Single-atom doping and single atom device development

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The ability to introduce dopant atoms into nano-structures with high spatial resolution, flexibility in dopant species and high fidelity opens opportunities for the study of dopant fluctuation effects in nanometer scale devices and the development of devices in which function is based the manipulation of single atoms and their quantum states. Possible single atom devices include quantum computers based on orbital or spin states of single dopant atoms, e. g. in silicon with donors or acceptors, or in diamond with color centers such as the nitrogen-vacancy center. In our presentation we describe the recent development of a single atom injector, or implanter, in which the imaging and alignment capabilities of an atomic force microscope are integrated with ion beams from a series of ion sources and with sensitive detection of current transients induced by incident ions [1, 2]. Ion beams are collimated by a small hole in the AFM tip and current changes induced by single ion impacts in transistor channels enable detection of single ion hits with 100% fidelity. We will discuss resolution limiting factors in ion placement and processing and paths to single atom (and color center) array formation for systematic testing of quantum computer architectures in silicon and diamond.

References:

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