Carbon-Molecule Junctions:
A Reliable Platform for Molecular Electronics

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Universal lithographic methodologies for creating single-molecule devices based on single-walled carbon nanotubes (SWNTs) or graphenes as point contacts has been developed. These contacts are formed by electron beam lithography and precise oxygen plasma etching. Through robust amide linkages, functional molecular bridges with amino groups are covalently wired into carboxylic acid-functionalized nanogaps to afford carbon-molecule junctions with desired functionalities.[1-3]

In this talk, I will first report a method to fabricate nanoelectrodes formed form carbon nanomaterials for improving electrode/semiconductor interfaces. By using these electrodes, we significantly reduced the contact resistance and thus achieved stimuli-responsive organic nanotransistors with high-performance. These studies apparently provide the deeper understanding of the interplay between molecular structure, assembly, and emergent functions at the molecular level and consequently novel insights into designing novel optoelectronic devices. On the other hand, I will detail our rational bioassay techniques by using single-molecule devices capable of subsequent biocompatible assembly through the combination of programmed chemical reactivity and directed self-assembly. We bridge a nanogap with a molecule that can react with a biochemical probe molecule. The probe then binds to a complementary molecule to form a noncovalent assembly. We electrically monitor each step of the process at the single event level and in real time. We have tested this approach in chemical and/or biological systems, including molecular photoswitching, DNA hybridization, DNA-protein interaction, and biotin/streptavidin binding.[4-8] These works have positioned carbon–molecule junctions as a new-generation testbed for molecular electronics.

References

[1] C. Jia, X. Guo, *Chem. Soc. Rev.*, 42, 5642 (2013).
[2] X. Guo, *Adv. Mater.*, 25, 3397 (2013).
[3] A. Feldmen, M. L. Steigerwald, X. Guo, C. Nuckolls, *Acc. Chem. Res.*, 41, 1731 (2008).
[4] X. Guo, P. Kim, C. Nuckolls, et al., *Science*, 311, 356 (2006).
[5] X. Guo, A. Gorodetsky, J. K. Barton, J. Hone, C. Nuckolls, *Nat. Nanotechnol.*, 3, 163 (2008).
[6] S. Liu, X. Guo, et al., *Angew. Chem. Int. Ed.*, 50, 2496 (2011).
[7] Y. Cao, X. Guo, et al., *Angew. Chem. Int. Ed.* 51, 12228 (2012).
[8] C. Jia, X. Guo, et al., *Angew. Chem. Int. Ed.* 52, 8666 (2013).