Therefore complementary techniques are needed to continue extreme scaling and extend Moore's law. Selective deposition processes can be used to increase and enhance patterning capabilities at very low cost. In our lab, a new selective Plasma Enhanced ALD process has been developed by adding etching steps in the PEALD flow. To be effective, 3 conditions must be satisfied (Figure 1):

- A different nucleation delay on different substrates
- A nm scale etching of the thin film
- The etching step must add a new nucleation delay

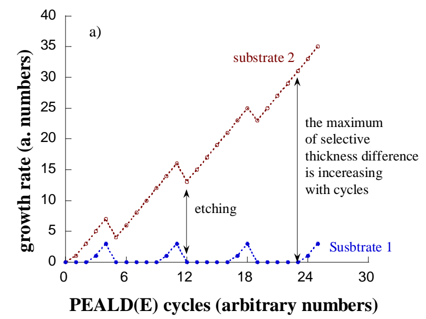

Figure 1 – Illustration of the selective deposition process

We used this process for the selective deposition of Ta_2O_5 with TBTDET (TertButylimido Tris(DiEthylamino Tantalum) precursor and a plasma gas mixture of $O_2/Ar/NF_3$ for deposition and etching steps. Ta_2O_5 has been selectively deposited on a metal substrate (TiN) versus SiO_2 and Si substrates (no deposition on these substrates). For this process, the different substrates have been patched onto a Si wafer and introduced simultaneous into the PEALD reactor. [1]

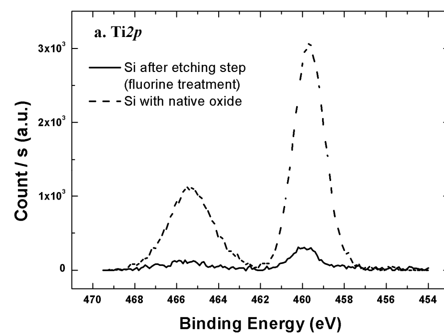

Figure 2 - XPS results Ti2p peak

For this presentation we will present the selective process developed for TiO_2 with TDEAT (Tetrakis DiEthylAmido Titanium) precursor. The ALD selective process has been successfully developed for the deposition of TiO_2 on three different metallic substrates (TiN, NiPt and W). As for Ta_2O_5 deposition, a thin TiO_2 film is deposited on the different metal substrates but not on Si and SiO_2 substrates although all substrates are introduced simultaneously in the deposited chamber. Details on the process will be given during the presentation with a focus study on precursors and radicals interactions with the different surfaces after each step of the process. In this study, quasi in situ XPS was used. Figure 2 shows Ti2*p* peak for one titanium pulse on silicon substrate with or without etching step. Fluorine treatment lead to thinner layer. This difference is explained by Si-F and Si-O-F bonds presence at the surface. This fluorine bonds blocks the titanium growth.

The thin oxide films selectively deposited will be used in 3D nonvolatile memory devices. Our objective is to realize a crosspoint memory in backend level from a pattern area or a trench area without the photolithography step. Therefore, electrical properties of the Ta_2O_5 and TiO_2 oxides deposited with the standard PEALD process are compared to those of thin films selectively deposited thanks to C(V), C(f) and I(V) measurements. We will show that the selective ALD process does not degrade the dielectric properties of the films in terms of leakage current and electrical field breakdown. Resistive memories cycles are also compared and discussed. Finally, 3D structures with the selective deposition process will be shown.

[1] Vallat, Rémi, et al., *Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films* 35.1 (2017): 01B104.