

Plasma-Assisted Atomic Layer Etching of Silicon Nitride with Unfragmented Fluorocarbons

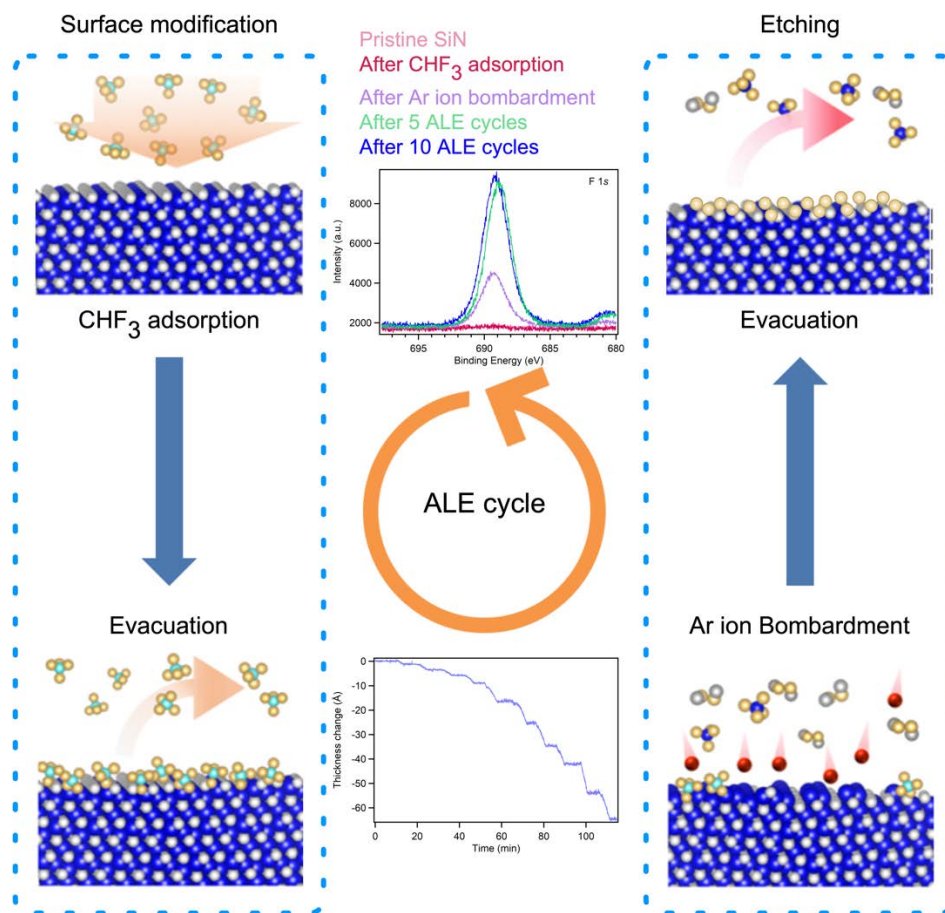


Figure 1. A schematic for fluorocarbon-based plasma-assisted ALE is shown. One ALE cycle combines direct CHF_3 adsorption as the surface modification step and argon ion bombardment as the etch step. The F 1s XPS spectra show the evolution of the 1st, 5th and 10th ALE cycle performed at 24 °C. An obvious F 1s peak is detected after the first Ar bombardment step and it indicates the energetic argon ions facilitating a reaction between fluorine and silicon. After 5 and 10 cycles, the F 1s peak maintains the same level, which indicates that the residual fluorine is left behind after argon ion bombardment. The ellipsometry result show the etch rate for the 10 ALE cycles. The etch rates of the first five cycles are lower since the silicon nitride film has an oxidized surface. After the oxidized layer is removed, the etch rate increases to ~ 1 nm/cycle.

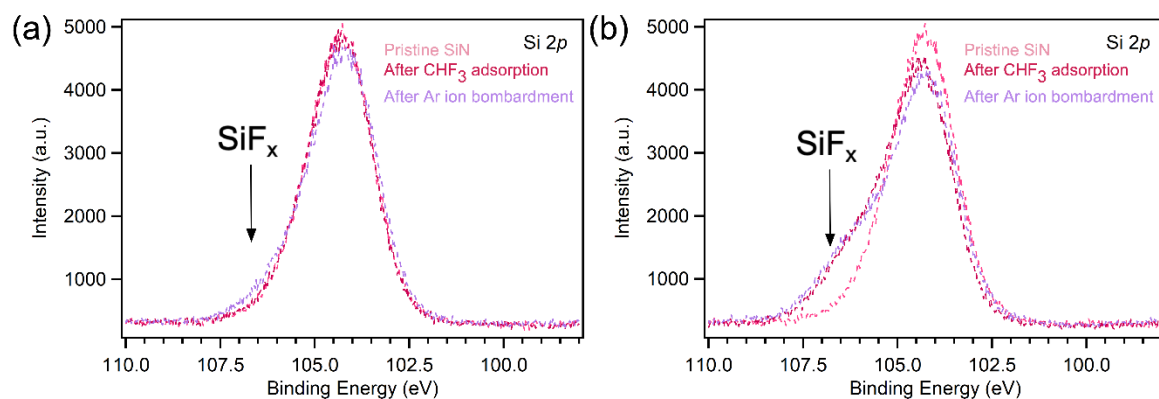


Figure 2. Si 2p XPS spectra for silicon nitride after exposure of CHF_3 at 30 mTorr (red) and argon ion bombardment (purple) at (a) 24 °C and (b) 100 °C.