



THE SALZBERG CHEMISTRY SEMINAR SERIES



The City College
of New York



Monday, April 3, 2023 @ 12:00 noon – MR1027

Probing Electron Transport in Nanoscale Junctions

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Abstract: Realizing how one can manipulate electron transport properties in nanoscale molecular junctions can be essential in controlling the overall functionality of a molecule when it is wired into a circuit. My research group investigated electron transport properties using scanning tunneling microscopy (STM) and conductive atomic force microscopy (AFM). STM molecular break junctions enabled the group to observe conductance switching in vertically aligned tunnel junctions formed by porphyrin molecules ligating a zinc (ZnP) or iron (FeP) atom. Measurements were taken by forming single molecule junctions between a STM tip and a gold substrate. Peaks in the conductance histogram showed molecules switched from a low to a high conducting state in the range of $10^{-4} - 10^{-5} G_0$ upon mechanical stretching of the molecule, which led to the observation of a two-state conductance in the nanoscale junction. With conductive AFM, at $\pm 1V$ we observed high rectification ratios (up to 9000) in FeP molecular layers; measured current-voltage characteristics from FeP molecules to determine the electron attenuation coefficient ($0.6 - 0.8 A^{-1}$); and for the later system observed a voltage-dependent barrier height for the voltage range $|V| \leq 2$. Lastly, we explored two-state conductance switching and vibrational modes using inelastic electron tunneling spectroscopy in porphyrin molecules positioned between two fabricated electrodes separated by a nanogap. Currently, we have an active collaboration with Columbia University MRSEC on Precision-Assembled Quantum Materials in partnership with the City College of New York, Harvard University, and Stony Brook University, to explore electron transport in quantum materials.

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Biography: Dr. Kim Michelle Lewis is from New Orleans, Louisiana. She received her secondary education in the New Orleans Public school system and in 1994 graduated from McDonogh #35 Senior High School, the first public four-year high school for African American students in the city. She studied at Dillard University, a Historical Black College and University in New Orleans, and received the David and Lucile Packard and the UNCF/Mellon Fellowships. She earned her Bachelor of Science degree in Physics in 1998. In that same year Dr. Lewis was accepted to the University of Michigan Applied Physics Ph.D. Program and received a David and Lucile Packard Fellowship and several Pre-doctoral Research Grants from the Social Science Research Council. Dr. Lewis' thesis work in Condensed Matter Physics was the development of single electron devices for application as low-noise electrometers. Her graduate advisor was Professor Çagliyan Kurdak. Her work led to a U.S. Patent No. 6,777,911 in August 2004. Dr. Lewis completed her Master of Science in Electrical Engineering in August 2003 while working toward her Ph.D. in Applied Physics which she earned in August 2004 from the University of Michigan.

Dr. Lewis accepted a 2004 postdoctoral position at Louisiana State University in Baton Rouge in the Department of Electrical and Computer Engineering and the Center for Computation and Technology with Professor Theda Daniels-Race. In April 2005, she received a Ford Foundation Postdoctoral Fellowship to continue her research in molecular electronics.

In 2006, Dr. Lewis joined the faculty in the Department of Physics, Applied Physics and Astronomy at Rensselaer Polytechnic Institute. She was awarded a 2009 Career Enhancement Fellowship by the Woodrow Wilson Foundation and a 2009 National Science Foundation (NSF) BRIGE Award. She received the NSF Career Award in 2012. In 2017, Dr. Lewis was appointed as the Associate Head of the Department. Her research expertise is in quantum transport in nanoscale structures, such as thin films and molecular junctions using techniques that include inelastic electron tunneling spectroscopy and scanning probe microscopy. Other interests of Dr. Lewis include the study of electron transport of quantum materials in nanoscale junctions.

In 2018 Dr. Lewis became the Associate Dean for Research, Graduate Programs, and Natural Sciences and Professor of Physics in the College of Arts and Sciences at Howard University. As the Associate Dean for Research, in FY '22 the college led in proposals submitted and grants and contracts awarded at the University. Under her leadership, she established a Pre- and Post-Award Grants Team and to-date she has made three hires to build this team with another hire expected in FY '24. Currently, she serves on several committees at the university level, including an Interdisciplinary Research Committee that discusses the administration of grants, awards, and contracts with upper-level administrators; and the Research 1 Task Force for Grants Expenditures and Doctoral Conferrals Working Groups. Her interests are to provide college-wide leadership to strengthen its research and graduate programs.