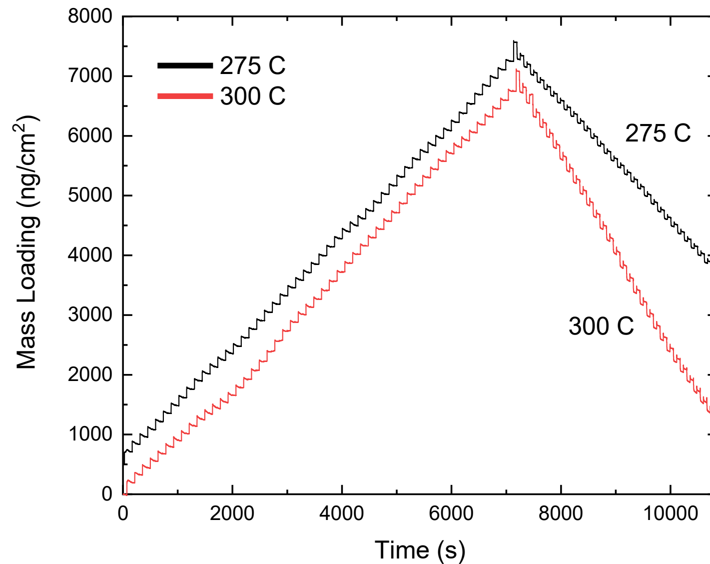

Figure 1. HfO_2 mass uptake from in-situ quartz crystal microbalance measurements during 50 ALD cycles followed by 30 ALE cycles at 275°C (black) and 300°C (red). Mass loading at 275°C is offset by +500 ng/cm^2. The deposition rate remains the same at each temperature, while the etch rate is faster at the higher temperature.

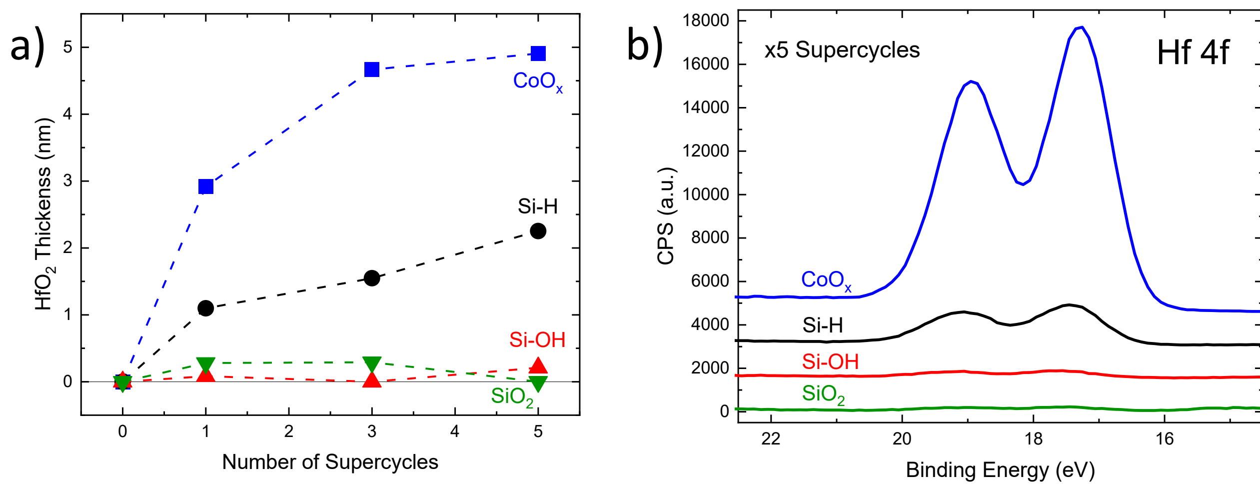

Figure 2. a) HfO_2 film thickness from ellipsometry measurements as a function of supercycle on Si-OH (red), Si-H (black), SiO_2 (green), and CoO_x (blue) substrates deposited at 275°C. Film growth behavior on RuO_x and SiCOH substrates with ALD/ALE supercycling behave similarly to the Si-OH and SiO_2 substrates. Each supercycle consists of 20 ALD cycles followed by 20 ALE cycles. After 5 supercycles, CoO_x and Si-H substrates have 4.9 nm and 2.2 nm of HfO_2 film growth, respectively, while the Si-OH and SiO_2 substrates have less than 0.2 nm of HfO_2 growth. b) XPS Hf 4f high resolution scans of HfO_2 films on Si-OH, Si-H, SiO_2, and CoO_x substrates after 5 supercycles showing elevated Hf content on CoO_x and Si-H substrates compared to Si-OH and SiO_2 surfaces.