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Nanoscale placement of germanium quantum dots on silicon surface by low dose focused ion beam templating of the substrate MARIA GHERASIMOVA, Unvieristy of Bridgeport, ROBERT HULL, Rensselaer Polytechnic Institute, FRANCES ROSS, IBM T. J. Watson Research Center — Germanium nucleation on silicon surface typically proceeds via spontaneous formation of nanoscale islands at random locations due to the strain caused by the lattice mismatch. Due to the narrower band gap width of germanium relative to silicon, quantum confinement of charge carriers in the islands causes them to exhibit the properties of zero-dimensional quantum dots (QDs). For a variety of potential applications, such as the construction of quantum cellular automata (QCA), it is desirable to control the placement of the nucleating islands on the surface. In this work, controlled placement of Ge islands on Si substrate is achieved by templating the Si surface with focused ion beam (FIB) pulses prior to Ge growth by chemical vapor deposition in an ultra-high vacuum (UHV) environment. Ge islands are synthesized inside a transmission electron microscope equipped with a video-rate data capture capability for in situ observation, immediately after the FIB implantation in an adjacent UHV chamber. QD assembly reliability on the patterned sites is studied as the separation between the target QD locations is decreased below 100 nm, and the role of surface diffusion during growth is identified as one of the mechanisms influencing the fidelity of pattern registration. The formation of square clusters of four closely spaced islands (the arrangement of interest for the QCA) is discussed in detail as the four-fold symmetry of the (100) Si surface may provide means for obtaining the desired configuration via self-assembly.

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