Fabrication of nano structures for Dimensional Metrology and Device Applications

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Fabrication of 3D structures with near atomic precision via direct patterning on an atomically defined surface is gaining practical value, because the conventional techniques for device fabrication are already at their limits. It is necessary to develop technology based on processes that operate beyond nanoscale down to molecular or atomistic dimensions. Scanning probes with their ability for direct positional control at the atomic scale stands out as a viable alternative for device manufacturing and metrology applications at this scale.

The process which starts from developing methods to control the step-terrace patterns at the atomic scale by a UHV high temperature process on a sample pre-fabricated with micro-scale fiducial marks will be presented. The surfaces thus obtained consists of extremely wide (>10 μm) atomically flat terraces on Si (100) surface. Nano scale patterns are prepared on these surfaces using STM by selectively removing H atoms from hydrogen passivated surface. These patterns form activated sites that could be used for further chemical processing via ALD/ oxidation RIE. The fiducial marks facilitate the relocation of the patterns for analysis after RIE. Atomic scale lithography cannot be implemented without mechanically stable, atomically sharp tips. The tip preparation process which we have developed to create atomic configurations (including a single atom) at the tip-apex for stable tunneling conditions in STM will be discussed.

The challenge is to go beyond the standard homogeneous-surface ALD/RIE processes and achieving adequate performance in the atomic scale depassivated sites. These well-defined features are ideal for emerging technologies such as the nano imprint where the lack of well-defined 3D nano structures has become a severe limitation.