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Application Note

LT STM: Atomic-scale rewritable memory using scanning tunnelling microscopy techniques*

Prof. Wolkow and his co-workers at the University of Alberta in Edmonton, Canada have created the most dense, solid-state memory in history using scanning probe microscopy techniques.

The new discovery for atomic-scale rewritable memory allows for the creation of small, dense memory at the atomic-scale which is also stable at room temperature.
Such devices are created by atom manipulation in combination with efficient error correction/editing based on machine learning methods. These new techniques have been used to control the tip for automated error-free device fabrication in a Scienta Omicron LT STM at 4 Kelvin.

The patterns are written by hydrogen lithography with atomic precision into a hydrogen-passivated Si(100)-2×1 surface by applying voltage pulses of 1.8 – 3.0 volts until the hydrogen is removed. In a second step dangling bond structures are created and corrected by hydrogen repassivation if necessary. The repassivation is done by depositing H atoms from a hydrogen loaded STM tip.

In contrast to previous systems the new devices are isolated between atoms and substrate, allowing for circuit applications.
Hydrogen lithography and hydrogen repassivation unlock a wide range of new possibilities including the creation of hundreds of precisely placed identical qubits for quantum computation and the realization of room temperature, stable, atomic-scale memory. QSi is now developing a facility to produce 1 million chips per year.

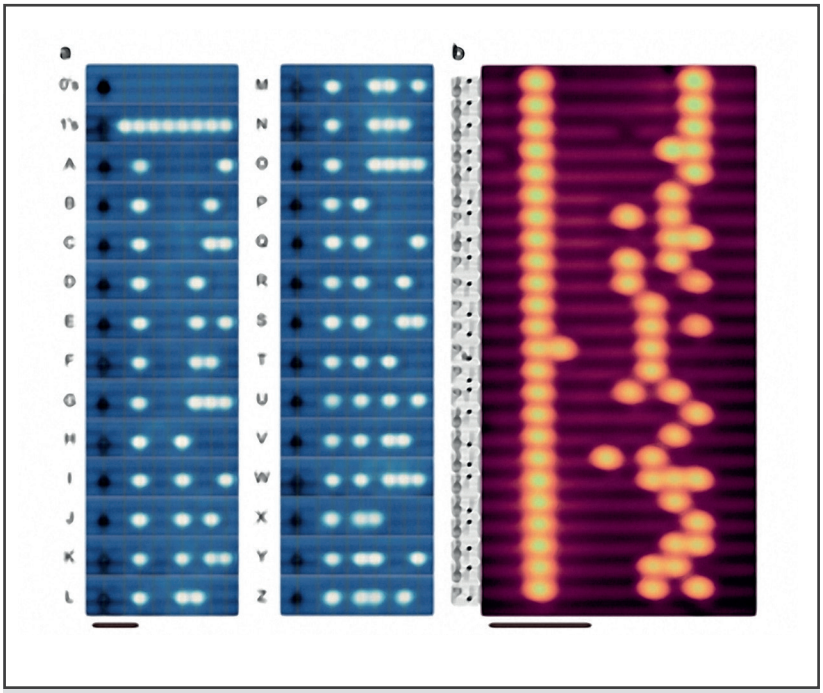

Fig.:1 8-bit and 192-bit atomic rewritable memories. The 192-bit array was written in 250 seconds into a hydrogen-passivated Si(100)-2×1 surface.

*"Lithography for robust and editable atomic-scale silicon devices and memories" (doi:10.1038/s41467-018-05171-y)—appears in the current issue of Nature Communications.