Moataz Khalifa

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EDUCATION

Doctor of Philosophy, Physics, Virginia Tech, Blacksburg, Virginia, USA, February 2015
Dissertation Topic: Nanolithography Using Atomic Force Microscopes and Ionic Self-assembled Polymers

Master of Science, Physics, Virginia Tech, Blacksburg, Virginia, USA, May 2014

Master of Science, Physics, The American University in Cairo, Cairo, Egypt, May 2006

Bachelor of Science, Physics, The American University in Cairo, Cairo, Egypt, December 2004
- **Minors: Computer Science, Electronics, Instrumentation**

RESEARCH INTERESTS
- Robotics
- Autonomous Self-Reconfiguring Robots
- Bio-Inspired Robotics
- Nanolithography using atomic force microscopes by using nanografting, anodic oxidation and dip-pen nanolithography
- Self-assembled polymers, thin films, and nanostructures and their use in fabricating nano-scale electronics
- Nanoelectronics
- Metrology using atomic force microscopes
- Use of Transmission Electron Microscopy in studying the structure of nano materials
- Model Based EELS for improving quantitative data extracted from EELS spectra

RESEARCH EXPERIENCE

Mobile Autonomous Reconfigurable Robots, Physics and Engineering Department, Washington and Lee University, Lexington, VA, December 2016 – Present
- Secured external funding from the electronics designing and manufacturing company SparkFun Inc. to develop an autonomous reconfigurable robot in a research program I developed to engage undergraduate students at Washington and Lee students
- Designed and built an autonomous modular reconfigurable robot capable of navigating mazes and autonomously find and reconnect its various modules
- Designed the robot modules to be possible to reconfigure their locomotion modes from wheeled to legged locomotion based on the terrain navigated
- Developed software packages and applications that enhance Bluetooth communications with robotic systems for integrated control

Detecting Bacteria Resonance Frequencies Using an Atomic Force Microscope, Hear LLC, Lexington VA

- Contracted by HEAR LLC to develop a method to directly measure resonance frequencies of bacteria using an atomic force microscope
- Developed a method to directly excite samples and record their resonance frequencies
- Designed and built a novel platform capable of vibrating at 100 kHz from unique materials and components
- Developed a method to use the controller of an atomic force microscope to detect the oscillations of the platform and the bacteria mounted on it to find resonances

Doctoral Research Projects, Physics Department, Virginia Tech, Blacksburg, VA, January 2010 - Present

Nanoelectronics:
- Designed and implemented new nanolithography experiments to find methods to construct circuit elements on the nanometer scale using atomic force microscopes and self-assembled polymers
- Led experimental studies spanning several types of materials and methods including charged polymers, polyelectrolytes, gold nanoparticles, and silicon nanoparticles to match our desired nano-scale circuit elements
- Developed experimental methods to pattern and characterize ionic self-assembled monolayers of polymers using nanografting and local anodic oxidation techniques utilizing atomic force microscopes
- Established criteria for the optimization of selective deposition of self-assembled monolayers of charged polymers on patterned areas on functionalized gold and silicon substrates to facilitate a bottom-up approach in building nano-circuit elements

Cleanroom Technology:
- Designed and negotiated with masking companies the implementation of photolithography masks, which I later used in our cleanroom facilities, to enable the integration of our approach to nanoelectronics with the standard photolithography approach in the present day semiconductor industry
- Extensive experience in all of the standard up to date cleanroom processes

Transmission Electron Microscopy (TEM):
- Studied TEM in classes designed by world class experts in the field at Virginia Tech.
- Performed TEM sample preparation and TEM tests on the materials used for our research and the nano structures which I constructed using AFM nanolithography.
- Attended the TEM winter school held annually by Arizona State University
- Working on a project involving model based electron energy loss spectroscopy to determine mechanism of heavy metal scavenging properties of manganese oxide structures
- Developing parametric statistical models to accurately simulate the interaction cross sections between electrons and collision centers in TEM samples undergoing EELS measurements

Collaboration Projects, Physics Department, Virginia Tech, Blacksburg, January 2010 - Present
- Provided atomic force microscope metrology services and various other metrology tools to aid in developing a novel biosensor aimed at detecting MRSA infections in patients on site
- Aided in studying plasmonic lifetimes in different nano-structures by performing atomic force microscopy measurements on polymer multilayers and analyzing the resultant data

- Studied adhesion properties of semiconducting silicon nanoparticles in a nano-scale actuators using atomic force microscopy
- Analyzed surface properties of new materials used in constructing solar cells to help characterize the materials and methods used
- Maintain several types of atomic force microscopes
- Train users on several types of atomic force microscopes

WORK EXPERIENCE

Assistant Professor and Director of Data Education, Washington and Lee University, Lexington, VA, July 2017 – Present
- Design and Teach courses on data science and analytics
- Provide research support to faculty and students involved in data heavy projects
- Design and teach introductory courses on machine learning

Visiting Assistant Professor of Physics, Washington and Lee University, Lexington, VA, July 2015 - 2017
- Design and teach Robotics courses in the Physics and Engineering Department and the Computer Science Department
- Teach physics and electronics classes to physics and engineering students
- Help develop the curriculum for and teach nanoscience classes
- Teach circuits and electronics classes
- Teach measurements and metrology fundamentals

Adjunct Assistant Professor of Material Science and Engineering, Virginia Tech, Blacksburg, VA, July 2015 - Present
- Develop mathematical and computational model based methods for quantifying EELS measurements in TEM analysis
- Guide students in doing research on developing models for the extraction of quantitatively reliable data from TEM EELS spectra of iron hematite nanoparticles
- Manage a collaboration between Virginia Tech and Washington and Lee university allowing students and researchers from Washington and Lee University to access Virginia Tech state-of-the-art facilities

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<u>Instructor</u>
Nanomaterials Fabrication and Characterization, Virginia Tech, Blacksburg, VA, August 2014 – May 2015

- Taught a junior level class in Virginia Tech's Nanoscience department specializing in nanomaterials fabrication and characterization methods.

Nanoscience Lab Instructor, Virginia Tech, Blacksburg, VA, August 2012 – May 2015

- Taught Quantum Physics Nanostructures labs examining various aspects of modern physics and their relationship to the developing field of nanoscience

<u>**Research Assistant,**</u> Virginia Tech, Blacksburg, VA, August 2007 – May 2015

- Developed new methods for constructing nano-scale circuits using atomic force microscope-based nanolithography combined with self-assembled polymers
- Developed methods for characterizing thin films of polymers, nanoparticles, and biological materials deposited using self-assembly techniques

PUBLICATIONS

- Jonathan S. Metzman, Jason I. Ridley, Moataz Khalifa, James R. Heflin. *Stable Anti-reflection Coatings via the Self-Assembly Encapsulation of Silica Nanoparticles by Diazo-Resins.* Journal of Physics and Chemistry of Solids 87 (2015) 271-277
- Ashry, Islam; Zhang, Baigang; Khalifa, Moataz; Calderone, Joseph; Santos, Webster; Heflin, James; Robinson, Hans; Xu, Yong. *Fluorescence Lifetime Based Characterization of Active and Tunable Plasmonic Nanostructures.* Opt. Exp. 22, (2014) 20720-20726

SCHOLARSHIPS AND AWARDS

- Lenfest Research Grant at Washington and Lee Univeristy, April 2018
- SparkFun Inc. Community Partnership Award, May 2017
- Lenfest Research Grant at Washington and Lee University, April 2016
- Fellowship at The American University in Cairo, Physics Department, August 2005

HONORS
Exemplary Student Award, Physics Department, The American University in Cairo, April 2003
Excellence in Academic Achievement Award, The American University in Cairo, April 2003
Exemplary Student Award, Physics Department, The American University in Cairo, April 2002

COMPUTER AND LANGUAGE SKILLS

- Excellent knowledge of MATLAB, C, Python, and R
- Excellent knowledge of MS Office applications: Word, Excel, Access and Power Point
- Excellent knowledge of AutoCAD
- Fluent in English and Arabic