

Toolbox for thin film atomic layer deposition and selective processes

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In the past decades, Moore's law drives the semiconductor industry to continuously develop towards miniaturization and integration. However, the traditional top-down "deposition-lithograph-etching" multiple fabrication steps are limited by significant challenges, such as the control of edge placement errors (EPE) and the complexity of the processes. Atomic layer deposition (ALD) and atomic layer etching (ALE) provides high accuracy with nanometer or close-to-atomic scale to fabricate nanostructures. In this talk, the thin films fabrication processes via ALD/ALE are presented. Firstly, the fundamentals of ALD are introduced, ALD is distinguished for its self-limiting nature that achieves film fabrication with atomic-level thickness control, large-scale uniformity, and outstanding conformality. Atomic layer etching which is a reverse approach of ALD is also introduced, it is especially beneficial to achieve monolayer etching precision. The development and prospects of scientific researches and industrial applications for logic and memory devices are discussed. Selective ALD process enabling depositing atoms at desired surface locations. Through embedding selective atomic layer deposition into patterned substrates, vertical angstrom resolution can be achieved as well as lateral resolution. The downscaling of transistors drives the selective deposition of dielectrics and metals for alignment. Various template-assisted and inherent selective deposition methods have been utilized for the alignment of 3D complex structures. The surface reaction kinetics are important to tune the selectivity. Thin films with different properties are important for various functions, such as dielectric films, metal oxides with high mobility etc. These bottom-up approaches may provide ultimate solutions to achieve advanced technology nodes. Thus, the atomic layer deposition enables significant advancements across the semiconductor industry and a broad spectrum of technological applications, providing a powerful toolbox in precision manufacturing.
