Applying Lessons From Atom-Scale Science To Develop True Single-Atom Sized Electron And Ion Sources

Robert A. Wolkow
Department of Physics, University of Alberta
Edmonton, Alberta

Over the last 2 decades, since the emergence of scanning tunneling microscopy, numerous new insights related to atomic structure at surfaces – both geometric and electronic structure – have emerged. In this talk a number of such advances will be described as background to the development of new nano-tips (1) that appear to be near ideal electron, and ion sources.

Examples will include a process for automatically assembling ordered multi-molecular nano-structures on silicon (2), a new concept for a single molecule transistor (3), and very recent work describing controlled coupling and occupation of silicon atomic quantum dots (4). The latter will be described as an embodiment of the "QCA", or Quantum Cellular Automata, scheme for building a new generation of ultra low power computers.

The atom-scale crafting of nano-tips will be described and directly illustrated. The talk will conclude with a description of our current effort to realize Gabor's dream of a point-projection microscope capable of atom-resolved, element specific, tomographic imaging of nano-structures.

1) Tungsten nanotip fabrication by spatially controlled field-assisted reaction with nitrogen, Rezeq M, Pitters J, Wolkow R, J. Chem. Phys., 124, 204716 (2006)
2) Self Directed Growth of Molecular Nano Structures on Silicon, G.P Lopinski, D.D.M. Wayner and R.A. Wolkow, Nature 406, 48 (2000).
3) Field regulation of single-molecule conductivity by a charged surface atom, Paul G. Piva1,Gino A. DiLabio, Jason L. Pitters, Janik Zikovsky, Moh'd Rezeq, Stanislav Dogel, Werner A. Hofer & Robert A. Wolkow, Nature 435, 658-661 (2005)
4) Controlled Coupling and Occupation of Silicon Atomic Quantum Dots at Room Temperature, M Baseer Haider, M. Baseer Haider, Jason L Pitters, Gino A. DiLabio, Lucian Livadaru, Josh Y Mutus and Robert A. Wolkow, Physical Review Letters 102, 046805 (2009)