

Characterizing a Reversible, 3D, Three-State Molecular Switch

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Single-molecule switches are a rapidly developing class of molecular nanotechnology, with several attempts in recent years to realize device-like characteristics from motion of a single atom.^{1,2} Herein, we present an exploration of a novel molecule tetrakis(iodomethyl)germane (Ge(CH₂I)₄; TIME-Ge), which when deposited has a normal-facing CH₂I group. At 77 K the CH₂I is thermally driven and images as a 3-lobed feature. At 4K, the CH₂I “freezes” into one of its three potential energy-minimized rotamers. The CH₂I can, however, be mechanically and reversibly³ manipulated into either of the two other rotamer positions using AFM. We demonstrate this by $\Delta f(z)$ curves over the intended position, letting the attractive force pull the CH₂I into the new rotamer. $\Delta f(z)$ and constant-height scanning are used to study the feature and explore the force needed to rotate the CH₂I. With the probe tip fixed in position, tunnel current is shown to change as a function of CH₂I rotation, suggesting suitability as a three-state organic molecular switch.

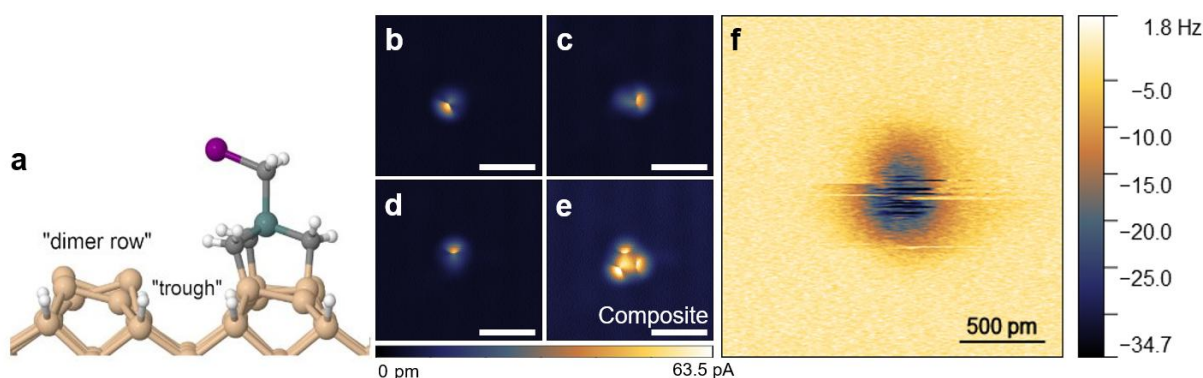


Figure 1. (a) Ball-and-stick model of a TIME-Ge molecule surface bound to a Si(100) 2x1 surface. (b-d) 4 K STM constant-height images of the three potential CH₂I rotamers of a given molecule. (e) Composite image of the rotamers from (b-d). (f) AFM constant-height scan of TIME-Ge. Line discontinuities are attractive interactions with the molecule, pulling it into its three rotamers during the scan, resembling the composite STM image.

Reference

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