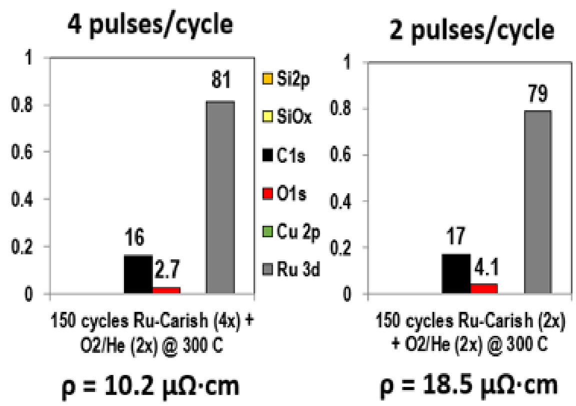

Fig. 1. Effect of Ru-Carish pulses on Ru resistivity. At 300 C, after 150 cycles at 2 pulses per cycle of Ru-Carish, the film contains roughly 4.1% O, with a resistivity of 18.5 μΩ·cm. Doubling the number of pulses reduces the percentage to 2.7%, with a decrease in resistivity to 10.2 μΩ·cm.

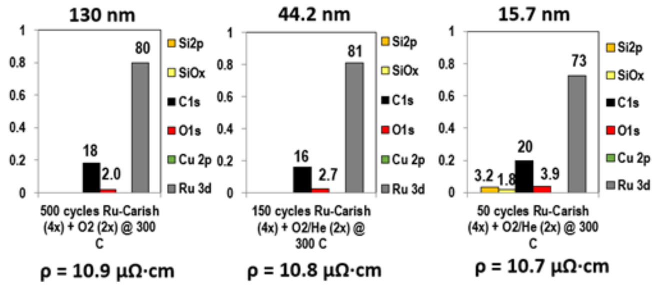

Fig. 2. Resistivity-thickness relationship for Ru ALD. At 300 C and 4 pulses/cycle, the growth rate was determined to be 0.25 nm/cycle, with low oxygen persisting to 15.7 nm film thickness. Thickness measurement for the 130 nm film was performed via cross-sectional SEM, while thicknesses for the 44.2 and 15.7nm films were determined via XRR. Four-point-probe resistance measurements showed resistivities of 10.9, 10.8, and 10.7 μΩ·cm, respectively.

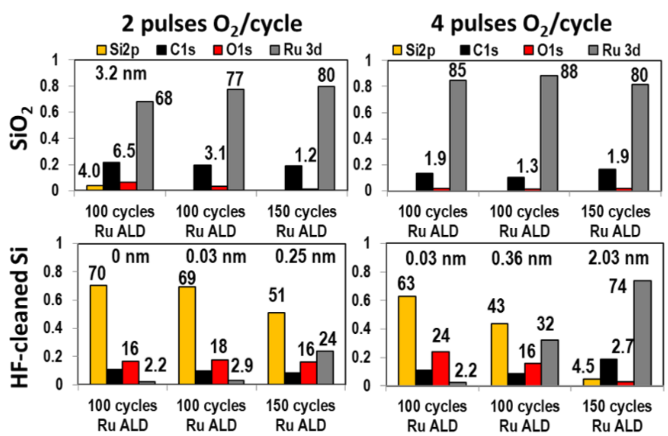

Fig. 3. Substrate selectivity during Ru ALD on SiO_2 and Si. At 300 C and 2 pulses of O_2, the first 100 cycles deposited results in a 3.2 nm Ru film on SiO_2, with a near-zero thickness on HF-cleaned Si. At the target of 350 cycles, only 0.25 nm was deposited on HF-cleaned Si despite XRR showing a 30 nm Ru film on SiO_2. Doubling the number of O_2 pulses increased the growth rate on HF-cleaned Si, but the growth rate remained significantly lower, with only 2 nm on Si after 350 cycles.

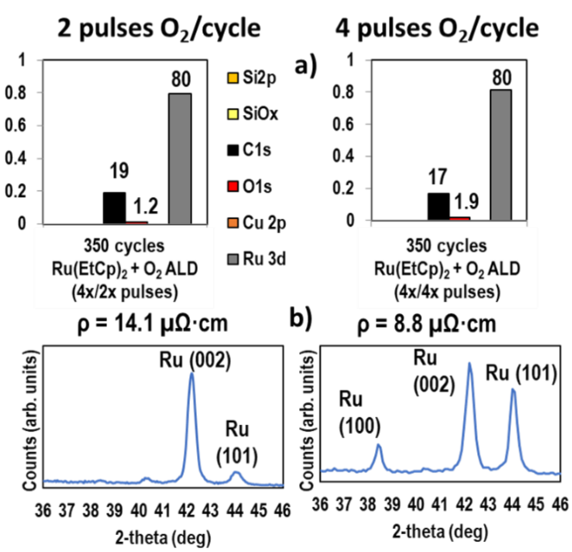

Fig. 4. Resistivity-oxygen dose relationship for Ru ALD using $Ru(EtCp)_2$. At 2 pulses/cycle, growth rate was 0.9 Å/cycle, while at 4 pulses/cycle, growth rate was 1.0 Å/cycle. a) Oxygen content of both films was sub 2%, with the 2 pulse and 4 pulse/cycle films having a resistivity of 14.1 and 8.8 μΩ·cm, respectively. b) XRD and XRR of the films shows that the Ru(002) peak is dominant, but the Ru(101) grain size increases from 18.4 nm to 28.0 nm.