

How do we Make Scanning Probe Atom-by-atom Phosphorus Doping into a Manufacturing Process?

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Because of its atomic precision in both imaging and manipulating structures on a surface, the STM has the potential to be a powerful tool for the manufacture of devices where the placement of every atom is controlled. In our lab, we are able to incorporate individual phosphorus atoms into silicon at desired sites to create quantum devices, such as donor spin qubits and analog quantum simulators, using hydrogen depassivation lithography (HDL) and related methods. The HDL process requires a great deal of interaction and expertise from the STM operator during all fabrication steps – it is not currently possible to supply a design file to the tool and expect it to output a device. We discuss reasons for this limitation and our approaches to transition from operator intensive methods to automated fabrication.