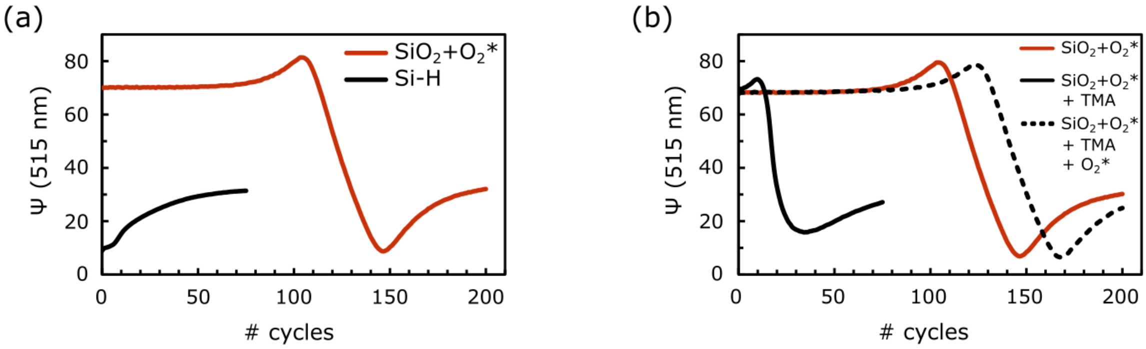

Fig. 1. (a) Raw in-situ SE data for Ru growth on blanket Si-H and O$_2$-plasma cleaned (O$_2$*) SiO$_2$ substrates suggesting that a selectivity window of about 70 cycles is present for the RuO$_4$/H$_2$-process. (b) One TMA pulse of 10s at 0.005 mbar on the plasma cleaned SiO$_2$ substrate completely removes the nucleation delay of the Ru ALD process (SiO$_2$ + O$_2$* + TMA), while performing an oxygen plasma after the TMA pulse reestablishes the nucleation delay (SiO$_2$ + O$_2$* + TMA + O$_2$*).

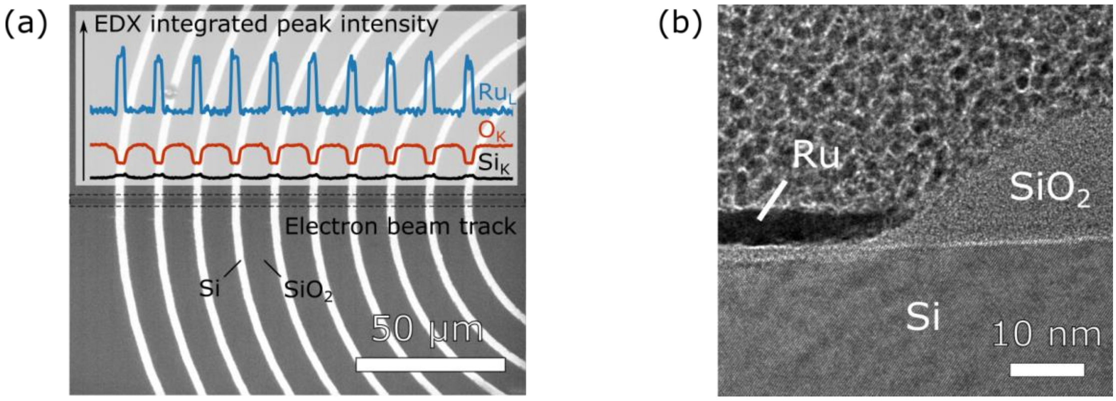

Fig. 2. (a) Planar view SEM analysis of patterned Si-H lines (3 µm width) on SiO$_2$ which were exposed to 20 cycles of the RuO$_4$/H$_2$-process. The SEM micrograph was acquired after an EDX line scan perpendicular to the Si lines and is overlaid with the corresponding EDX data for Ru, O and Si. (b) Cross section HRTEM performed at the edge a patterned Si-H line. It is clear that the Ru grows selectively on the Si-H. detailed inspection of the SiO$_2$ region using HRTEM confirmed that no Ru was deposited on SiO$_2$

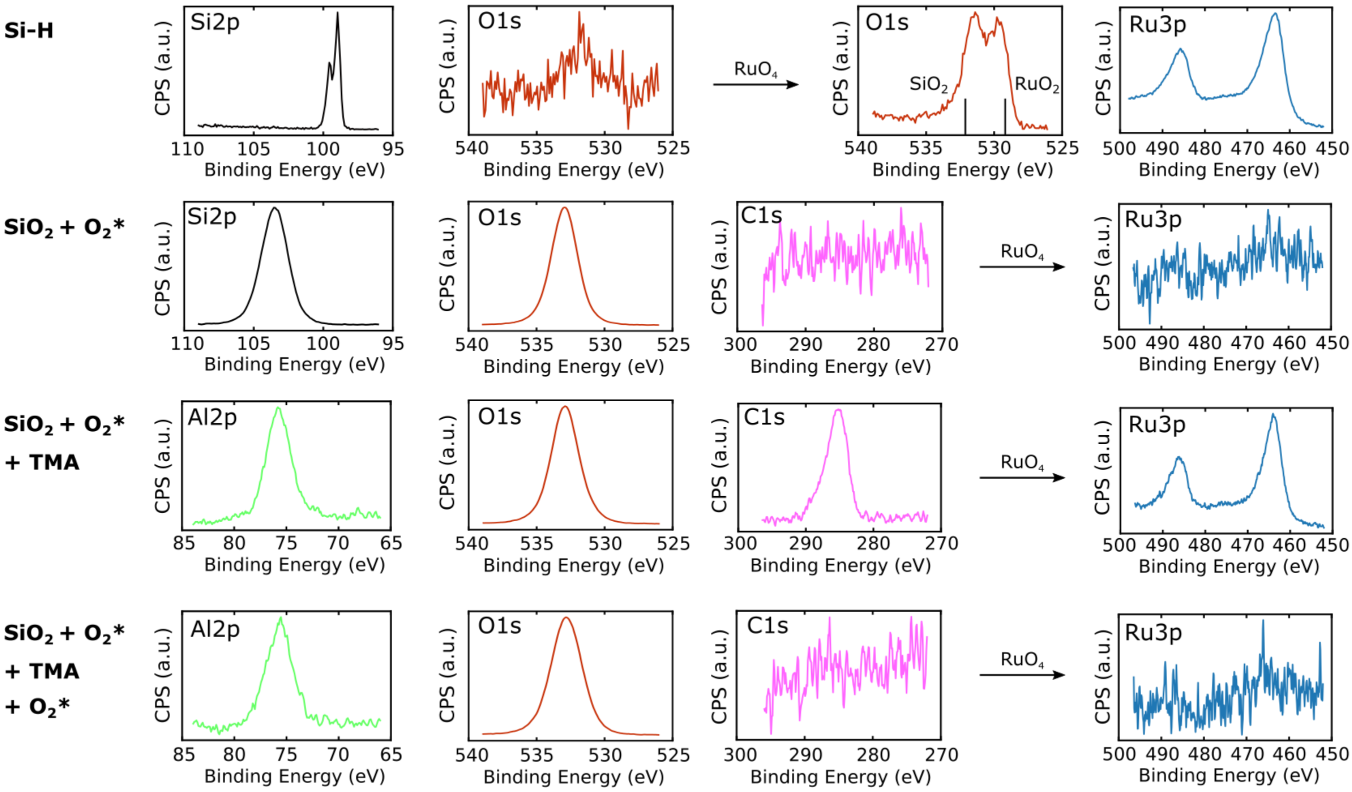

Fig. 3. In vacuo XPS data, acquired before (left) and after (right) a single 10s ToRuS pulse at 1.8 mbar, on different starting surfaces (indicated in bold on the left). On Si-H it is clear that Ru is deposited, and we can see a O1s contribution from both SiO$_2$ and RuO$_2$ (indicated by vertical bars). On O$_2$*-treated SiO$_2$, no Ru is deposited as the starting surface is already oxidized. If we pulse TMA (10s @ 0.005mbar), Al-CH$_3$-groups are introduced on the surface which allows for RuO$_4$ to react with the surface and leads to Ru deposition. This is confirmed by performing a O$_2$-plasma after the TMA pulse, which removes the CH$_3$-groups (no C1s signal), and avoids the deposition of Ru.