# Low Resistance ALD TiN from Low Temperature Thermal $N_2H_4$ + $TiCl_4$

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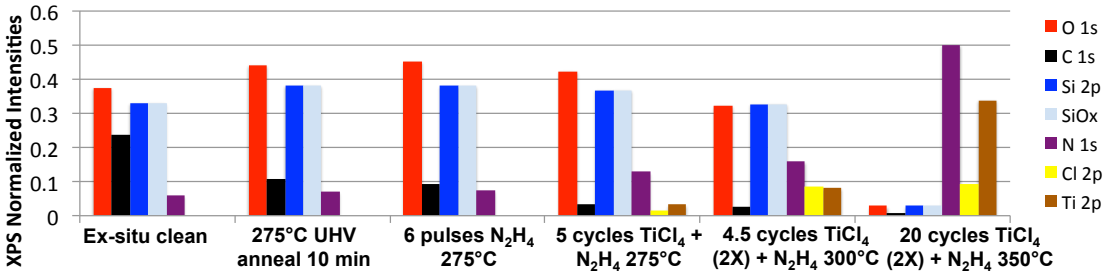


**Figure 1.** Normalized XPS of cyclic exposures of $TiCl_4$ and $N_2H_4$ on clean $SiO_xN_y$. Growth of Ti 2p and N 1s at a range of substrate temperatures between 275°C and 350°C. Estimated film thickness of 3 nm with ~10% Cl after a total of 30 cycles.

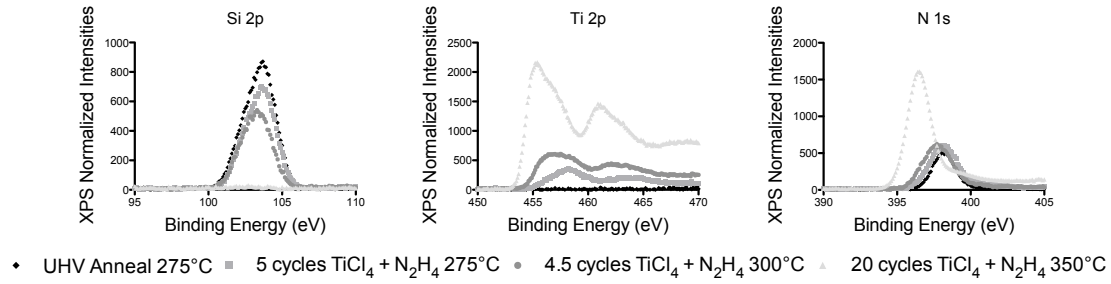


**Figure 2.** Elemental XPS Si 2p, Ti 2p, and N 1s regions for $TiCl_4$ + $N_2H_4$ cycles on $SiO_xN_y$. After 30 cycles the substrate Si 2p signal is nearly fully attenuated, while the Ti 2p3/2 binding energy shifts from ~458 eV (interfacial Ti-O bond formation) to ~455.2 eV after additional cycles consistent with the formation of TiN.

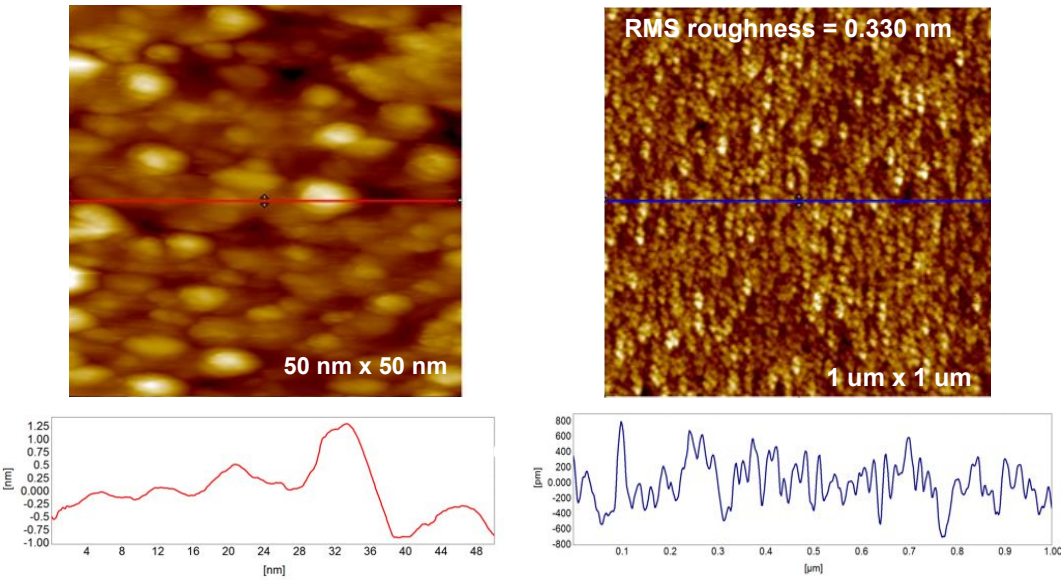


**Figure 3.** Left—50 nm x 50 nm STM image of deposited TiN film after 30 cycles. The film looks like it could be nanocrystalline. Right—AFM showing a 1 µm x 1 µm area that has a subnanometer RMS surface roughness of 0.330 nm.