Scanning Probe Atom-by-atom Fabrication of Phosphorus in Silicon Devices

Jonathan Wyrick, Pradeep Namboodiri, Fan Fei, Brian Courts, Utsav, and Richard Silver

National Institute of Standards and Technology

Gaithersburg MD 20899

Jonathan.wyrick@nist.gov

We are using atomically precise fabrication to engineer and study quantum structures made out of phosphorus imbedded in silicon. We have developed feedback-controlled methods using a scanning tunneling microscope (STM) that improve on hydrogen depassivation lithography, where atoms are selectively removed from a hydrogen resist by the STM, in order to achieve a measured 100% single phosphorus atom incorporation yield. The key element of this method is the use of STM tip-based manipulation of the adsorbed precursor molecule, PH_3, to dissociate hydrogen atoms, leaving a lone phosphorus on the silicon surface. We will discuss the details of our method, our current efforts in developing similar techniques for boron incorporation, and the fabrication of devices where single atoms are placed at predefined sites to achieve desired quantum operation.