TITLE:

Mechanosynthetic, atom-by-atom fabrication based on inverted-mode scanning tunneling microscopy and molecular tools

AUTHORS:

Brandon Blue, Zehra Ahmed, Adam Bottomley, Doreen Cheng, Rosemary Cranston, Christian Imperiale, Cameron Mackie, Terry McCallum, Mathieu Morin, Adam Powell, Sam Rohe, Luis Sandoval et. al.

ABSTRACT TEXT:

Molecular "tools" for atomically-precise chemical reactions with 3-dimensional, sub-Å manipulation of individual reagents (mechanosynthesis) have recently been explored[1]. Enabled by inverted-mode scanning tunneling microscopy[2], we demonstrate the mechanosynthetic addition (donation) and subtraction (abstraction) of individual Si atoms and C_2 moieties at 4 Kelvin *via* custom-synthesized molecular tools. Here, we use a model "build site": an atomically-clean and crystalline Si(100)-2x1 surface under ultra-high vacuum conditions, though other substrates are feasible. The influence of molecular tool design (especially the choice of bridgehead atom) on targeting specific reaction outcomes will also be highlighted. The structures resulting from the use of these molecular tools represent the first demonstrations of an emerging field of positionally-controlled chemical interactions not achievable by any other known method.

CITATIONS:

1. T. Huff et al., "Molecular tools for non-planar surface chemistry," arXiv:2508.16798 [cond-mat.mtrl-sci] (2025), https://doi.org/10.48550/arXiv.2508.16798 (submitted for peer review).
2. E. Barrera et al., "Inverted-mode scanning tunneling microscopy for atomically precise fabrication," arXiv:2512.24431 [cond-mat.mes-hall] (2025), https://doi.org/10.48550/arxiv.2512.24431 (submitted for peer review).

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