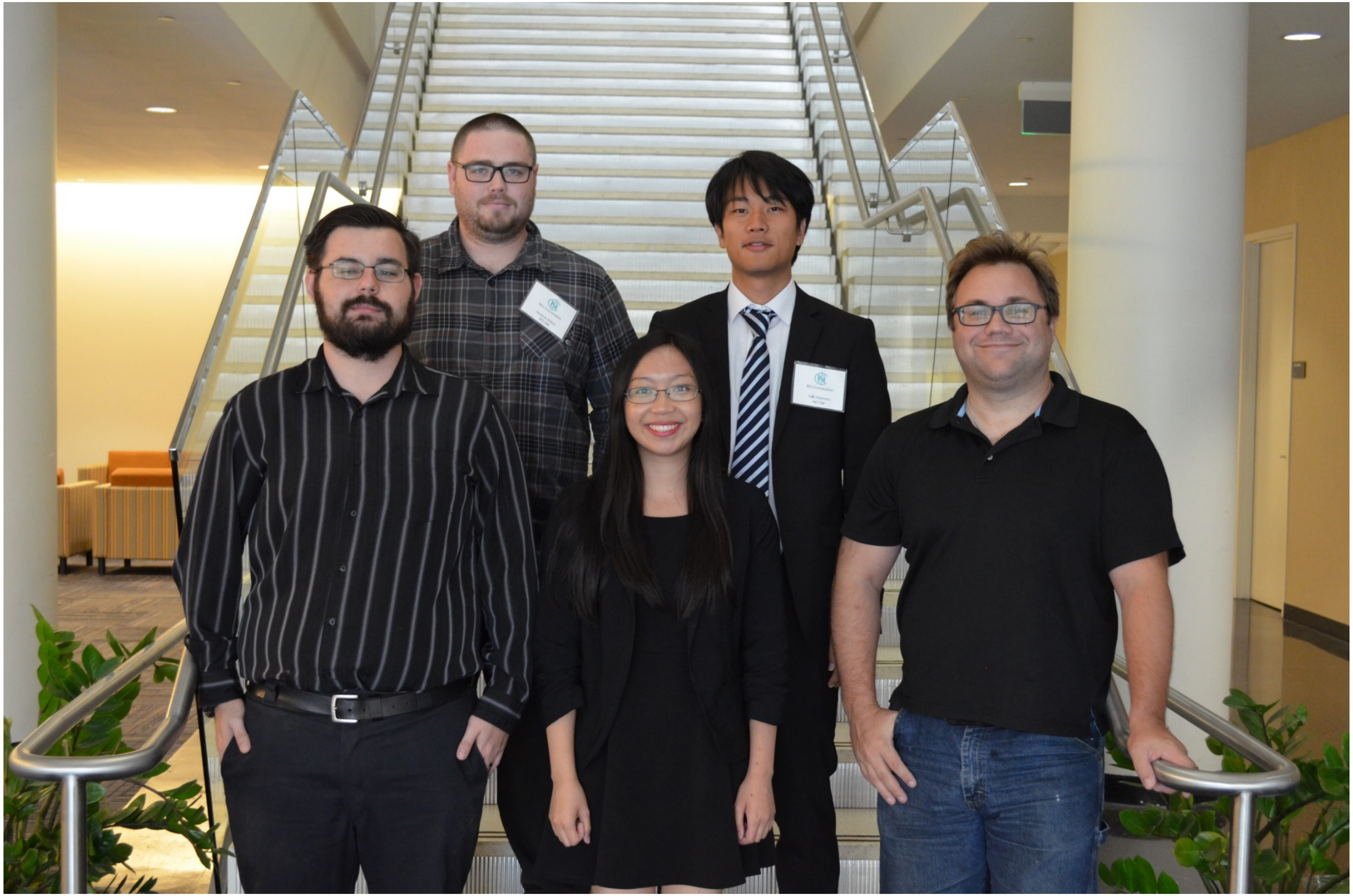
2017 NNCI REU Program

Arizona State University



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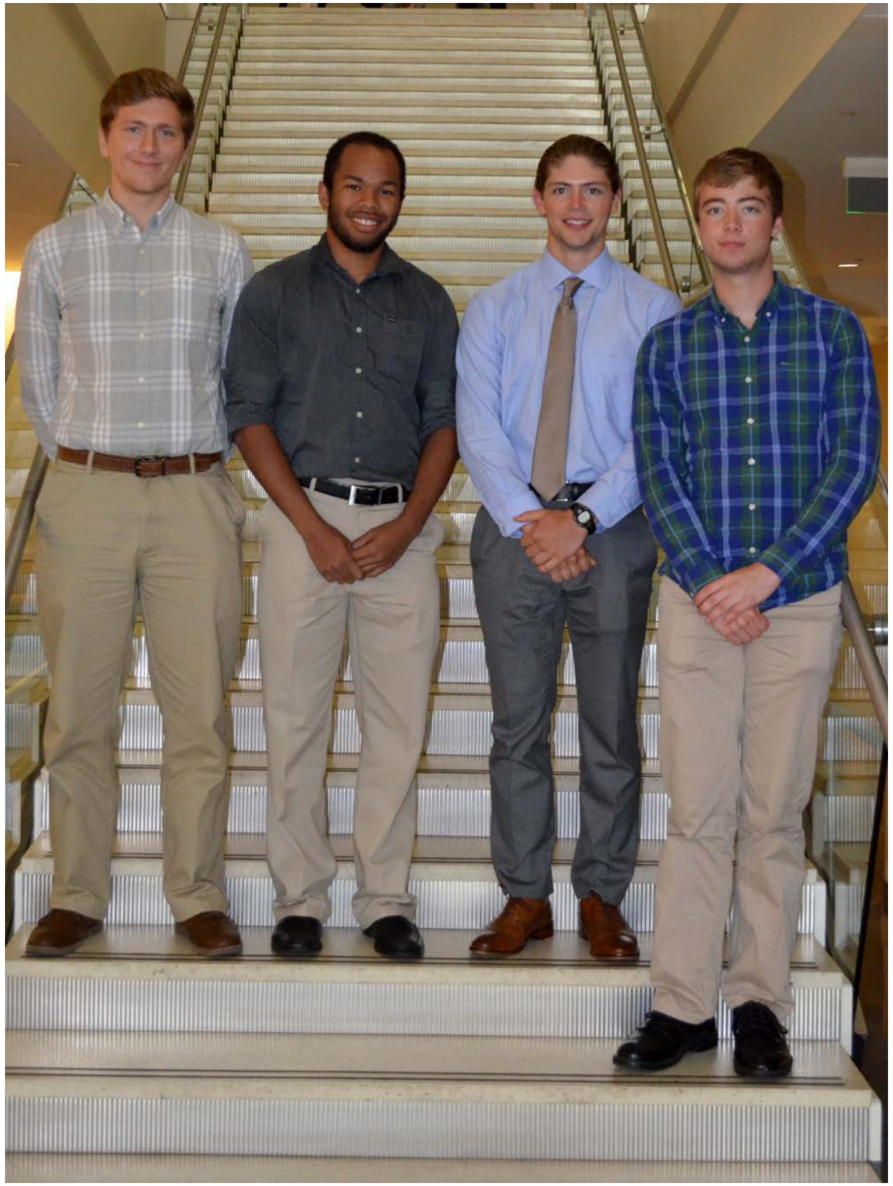

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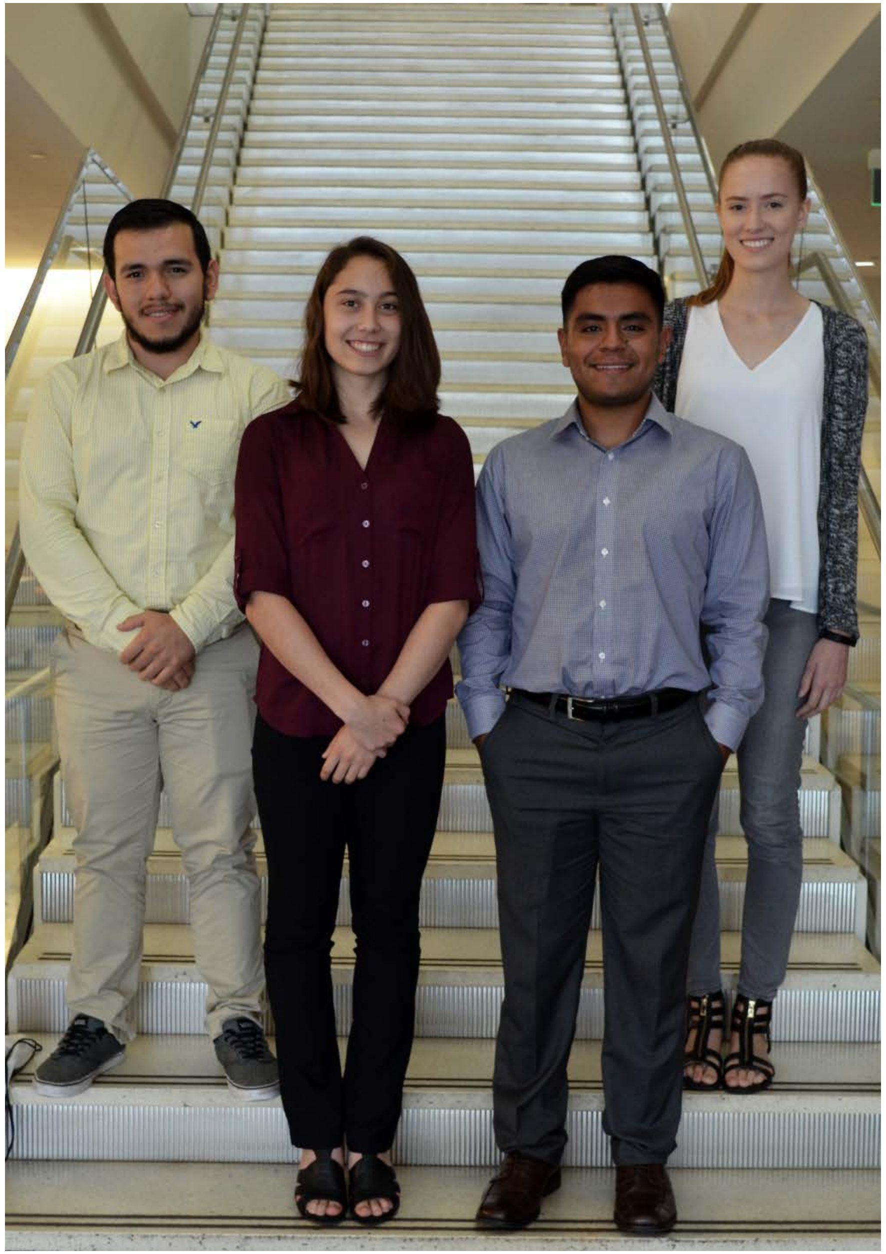

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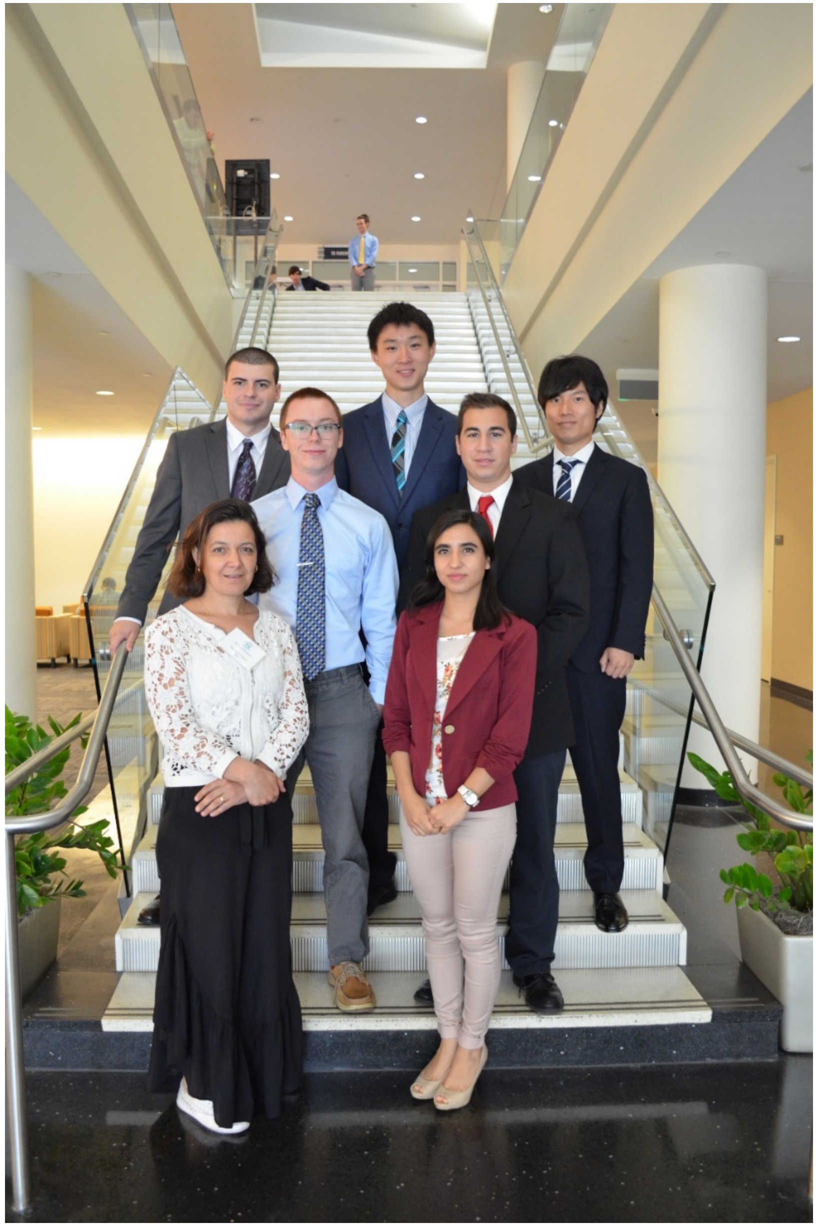

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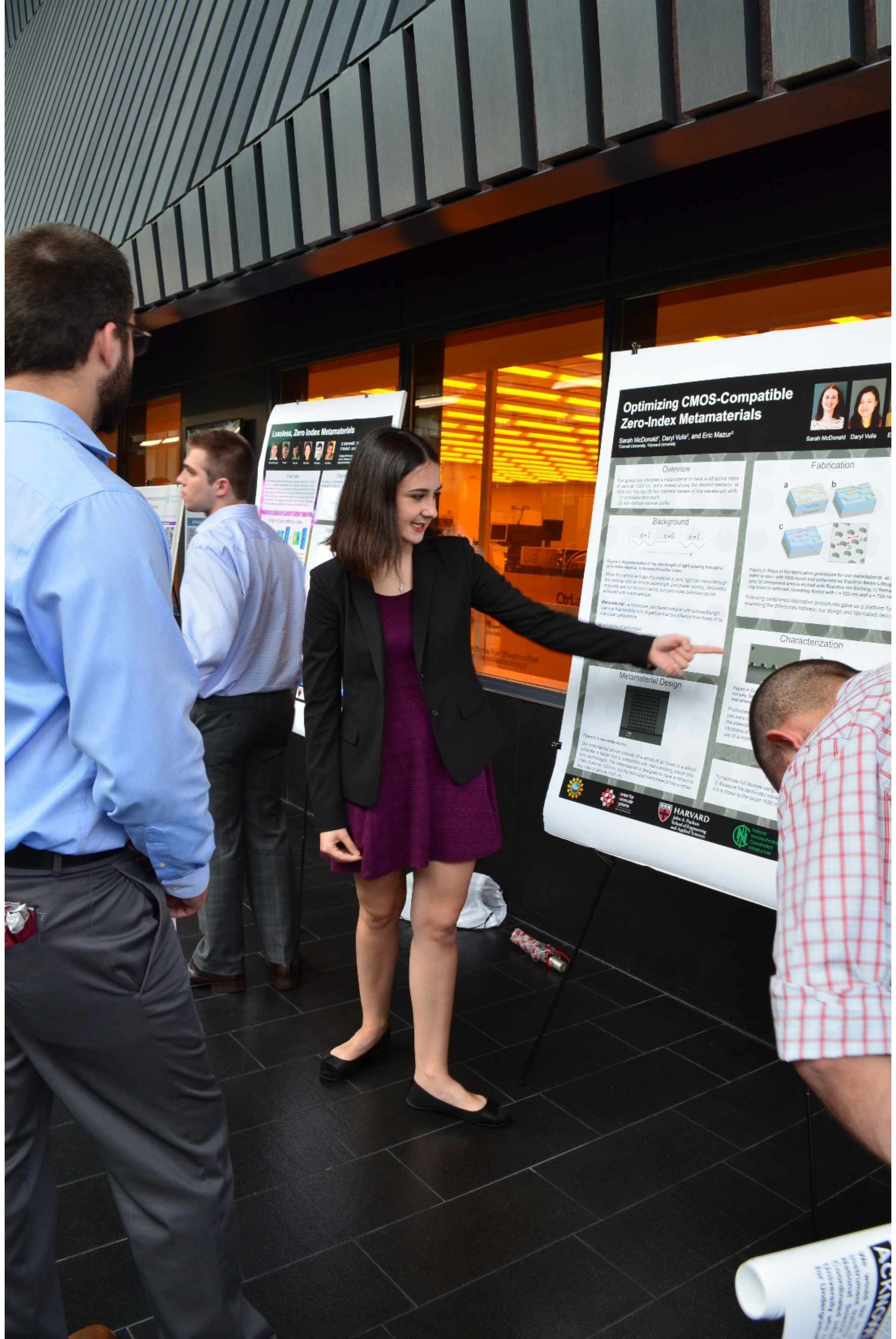
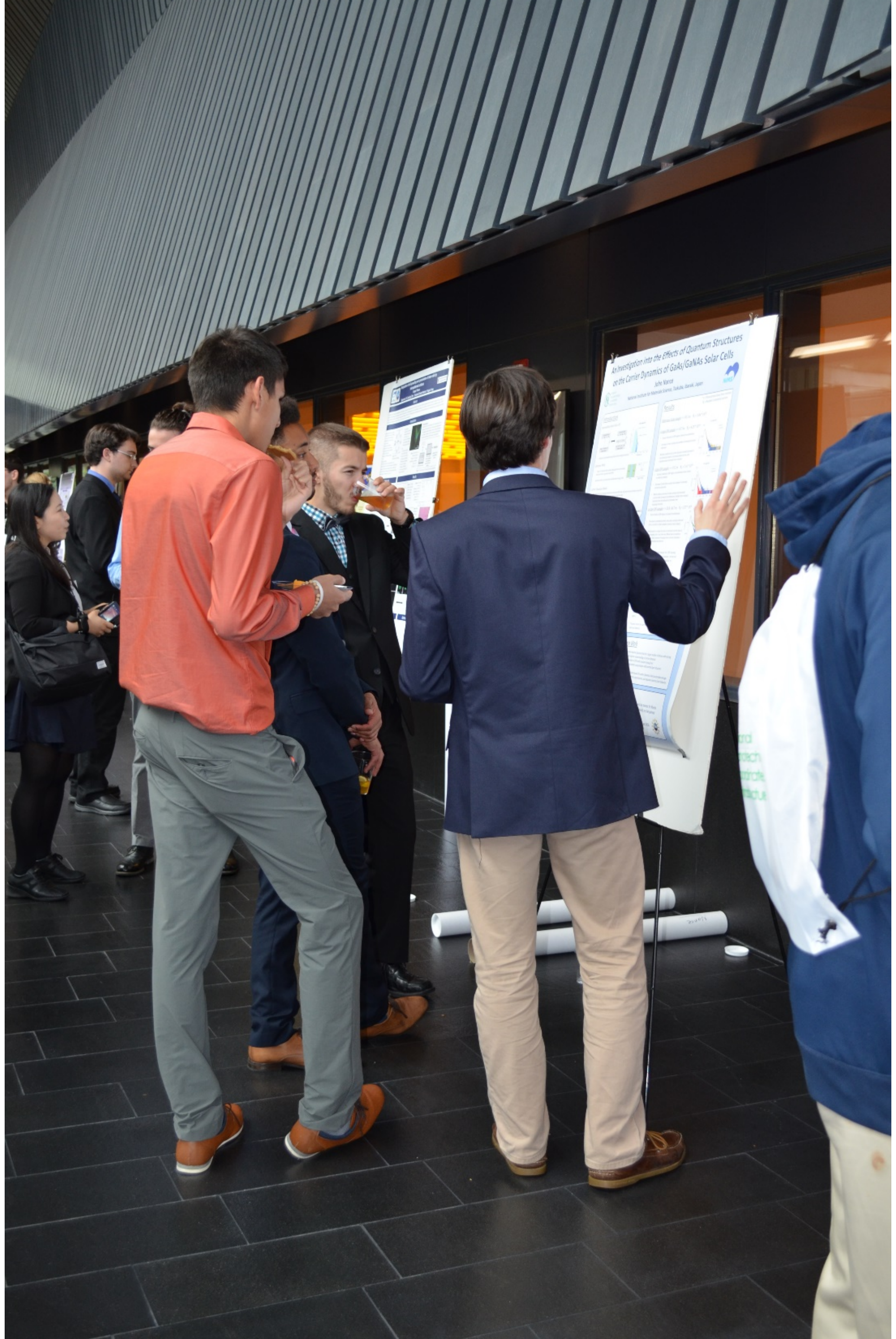

Optimizing CMOS-Compatible Zero-Index Metamaterials
Sarah McDonald, Daryl Vulis, and Eric Mazur
Sarah McDonald
Daryl Vulis
Overview
Background
Fabrication
Characterization
Metamaterial Design
HARVARD
Lossless, Zero Index Metamaterials


An Investigation into the Effects of Quantum Structures on the Carrier Dynamics of GaAs/GaNAs Solar Cells
John Nance
National Institute for Materials Science, Tsukuba, Ibaraki, Japan
Results


An Investigation into the Effects of Quantum Structures on the Carrier Dynamics of GaAs/GaNAs Solar Cells
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NIMS
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Conclusions
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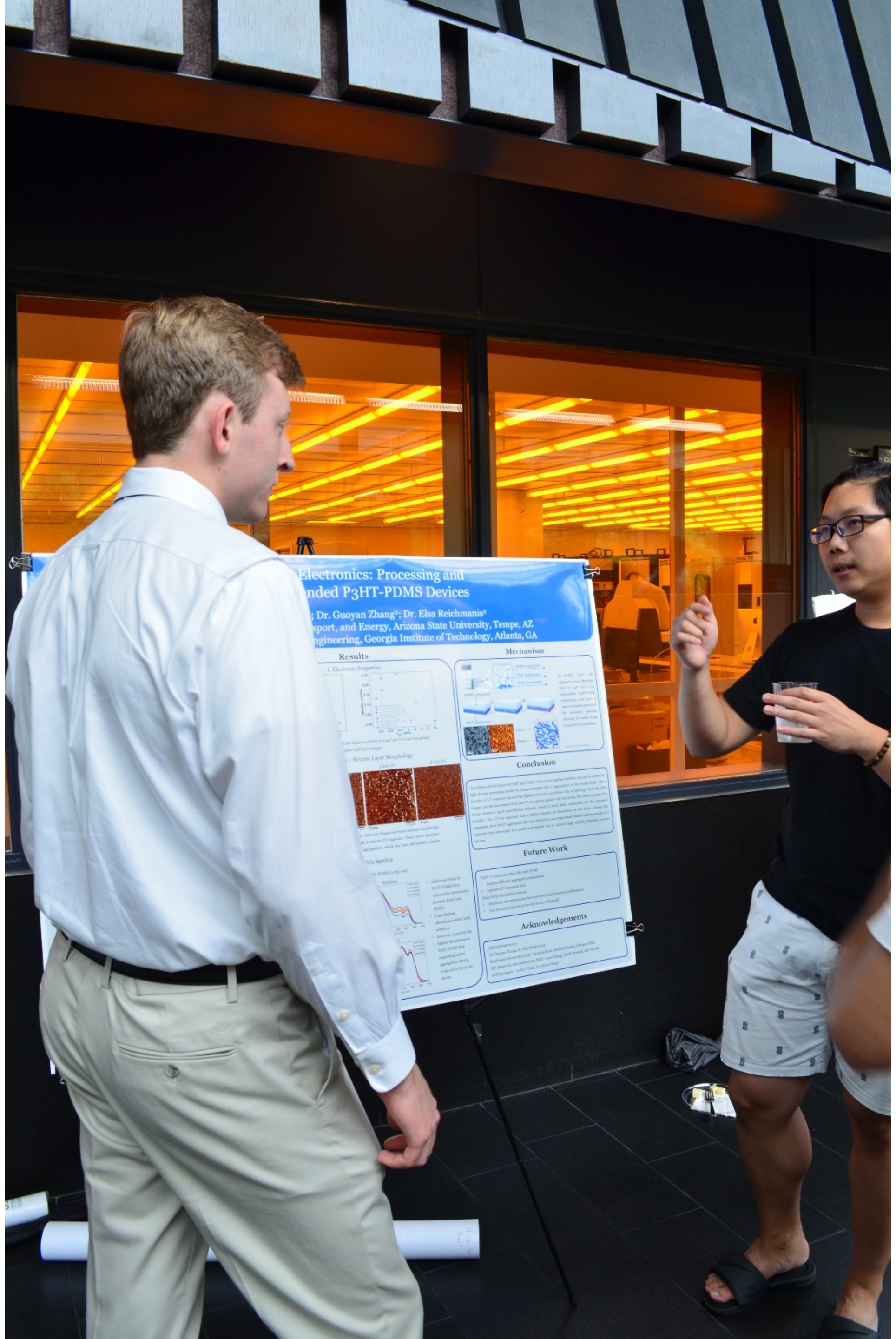
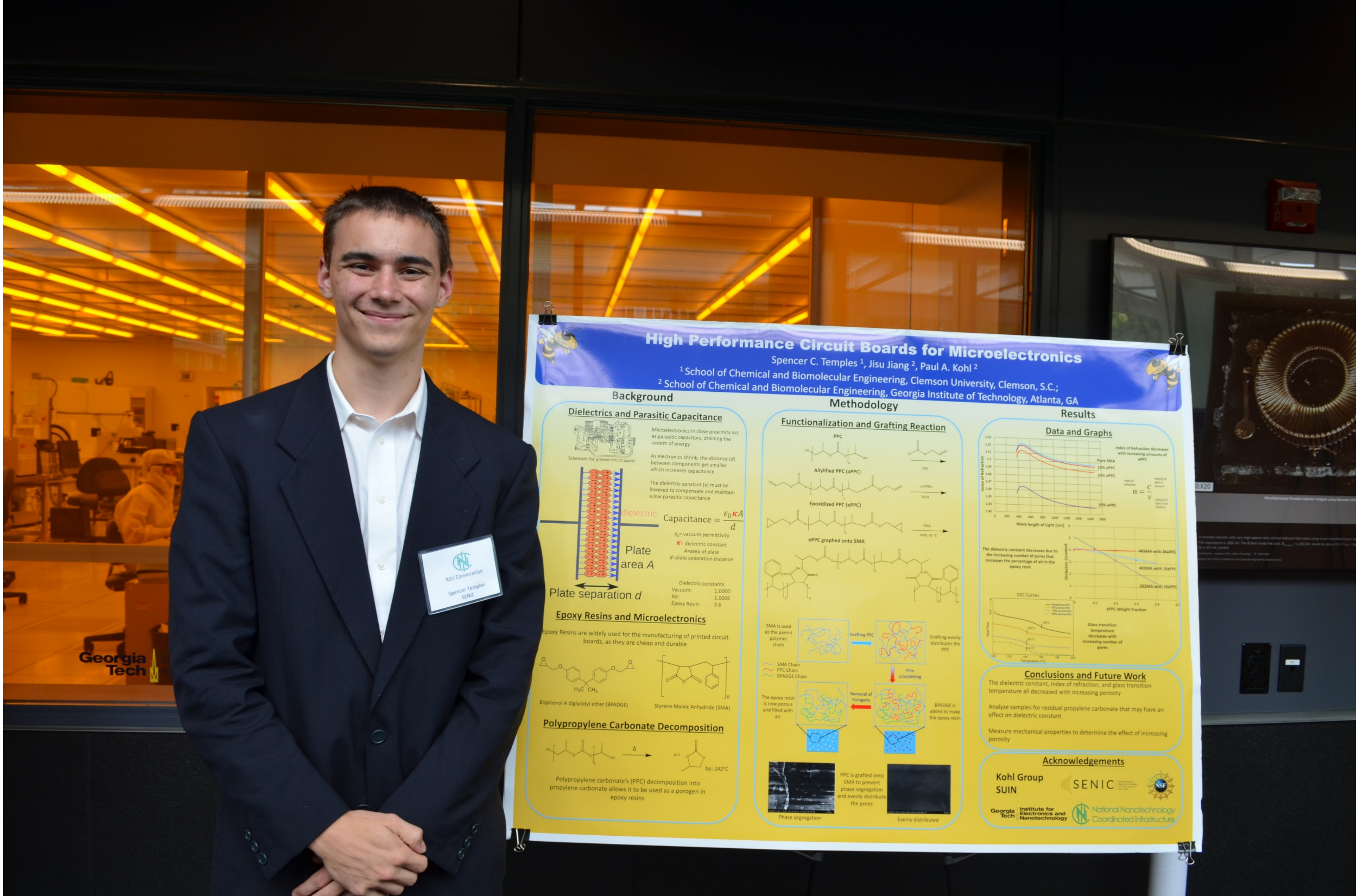
Acknowledgements


Electronics: Processing and
nded P3HT-PDMS Devices
; Dr. Guoyan Zhang²; Dr. Elsa Reichmanis²
sport, and Energy, Arizona State University, Tempe, AZ
ngineering, Georgia Institute of Technology, Atlanta, GA
Results
I. Electronic Properties
Mechanism
Conclusion
Future Work
Acknowledgements



High Performance Circuit Boards for Microelectronics

Spencer C. Temples [1], Jisu Jiang [2], Paul A. Kohl [2]
[1] School of Chemical and Biomolecular Engineering, Clemson University, Clemson, S.C.;
[2] School of Chemical and Biomolecular Engineering, Georgia Institute of Technology, Atlanta, GA

Background

Dielectrics and Parasitic Capacitance

Microelectronics in close proximity act as parasitic capacitors, draining the system of energy.

As electronics shrink, the distance (d) between components get smaller which increases capacitance.

The dielectric constant (κ) must be lowered to compensate and maintain a low parasitic capacitance

$$\text{Capacitance} = \frac{\varepsilon_0 \kappa A}{d}$$

ε_0= vacuum permittivity
κ= dielectric constant
A=area of plate
d=plate separation distance

Dielectric constants	
Vacuum:	1.0000
Air:	1.0006
Epoxy Resin:	3.6

Epoxy Resins and Microelectronics

Epoxy Resins are widely used for the manufacturing of printed circuit boards, as they are cheap and durable

Bisphenol A diglycidyl ether (BPADGE)

Styrene Maleic Anhydride (SMA)

Polypropylene Carbonate Decomposition

Polypropylene carbonate's (PPC) decomposition into propylene carbonate allows it to be used as a porogen in epoxy resins

Methodology

Functionalization and Grafting Reaction

SMA is used as the parent polymer chain

Grafting evenly distributes the PPC

BPADGE is added to make the epoxy resin

The epoxy resin is now porous and filled with air

PPC is grafted onto SMA to prevent phase segregation and evenly distribute the pores

Phase segregation

Evenly distributed

Results

Data and Graphs

Index of Refraction decreases with increasing amounts of ePPC

$$n = \frac{c}{v}$$

The dielectric constant decreases due to the increasing number of pores that increases the percentage of air in the epoxy resin

Glass transition temperature decreases with increasing number of pores

Conclusions and Future Work

The dielectric constant, index of refraction, and glass transition temperature all decreased with increasing porosity

Analyze samples for residual propylene carbonate that may have an effect on dielectric constant

Measure mechanical properties to determine the effect of increasing porosity

Acknowledgements

Kohl Group
SUIN
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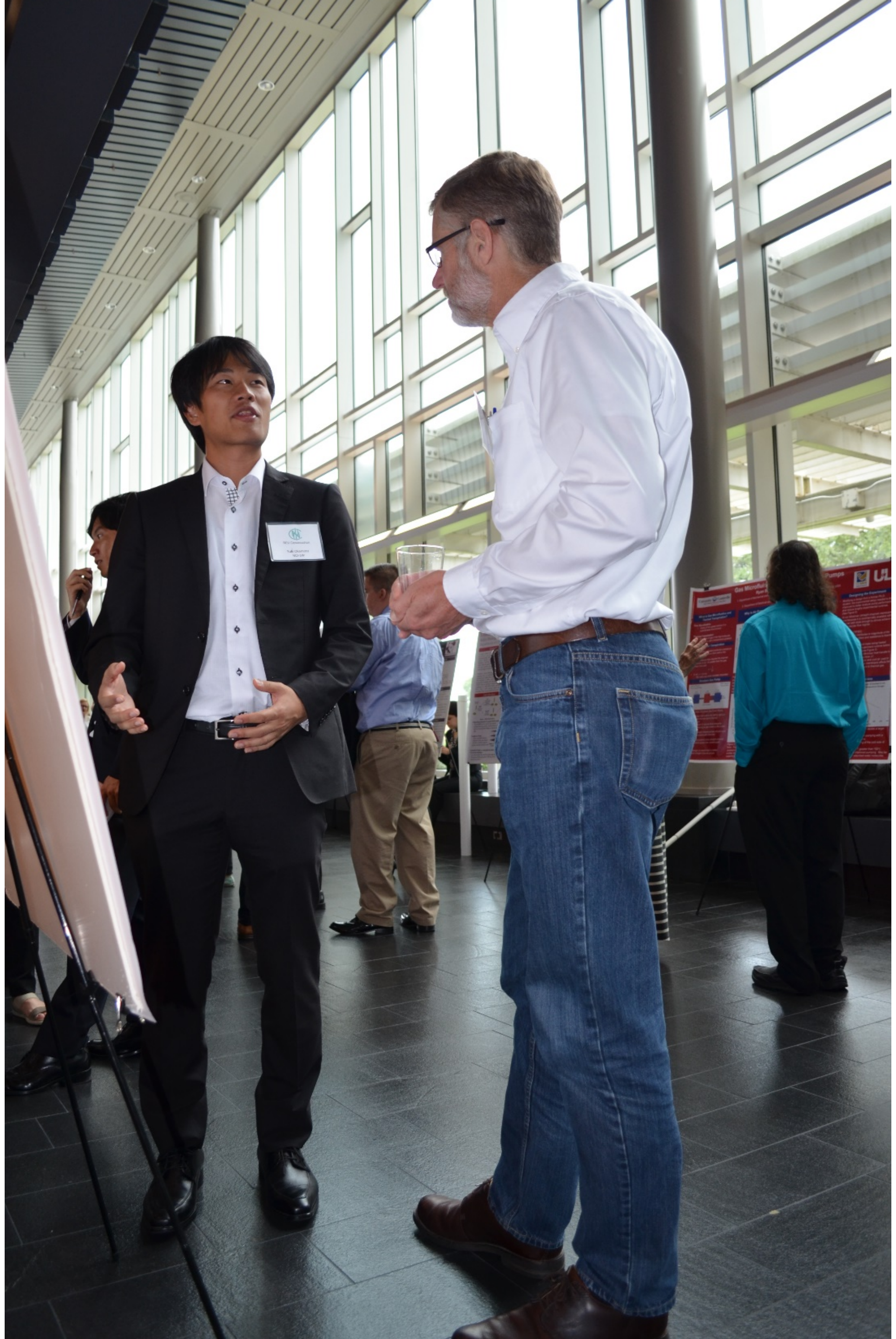
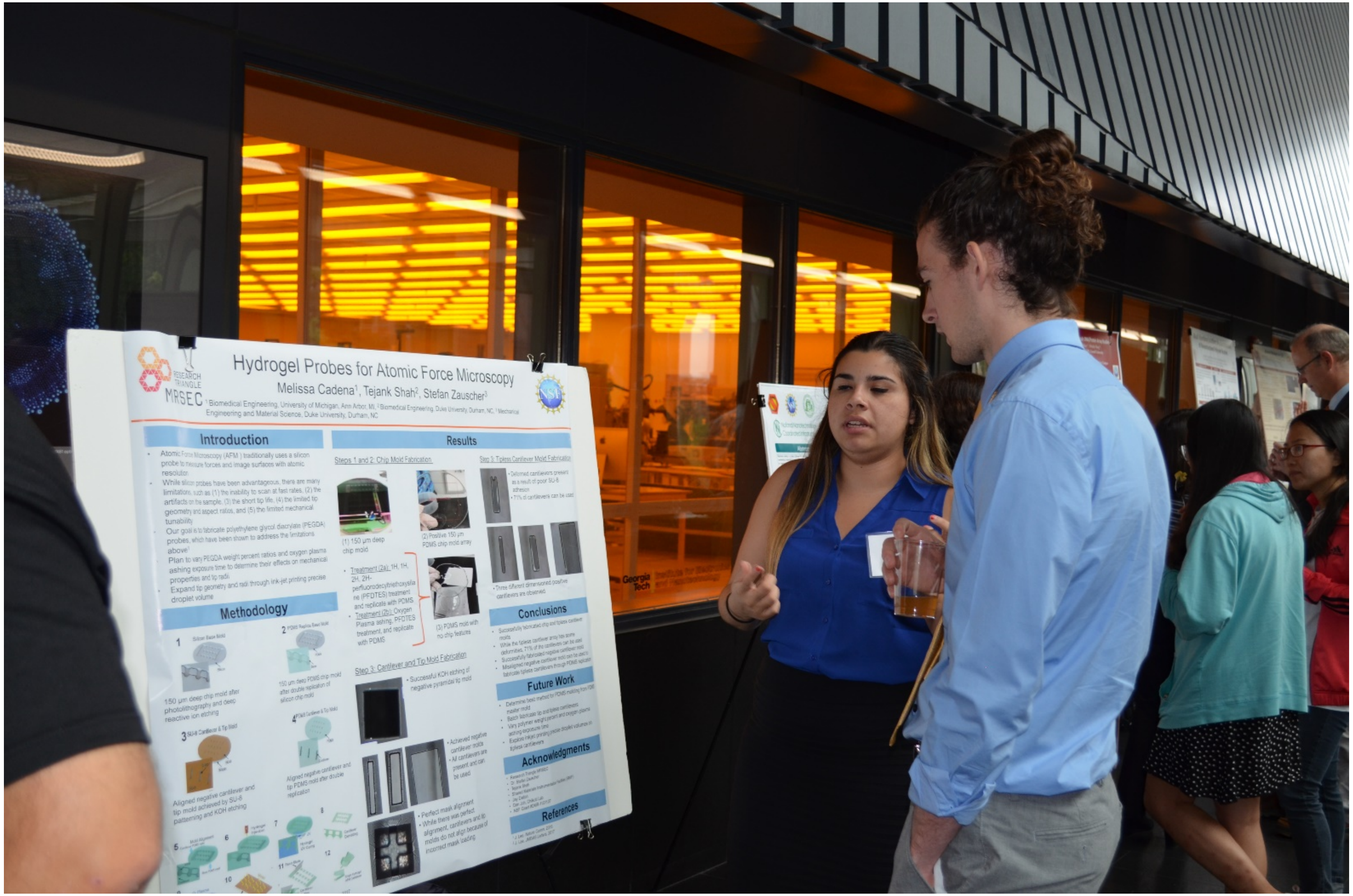
NSF
Georgia Tech Institute for Electronics and Nanotechnology
National Nanotechnology Coordinated Infrastructure




Hydrogel Probes for Atomic Force Microscopy
Melissa Cadena, Tejank Shah, Stefan Zauscher
MRSEC
Introduction
Results
Methodology
SENIC



Hydrogel Probes for Atomic Force Microscopy

Melissa Cadena[1], Tejank Shah[2], Stefan Zauscher[3]

[1] Biomedical Engineering, University of Michigan, Ann Arbor, MI, [2] Biomedical Engineering, Duke University, Durham, NC, [3] Mechanical Engineering and Material Science, Duke University, Durham, NC

Introduction

- Atomic Force Microscopy (AFM) traditionally uses a silicon probe to measure forces and image surfaces with atomic resolution
- While silicon probes have been advantageous, there are many limitations, such as (1) the inability to scan at fast rates, (2) the artifacts on the sample, (3) the short tip life, (4) the limited tip geometry and aspect ratios, and (5) the limited mechanical tunability
- Our goal is to fabricate polyethylene glycol diacrylate (PEGDA) probes, which have been shown to address the limitations above[1]
- Plan to vary PEGDA weight percent ratios and oxygen plasma ashing exposure time to determine their effects on mechanical properties and tip radii
- Expand tip geometry and radii through ink-jet printing precise droplet volume

Methodology

1 Silicon Base Mold

150 μm deep chip mold after photolithography and deep reactive ion etching

2 PDMS Replica Base Mold

150 μm deep PDMS chip mold after double replication of silicon chip mold

3 SU-8 Cantilever & Tip Mold

Aligned negative cantilever and tip mold achieved by SU-8 patterning and KOH etching

4 PDMS Cantilever & Tip Mold

Aligned negative cantilever and tip PDMS mold after double replication

Results

Steps 1 and 2: Chip Mold Fabrication

(1) 150 μm deep chip mold

(2) Positive 150 μm PDMS chip mold array

- Treatment (2a): 1H, 1H, 2H, 2H-perfluorodecyltriethoxysilane (PFDTES) treatment and replicate with PDMS
- Treatment (2b): Oxygen Plasma ashing, PFDTES treatment, and replicate with PDMS

(3) PDMS mold with no chip features

Step 3: Cantilever and Tip Mold Fabrication

- Successful KOH etching of negative pyramidal tip mold
- Achieved negative cantilever molds
- All cantilevers are present and can be used
- Perfect mask alignment
- While there was perfect alignment, cantilevers and tip molds do not align because of incorrect mask loading

Step 3: Tipless Cantilever Mold Fabrication

- Deformed cantilevers present as a result of poor SU-8 adhesion
- 71% of cantilevers can be used
- Three different dimensioned positive cantilevers are observed

Conclusions

- Successfully fabricated chip and tipless cantilever molds
- While the tipless cantilever array has some deformities, 71% of the cantilevers can be used
- Successfully fabricated negative cantilever mold
- Misaligned negative cantilever mold can be used to fabricate tipless cantilevers through PDMS replication

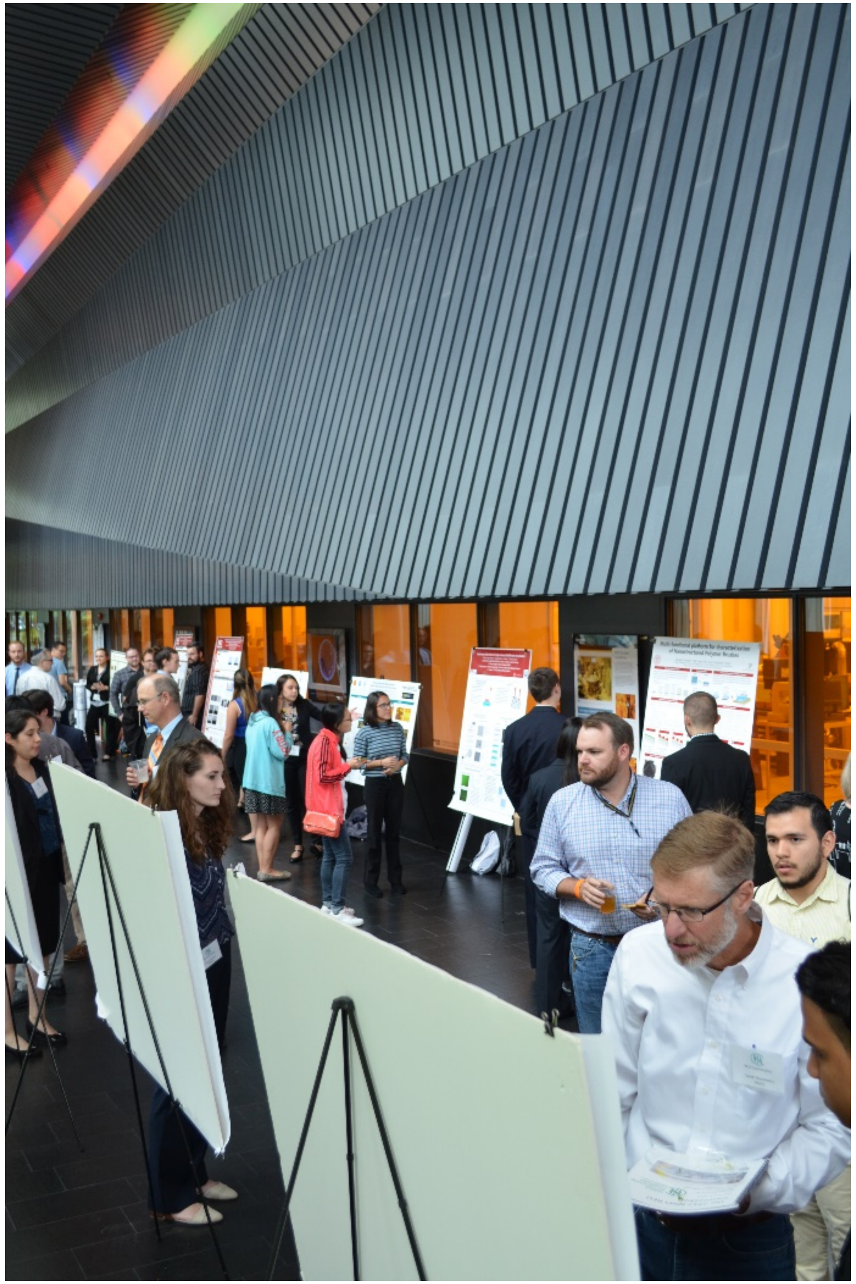
Future Work

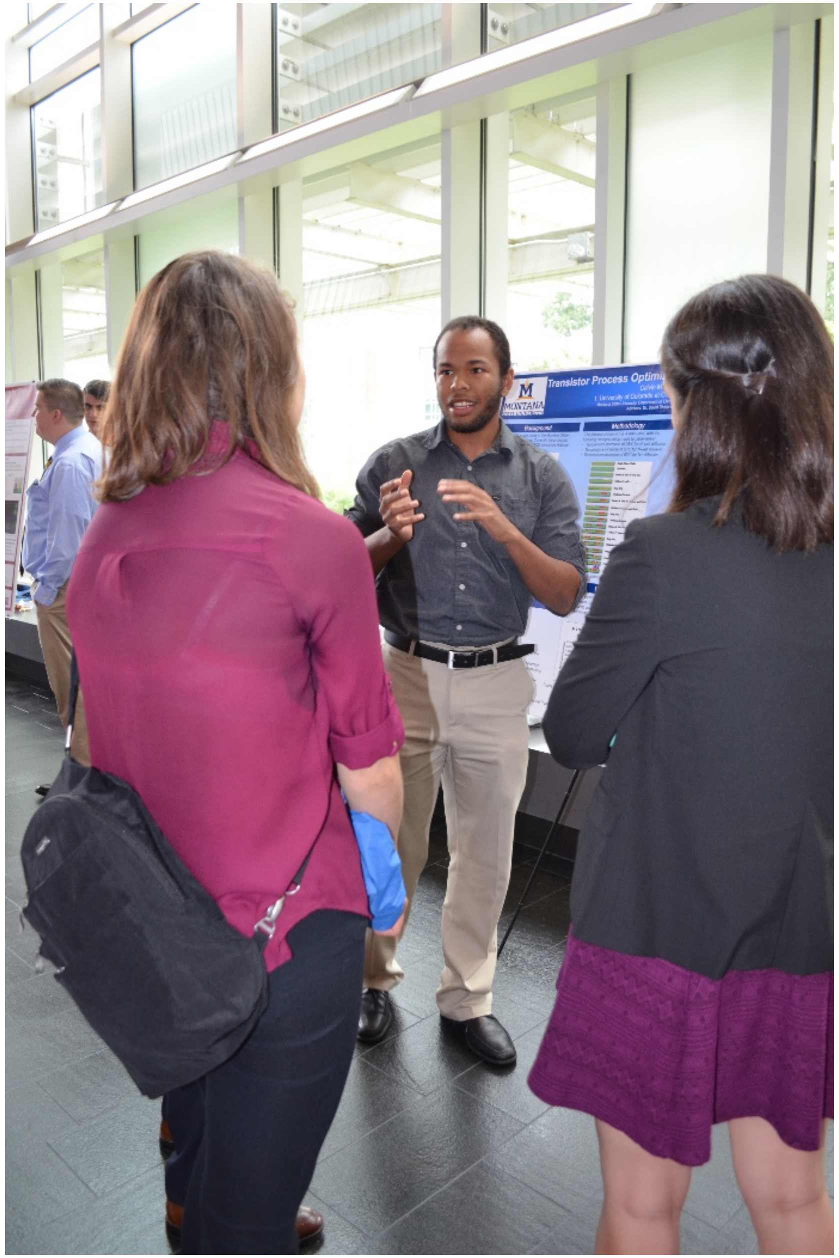
- Determine best method for PDMS molding from PDMS master mold
- Batch fabricate tip and tipless cantilevers
- Vary polymer weight percent and oxygen plasma ashing exposure time
- Explore inkjet printing precise droplet volumes on tipless cantilevers

Acknowledgments

References


Fabrication of dynamic surfaces for in vitro study of 'Epithelial-Mesenchymal Transition' progression
N-type Organic Semiconductors
Georgia Tech
SHyNE
CtrLayer




Transistor Process Optimi
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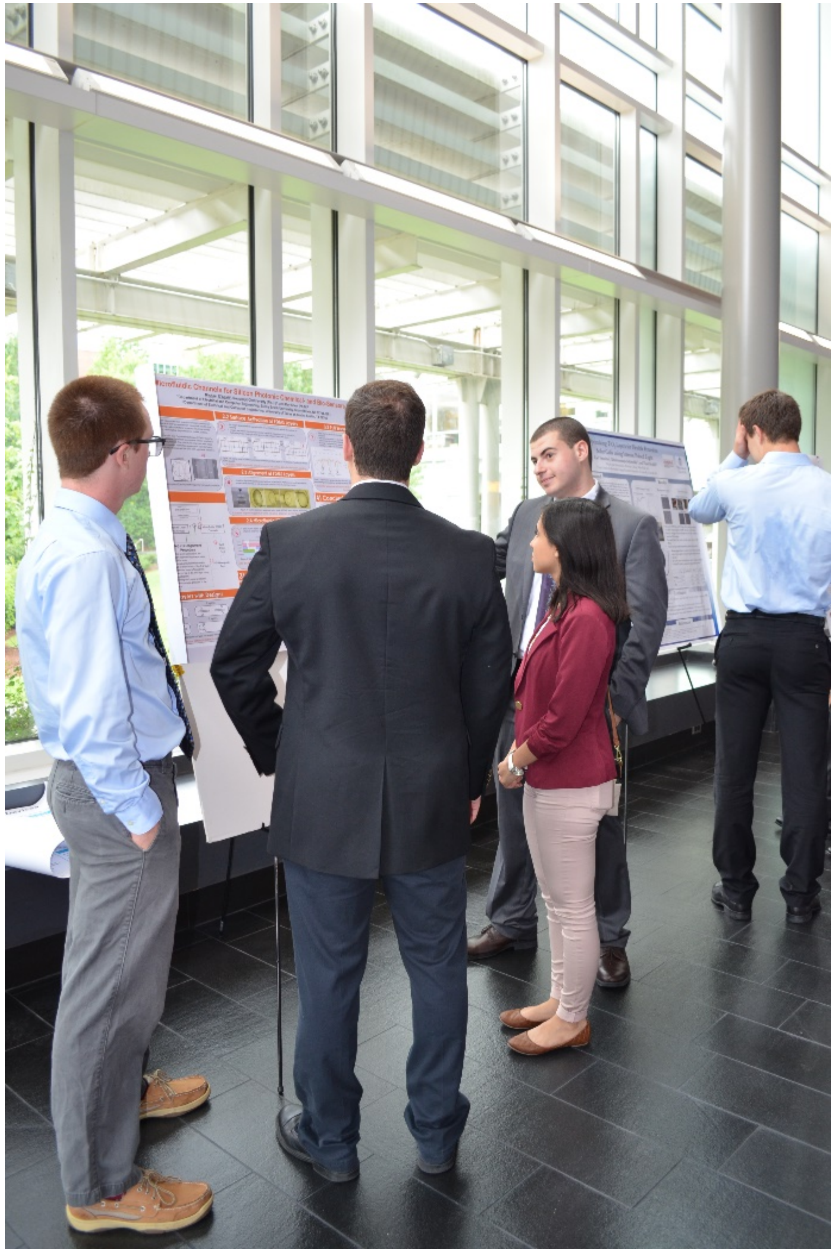
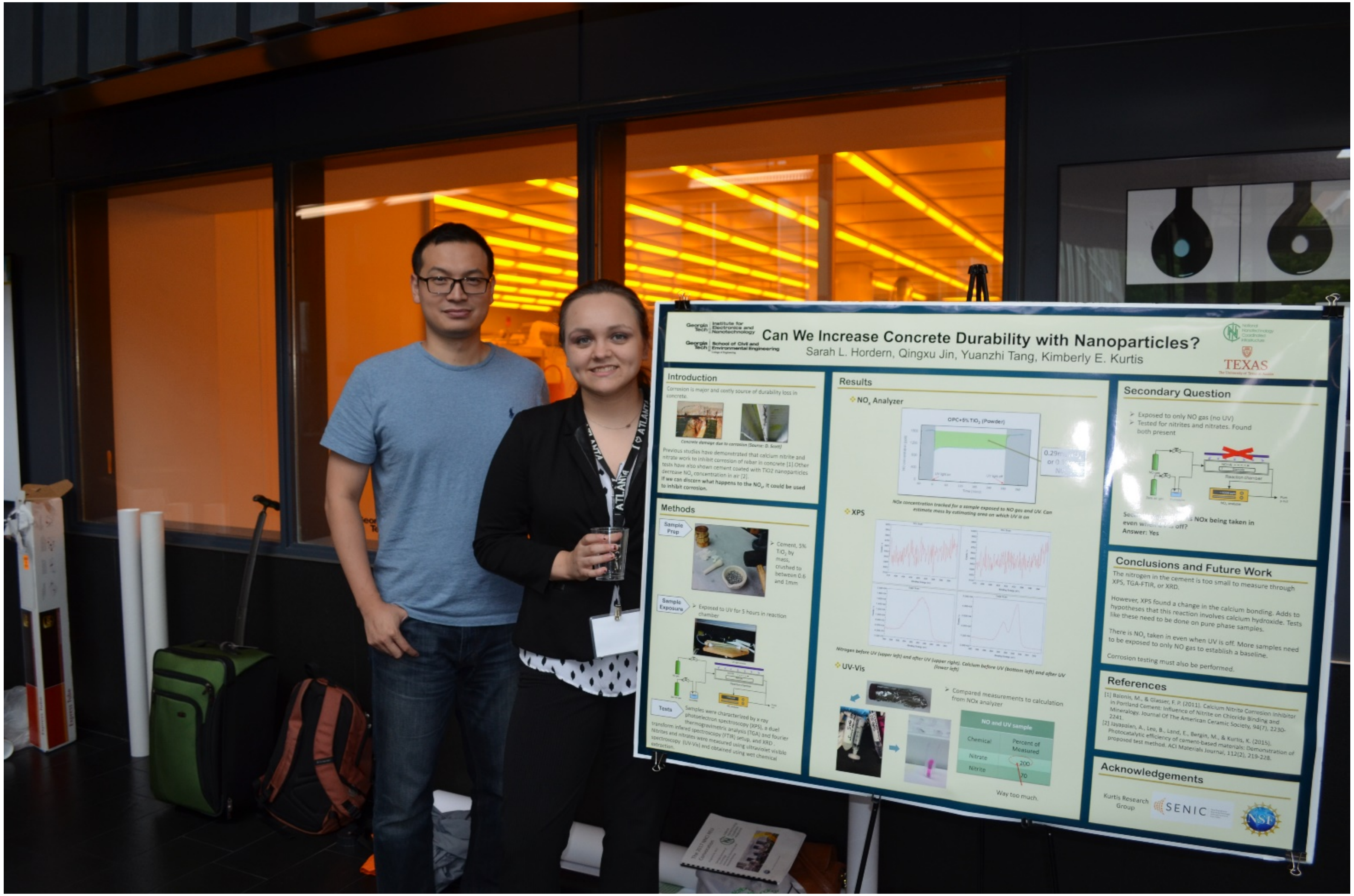

Microfluidic Channels for Silicon Photonic



Georgia Tech | Institute for Electronics and Nanotechnology

Georgia Tech | School of Civil and Environmental Engineering

Can We Increase Concrete Durability with Nanoparticles?

Sarah L. Hordern, Qingxu Jin, Yuanzhi Tang, Kimberly E. Kurtis

National Nanotechnology Coordinated Infrastructure

TEXAS

Introduction

Corrosion is major and costly source of durability loss in concrete.

Concrete damage due to corrosion (Source: D. Scott)

Previous studies have demonstrated that calcium nitrite and nitrate work to inhibit corrosion of rebar in concrete [1].Other tests have also shown cement coated with TiO2 nanoparticles decrease NO_x concentration in air [2].

If we can discern what happens to the NO_x, it could be used to inhibit corrosion.

Methods

Sample Prep

- Cement, 5% TiO_2 by mass, crushed to between 0.6 and 1mm

Sample Exposure

- Exposed to UV for 5 hours in reaction chamber

Tests

Samples were characterized by x-ray photoelectron spectroscopy (XPS), a duel thermogravimetric analysis (TGA) and fourier transform infared spectroscopy (FTIR) setup, and XRD . Nitrites and nitrates were measured using ultraviolet visible spectroscopy (UV-Vis) and obtained using wet chemical extraction.

Results

NO_x Analyzer

OPC+5% TiO_2 (Powder)

UV light on

UV light off

NOx concentration tracked for a sample exposed to NO gas and UV. Can estimate mass by estimating area on which UV is on

XPS

Nitrogen before UV (upper left) and after UV (upper right). Calcium before UV (bottom left) and after UV (lower left)

UV-Vis

- Compared measurements to calculation from NOx analyzer

NO and UV sample	
Chemical	Percent of Measured
Nitrate	200
Nitrite	70

Way too much.

Secondary Question

- Exposed to only NO gas (no UV)
- Tested for nitrites and nitrates. Found both present

Reaction chamber

Sec[illegible] s NOx being taken in even wh[illegible] off?
Answer: Yes

Conclusions and Future Work

The nitrogen in the cement is too small to measure through XPS, TGA-FTIR, or XRD.

However, XPS found a change in the calcium bonding. Adds to hypotheses that this reaction involves calcium hydroxide. Tests like these need to be done on pure phase samples.

There is NO_x taken in even when UV is off. More samples need to be exposed to only NO gas to establish a baseline.

Corrosion testing must also be performed.

References

[1] Balonis, M., & Glasser, F. P. (2011). Calcium Nitrite Corrosion Inhibitor in Portland Cement: Influence of Nitrite on Chloride Binding and Mineralogy. Journal Of The American Ceramic Society, 94(7), 2230-2241.
[2] Jayapalan, A., Lee, B., Land, E., Bergin, M., & Kurtis, K. (2015). Photocatalytic efficiency of cement-based materials: Demonstration of proposed test method. ACI Materials Journal, 112(2), 219-228.

Acknowledgements

Kurtis Research Group

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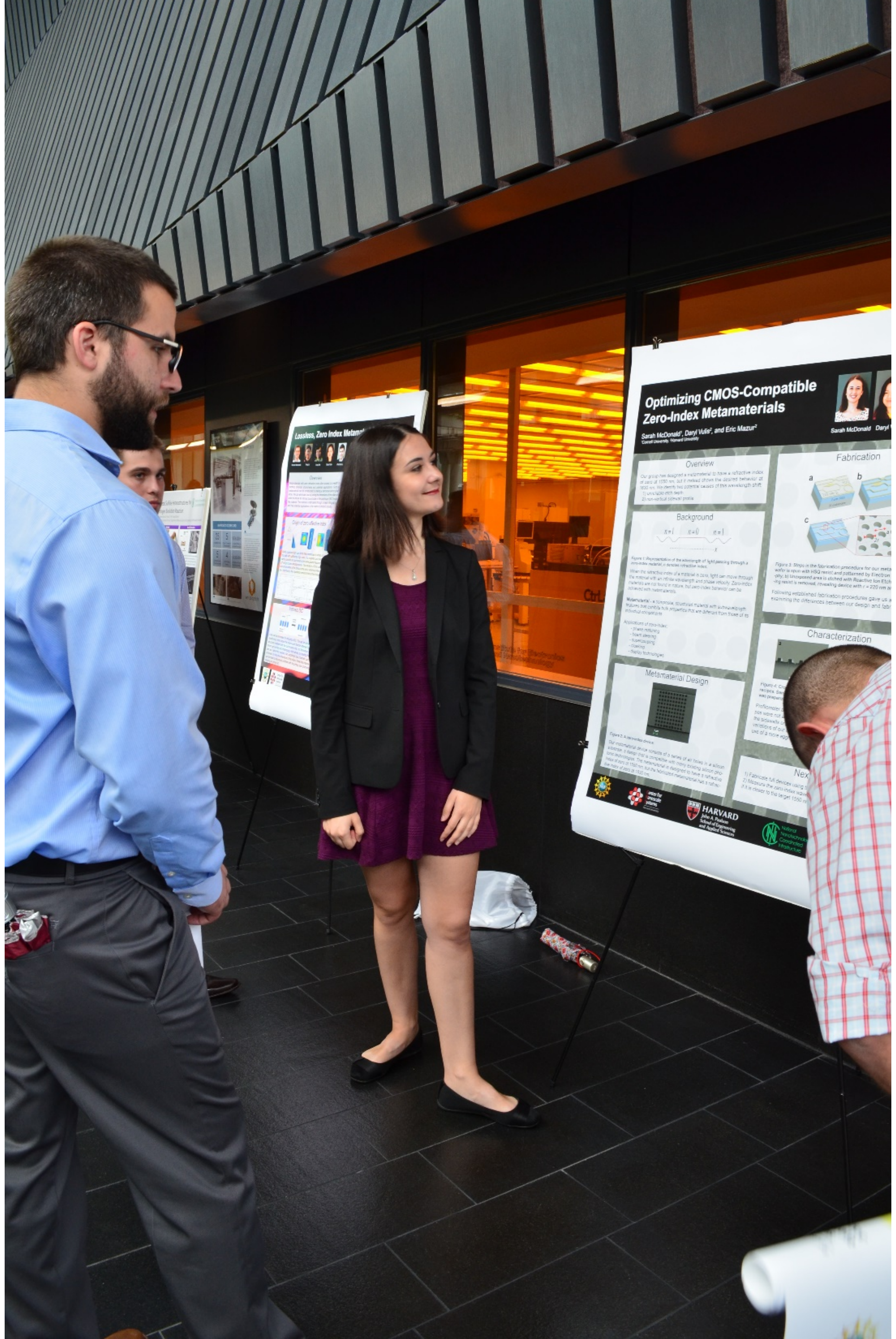
NSF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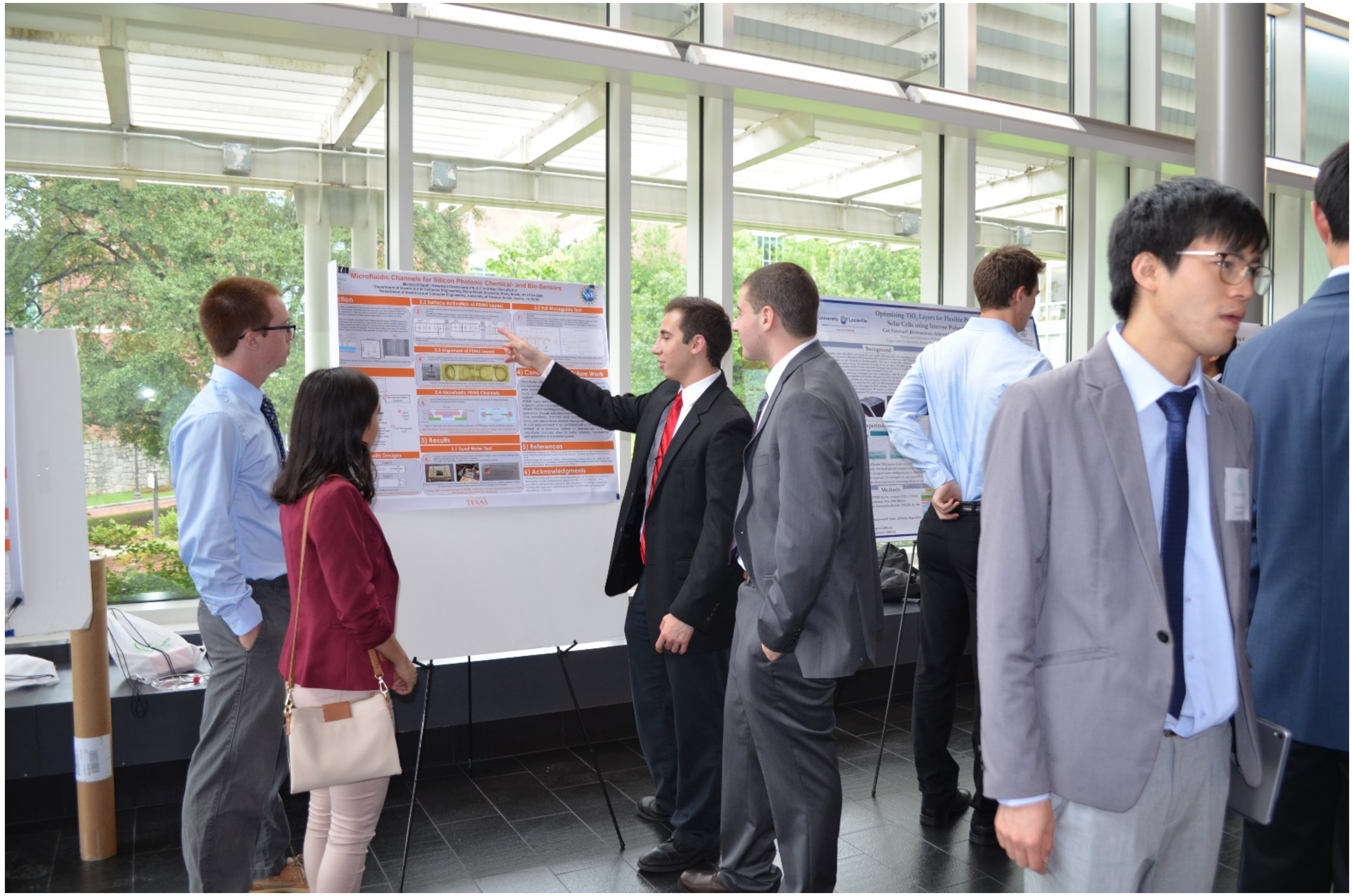
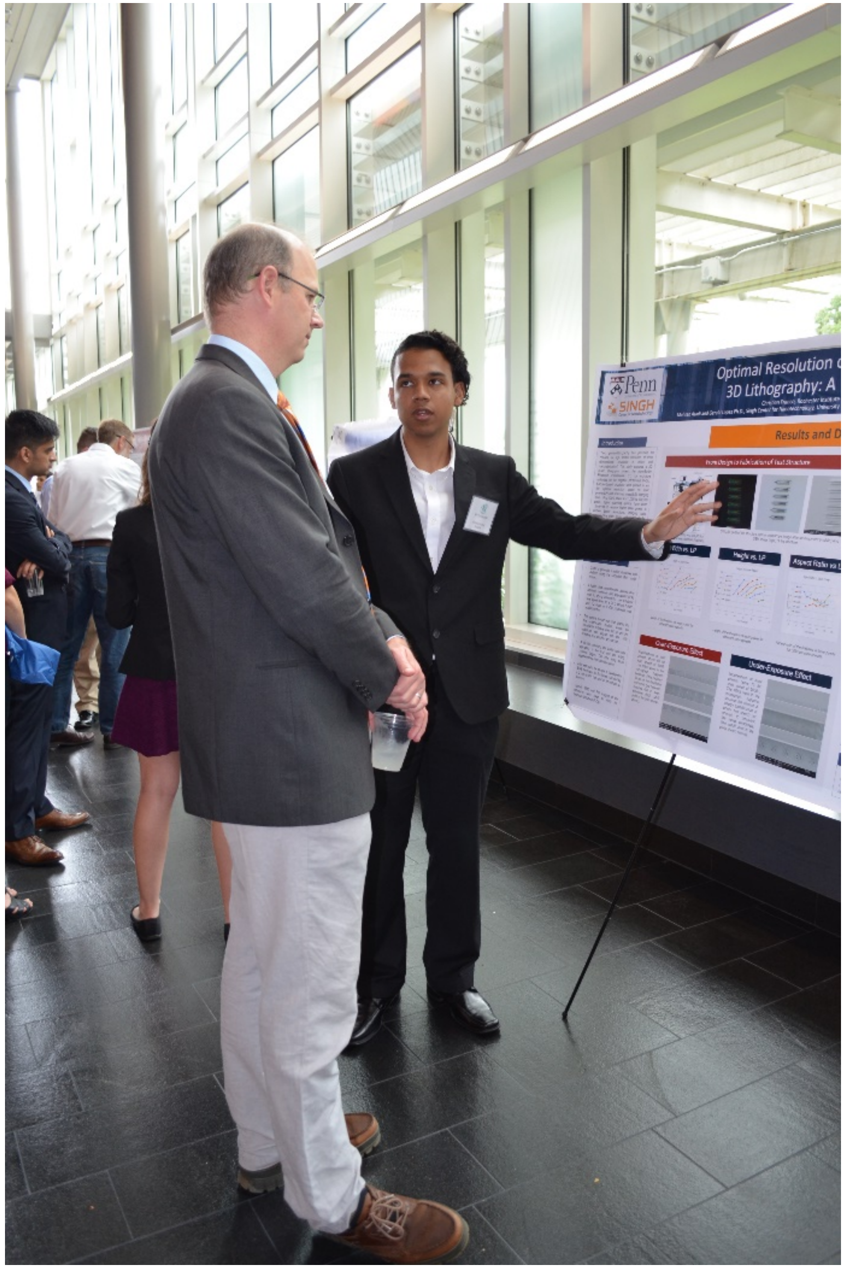

Microfluidic Channels for Silicon Photonic Chemical- and Bio-Sensors
2.2 Surface Activation of PDMS Layers
3.2 Full Waveguide Test
2.3 Alignment of PDMS Layers
2.4 Microfluidic PDMS Channels
3) Results
5) References
6) Acknowledgments
Optimizing TiO2 Layers for Flexible
Solar Cells using Intense Pulsed
Background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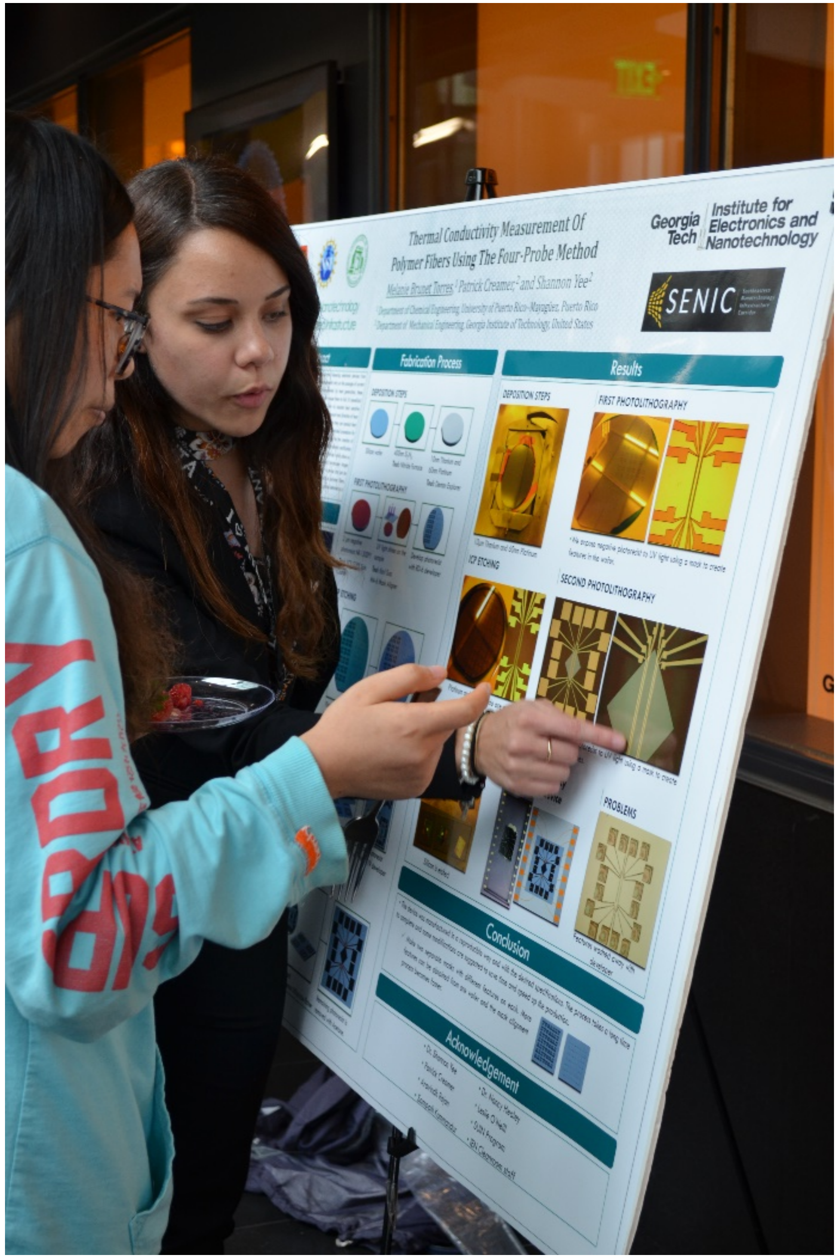
SINGH
Optimal Resolution o
3D Lithography: A
Results and D
Height vs. LP
Aspect Ratio vs
Under-Exposure Effect


Thermal Conductivity Measurement Of Polymer Fibers Using The Four-Probe Method
Melanie Brunet Torres,[1] Patrick Creamer,[2] and Shannon Yee[2]
[1] Department of Chemical Engineering, University of Puerto Rico–Mayagüez, Puerto Rico
[2] Department of Mechanical Engineering, Georgia Institute of Technology, United States
Georgia Tech
Institute for Electronics and Nanotechnology
SENIC
Fabrication Process
Results
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FIRST PHOTOLITHOGRAPHY
ICP ETCHING
SECOND PHOTOLITHOGRAPHY
PROBLEMS
Conclusion
Acknowledgement