

I am interested on working on new scientific and developing pathways where I can apply the experience I have acquired during my graduate studies. My research was focused on the field of nanotechnology, with an emphasis on molecular electronics (ME). Nowadays ME has become one of the most important and debated interdisciplinary topics, with a need of a better understanding of the role that organic molecules play when integrated into a nanoscale electronic device (Figure 1). Through my five years of research I have worked with several collaborators and projects on the synthesis of organic molecules towards the development and testing of new electronic test-beds.

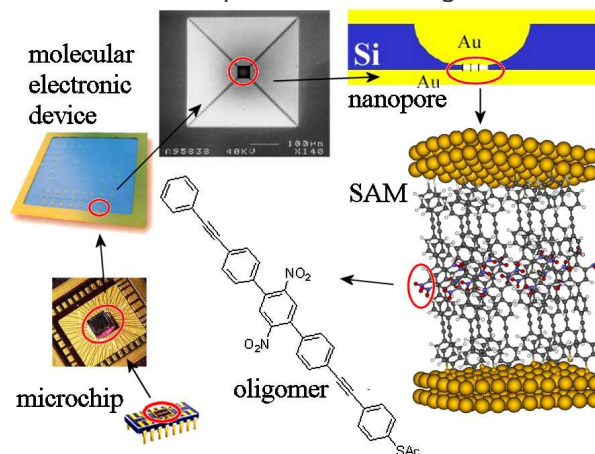


Figure 1

From the different projects that I have conducted, I can classify my interests in three main subjects: organic synthesis, analysis at the chemical interface, and fabrication and electrical testing of molecular electronic devices.

Concerning the first subject, my experience and knowledge in organic chemistry and organometallic chemistry allow me to follow a rational design and synthesize organic molecules that can play an active role in microelectronic devices. Several chemical aspects were covered such as the geometry and conformation of the molecule, its electronic nature and functionalization, as well as the characteristics of the molecular junction with the bulk contact (Figure 2). For the first aspect, geometrical diversity of the molecule was pursued in order to investigate the relation between molecular conformation and electrical properties. This was done experimentally with other collaborators by scanning probe microscopy (SPM), and theoretically by computational calculations. For the second aspect, the emphasis relies on different functional groups on the molecular backbone that promote electronic changes such as the net dipole moment.

Theoretical calculations support the hypothesis that electron-withdrawing groups such as nitro and electronegative atoms such as fluoro impart a higher chemical and thermal stability to the oligomer, promoting the electronic charge and the conduction that is needed for the molecule to act as a memory and switching device, as well as improving the electron flow by lowering the energy of the molecular frontier orbitals, so they may become closer to the Fermi level of the bulk contact. I have successfully conducted the synthesis of small and medium-size conjugated and alkyl chain oligomers capable to incorporate onto metallic, semiconductor and carbon materials, providing with new surface properties that are interesting for ME, MEMS and SPM applications.

My goal was to provide the molecule with an efficient, stable bulk contact-molecule linker that can assure a strong chemical and electronic interaction between the two systems. For these aspects, the analysis was conducted with different surface chemistry tools such as XPS, SPM, contact angle goniometry, CV, single-wavelength ellipsometry, FTIR, UV/vis/NIR and Raman spectroscopy; thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC).

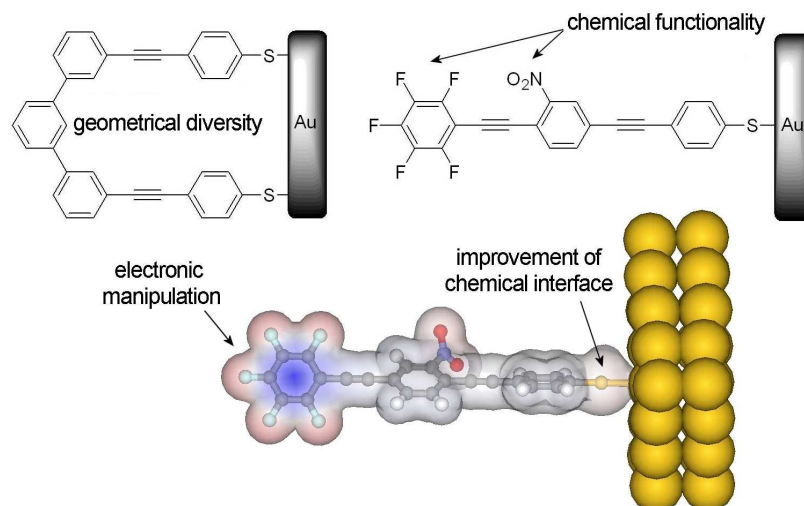


Figure 2

My interest on the functionalization and analysis of technologically interesting materials lead me to perform the analytical elucidation of organic-modified surfaces. I considered this subject of particular importance since the integrity of the chemical interface plays a crucial role in the overall electronic properties of the molecule-substrate system. I was involved in the development of a new alternative to achieve an organic functionalization for not only metallic surfaces, but also for primary, binary semiconductors and carbon materials and nanotubes (Figure 3). Using silicon-hybrid molecular electronic devices, we took advantage of the abundance and the importance of the current silicon technology. This novel approach did not rely on the typical thiol-gold structure for achieving a stable and strong bond between the electrode and the organic film. Instead, I synthesized organic molecules with the same chemically desired properties (fully conjugated, linear and conductive) and reacting with bulk materials that are properly prepared in order to afford the desired direct covalent bond without the need of an external activation.

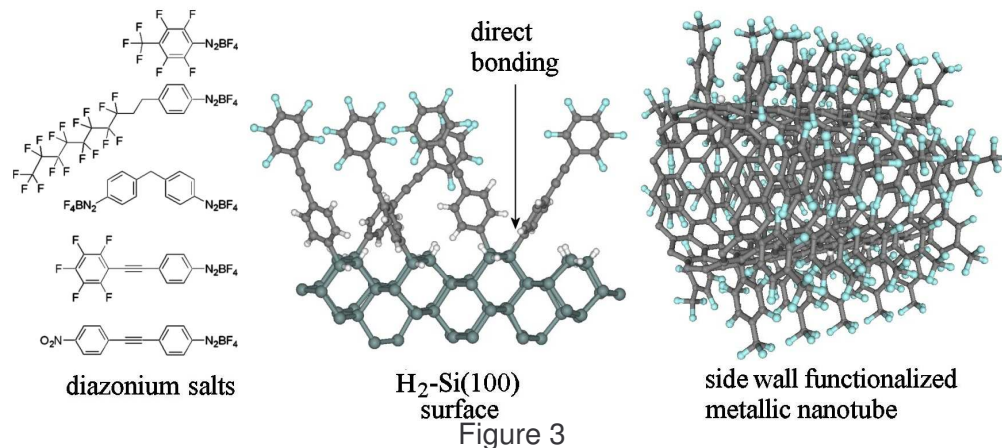


Figure 3

I also led a project of using functionalized SWNTs as SPM probes, requiring a covalent attachment to H-passivated Si surfaces (Figure 4). Different from the vertical approach, SWNTs are horizontally chemisorbed once their sidewalls are organically functionalized with conjugated linkers for further hydrosilylation reaction between the nanotube and the highly reactive layer of Hs on the Si substrate.

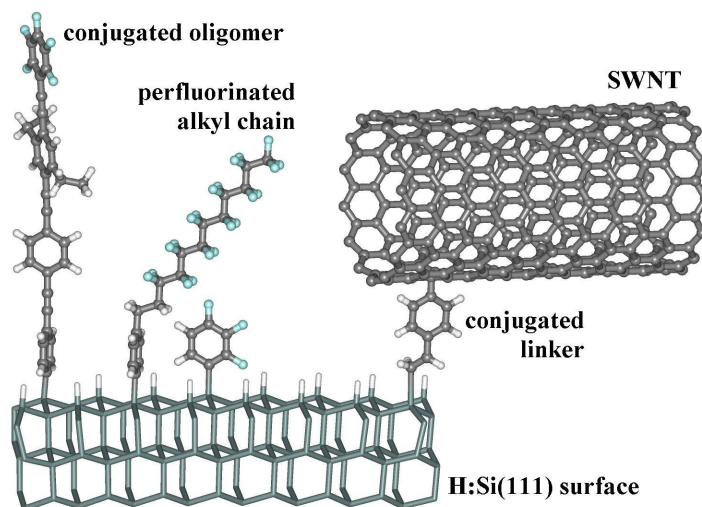


Figure 4

From my previous research activities before graduate school, I have acquired a solid experience in the technical use and control of analytical and instrumental tools, as well as working on physical organic research on carbon chemistry, specifically fullerenes: endohedral and cycloadducts fullerene derivatives for reactivity and spectroscopic studies. My goal was the isolation in tangible amounts of a whole series of noble gas atoms and other small molecules inside the fullerene cage. The incorporation of the noble gas atom to the fullerene spherical confinement required the development of a unique high-temperature, high-pressure reactor. The products were a perfect target for several physical and chemical studies. For instance, the interaction between the noble gas atom (or other diatomic species like CO and N₂) was far from being considered covalent. Instead, it was found as a van der Waals system, yet showing a great stability. This allowed us to pursue a whole series of spectroscopic studies, conceiving the C₆₀ storage-release capability as a molecular “nanocarrier” of monoatoms and diatoms. I was responsible for finding new ways of producing and isolating the last objective of the noble gas series: ¹²⁹Xe@C₆₀. I also prepared endohedral fullerene cycloadducts from Diels-Alder reactions, for spectroscopic studies and as precursors for further macromolecular species.

I also gained knowledge in the field of computational chemistry, designing and writing algorithms that could be incorporated in Monte Carlo and molecular mechanics calculations. The algorithms once used with the right force field, was capable to cover wide searches on the potential energy surface of atomically homogeneous nanoclusters of noble gases in the gas phase. This was done starting from a minima of the cluster that was previously calculated. The algorithm then started searching for other local minima that would have the same or lower energy; in other words, starting from a stationary point, the energy was kicked to higher energy levels and after landing, the optimization process began to scan for new stationary points nearby, performing a stochastic search of minima over the potential energy surface of small and medium size nanoclusters. The process was repeated, until no more new local minima seemed to appear.

Among my extra-curricular activities, I participate in several activities inside and outside the University campus.

I was a member of the Rice University Linux User Group; the goal is to provide a clearinghouse for Rice University peer Linux support, fostering project collaboration and contributing back to the Internet, by organizing activities to increase community awareness of Linux and other Open Source issues.

I was a member of the Hispanic Association for Cultural Enrichment at Rice, which is the most visible organization for Hispanics on Rice University. The Association offers many opportunities for all members and non-members of the Rice community and Houston, providing support and understanding of Hispanic issues and enjoying cultural, educational, political, service, outreach, and social activities. It also serves as a medium of communication between its members and the larger Rice community.

I was a member of the Rice Student Volunteer Program. The mission of the program is to heighten student awareness, increase community involvement, and raise social consciousness by committing its members to understanding and meeting the needs of the community through direct, thoughtful action. The main activities of the program is the promotion of student volunteers to mentor and teach youth, work in homeless shelters, organize clothing and food drives and work in an environmental preservation, among others.

Finally, I was a member of the Houston Racing Triathlon Club, an organization that not only practices and promotes sports but also gives general advice on racing, training, nutrition, injury prevention, and treatment to its members and to the community through charity and volunteer efforts.