Atomically Precise Fabrication Templated by Hydrogen and Halogen Monolayer Resists

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Atomic precision advanced manufacturing (APAM) techniques leverage the chemical contrast created between a hydrogen or halogen monatomic resist and atomic-scale patterns composed of dangling bond sites on a semiconductor substrate. The highly reactive nature of the dangling bond sites restricts APAM device processing to ultrahigh vacuum (UHV) environments and, in turn, severely limits the amount of compatible chemistries available for use. To extend APAM techniques beyond the confines of UHV environments we utilize halogen adatoms to passivate and protect the lithographically defined patterns against exposure to ambient conditions while maintaining the integrity and difference in chemical reactivity of the patterned region and the surrounding hydrogen resist. Here we discuss the identification of selective (wet) chemistries that target attachment to the halogen passivated regions and function as effective growth inhibitors for area-selective, atomic layer deposition (AS-ALD) processes. We apply these results to successfully integrate UHV-based APAM patterning with standard AS-ALD processing tools and grow an oxide etch mask to transfer patterns into the substrate with dimensions ranging from microns to atoms.

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