Probing Electron Transport in Nanoscale Junctions for Molecular Electronic Applications

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The focus of my research program investigates electron transport in nanoscale molecular junctions. Molecules as the active component in a circuit is an attractive option for decreasing the size of devices to a few nanometers and offers a range of functionalities that can be used to build electronic components, such as transistors, rectifiers, and switches. My research addresses fundamental questions related to the electronic behavior of molecules, such as switching and rectification behavior observed in molecular devices. The experiments probe electron transport and conduction mechanisms, including inelastic electron tunneling and temperature dependence that can affect the properties of the molecular device. These efforts are investigated by scanning probe microscopy techniques (e.g. atomic force microscopy and scanning tunneling microscopy) and molecular junctions formed by electromigration from nanowires fabricated by electron beam lithography and photolithography. We have reported a multi-state conductance in single porphyrin molecules, identified that molecular conductance can be modified by in-situ deprotection of thiol-based porphyrin, demonstrated temperature dependent bistability in porphyrins, reported high rectification ratios from molecular islands, and the stability of molecular rectification using our drop-dry method. In the past two years my research efforts have included using scanning probe microscopy to study the electrophysiology of biological materials, such as adult stem cells for therapeutic and regenerative medicine applications and bacterial nanowires for bioelectronics; and characterizing metallic and magnetoresistance properties of vanadium disulfide (VS_2) nanoflakes.

Biosketch: Kim Michelle Lewis is the Associate Head and Associate Professor of Physics, Applied Physics, and Astronomy at Rensselaer Polytechnic Institute in Troy, NY. She received her PhD in Applied Physics and a Masters in Electrical Engineering from the University of Michigan in Ann Arbor. In 2009 she was awarded a Career Enhancement Fellowship by the Woodrow Wilson Foundation and a National Science Foundation (NSF) BRIGE Award. She received the NSF Career Award in 2012, is funded by the New York State Focus Center, and has an active collaboration with Carl Zeiss Microscopy. Her research expertise is in the area of quantum transport in nanoscale structures, such as thin films and molecular junctions using techniques that include inelastic electron tunneling spectroscopy and scanning probe microscopy. For more information please visit: www.rpi.edu/~lewisk2.