9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Plasma-Based Atomic Layer Etching of Metals and Dielectric Materials

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The critical dimensions of semiconductor devices are continuously shrinking, reaching the nanometer and even angstrom scale in both 2D and 3D structures. As a result, the demand for atomic-scale precision in etching processes is rapidly increasing. This talk will present various plasma-based atomic layer etching (ALE) processes developed for both anisotropic and isotropic patterning of metals and dielectric materials, including molybdenum, ruthenium, cobalt, titanium nitride, tantalum nitride, aluminum oxide, hafnium oxide, zirconium oxide, silicon oxide, and silicon nitride [1–10]. Typical atomic layer etching (ALE) processes consist of two sequential steps: surface modification and material removal. Various surface modification techniques have been employed, including fluorocarbon film deposition, surface fluorination, chlorination, and oxidation using plasma-generated radicals. In the subsequent removal step, the modified layers are eliminated through methods such as ion bombardment, thermal desorption, ligand exchange, ligand volatilization, or halogenation. This talk will also cover key characteristics of plasma-based ALE processes, including reaction kinetics, surface roughness, and residual surface contamination.

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