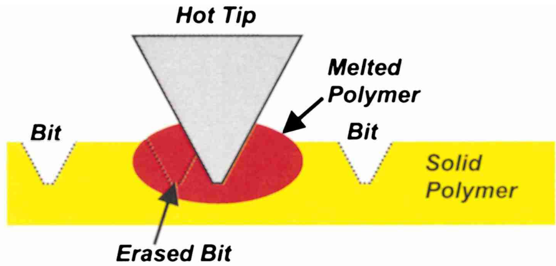

Figure 1: Thermal writing and erasing. Heat and force from the cantilever tip cause the polymer to soften and flow, forming an indentation data bit. Erasing or modifying previously written indentations is possible by melting the region near a previously formed structure.

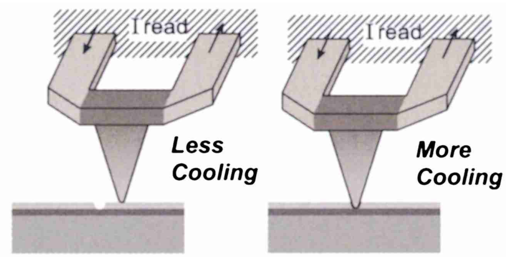

Figure 2: Thermal nanoimaging is accomplished by measuring the cantilever response to short (~10 μs) electrical pulses. The thermal resistance between the cantilever and the substrate varies as the cantilever tip follows the contours of previously written structures, producing a measurable change in the cantilever heating temperature.

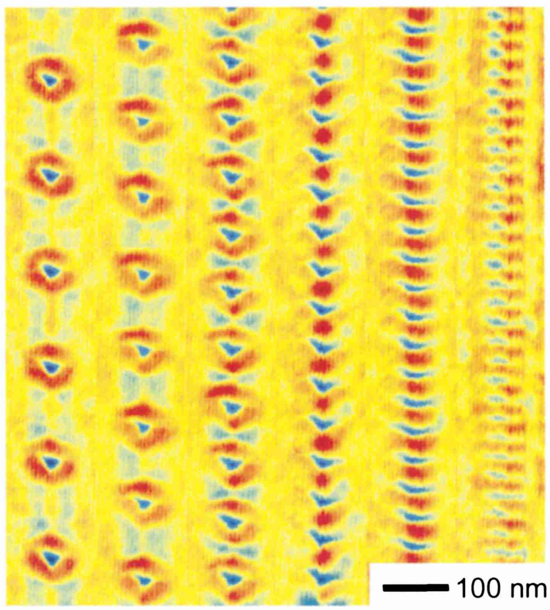

Figure 3: Tracks of thermally written indentations in a thin polymer layer. Color corresponds to the vertical, out-of-plane dimension. As the indentation periodicity increases, heat diffusion and melted polymer flow influences neighbor indentations. The maximum data density demonstrated here is 0.9 Tbit in^{-2}.

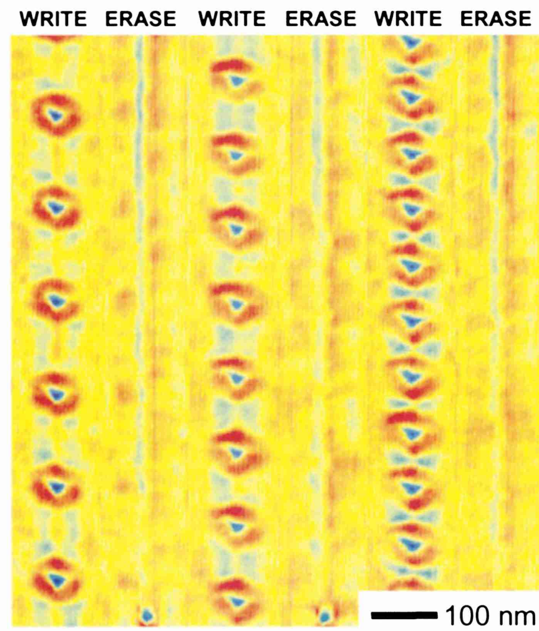

Figure 4: Tracks of thermally written and thermally erased indentations. Since erasing requires writing, each block of erased bits requires one 'erase' bit at the end of the track.

THERMAL WRITING AND NANOIMAGING WITH A HEATED ATOMIC FORCE MICROSCOPE CANTILEVER

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In thermal writing for surface modification or data storage, a heated atomic force microscope cantilever (AFM) tip is in contact with and scans over a thin polymer film, as shown in Fig. 1. Heat conduction along the cantilever tip induces thermomechanical formation of nanometer-sized indentations in the polymer. Erasing or modifying previously written structures is possible by writing such that heat from the tip and flow of the polymer influence nearby structures, also shown in Fig. 1. A thermal nanoimaging technique measures vertical feature sizes by monitoring changes in the thermal impedance across the cantilever-polymer gap as the cantilever tip follows the contours of the written structures, shown in Fig. 2.

Indentations written with varying periodicity in Figure 3 show that heat transfer and polymer flow near the tip limit the packing density of indentations, corresponding to a data storage density limit of 0.9 Tbit in^{-2}. Figure 4 shows indentations written and then erased. Figures 3 and 4 are made with the thermal nanoimaging technique at 3 KHz and a lateral pixel spacing of 3 nm. The $\Delta R/R$ reading sensitivity is 0.02 per vertical nanometer.