

Supplementary Materials: Atomic White-Out: Enabling Atomic Circuitry through Mechanically Induced Bonding of Single Hydrogen Atoms to a Silicon Surface

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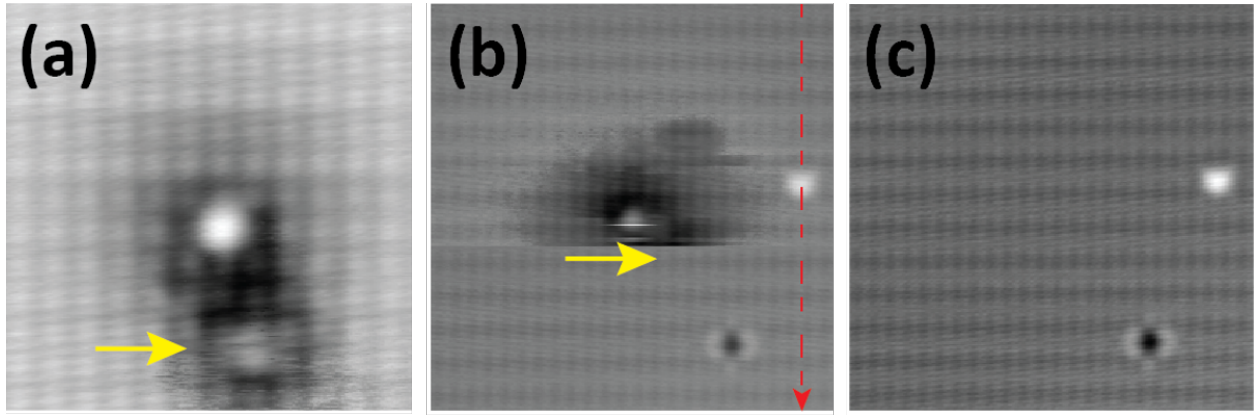


Figure 1: (a) Single hydrogen atoms physisorbed on the chemically inert H-Si(100) surface could be stably imaged in filled states at low voltage (+1.3 V). However, when the scanning voltage is increased to +1.7V in figure (b), the hydrogen atom is dragged by the tip. This dragging is not smooth, but can result in the H atom being moved close enough to the DB to cap it, as indicated by a change in contrast midway through the image and confirmed by a subsequent STM image of the same area (c). (b) and (c) are larger area ($10 \times 10 nm^2$) images of the area in (a). The location of the atomic hydrogen is marked with an arrow.

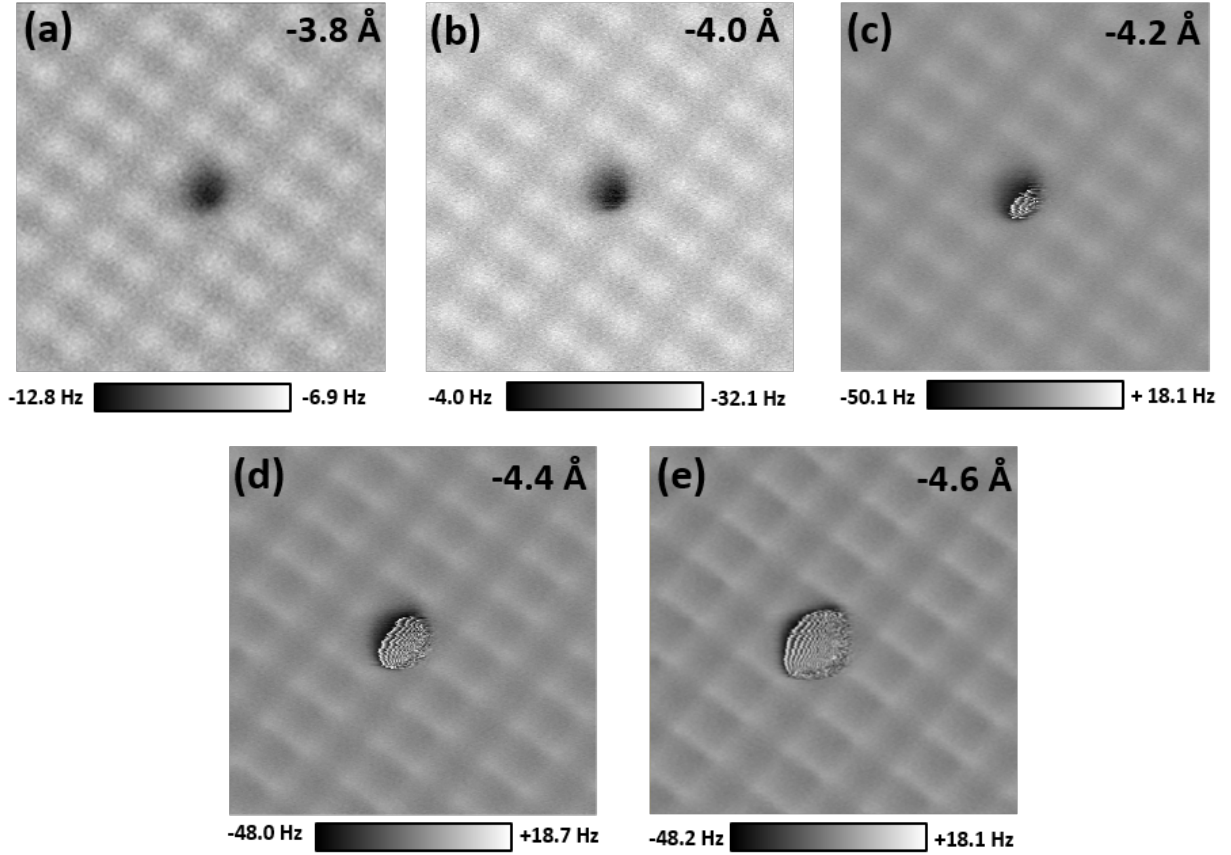


Figure 2: (a)-(e) Series of raw (3×3)*nm*² NC-AFM frequency shift maps of H-Si(100) surface at different tip-sample elevations. Images were recorded at 0 V and with an oscillation amplitude of 1 Å. We see the evolution from atomic to chemical bond contrast on the H-Si surface. For smaller tip elevations, much higher interaction force is seen on the DB than elsewhere on the surface. Z=0 Å corresponds to the tip position defined by the STM imaging set points (30 pA and +1.3 V) before switching off the feedback loop.

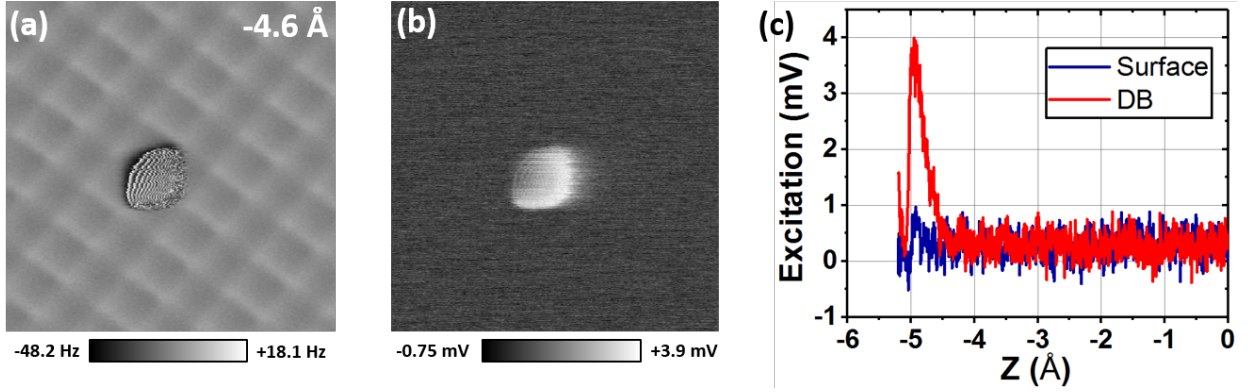


Figure 3: (a) NC-AFM frequency shift map of a single DB at small tip-sample distance (-4.6 Å) and (b) corresponding simultaneously obtained excitation channel map. (c) Superposed excitation versus tip elevation curves recorded on the same DB (red curve) and on the H-Si surface (blue curve)

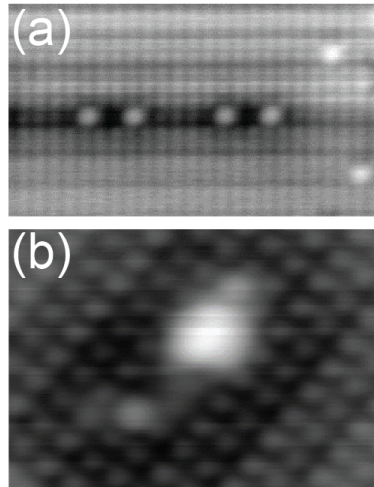


Figure 4: (a) and (b) show empty states images (50 pA , $+1.3 \text{ V}$) corresponding to Figure 5-a and 5-c from the main text, respectively. It can be seen clearly in (a) that for Figure 5-a, the coupled DBs are separated by 2 hydrogens. For Figure 5-b, (b) shows the central DB is separated from the top-most DB by 1 hydrogen separation, and the bottom-most DB by 2 hydrogen separation.