Stability investigation of atomic layer deposited cerium oxide depending on oxidant choice

7. DPR – Thin films, coatings and depth profiling

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Atomic layer deposition (ALD) has been used extensively to grow homogeneous films with excellent coverage and atomic-scale thickness control for a variety of applications. However, remaining challenges include unraveling the complex interplay between substrate and deposit as well as the oxide film and potential capping layers, which can cause significant deviations from bulk properties, especially for ultrathin (< 20nm) layers. In this work, we present a detailed investigation of ultrathin cerium oxide films grown using the novel $Ce(dpdmg)_3$ precursor with H_2O, O_2, and O_3 on different substrates. Using in-situ X-ray photoelectron spectroscopy and operando spectroscopic ellipsometry allows us to gain first-hand information on the growth dynamics without exposure to ambient conditions, revealing distinct changes in growth mode, oxide stoichiometry (see Fig. 1a), and residual contamination (see Fig. 1b-c) mediated by the use of different oxidants. Combined with ex-situ characterization by Raman spectroscopy and transmission electron microscopy, we are able to establish the connection between our in-situ observations and the formation of a stable oxide-substrate interface under ambient conditions, which is crucial for use in future applications.

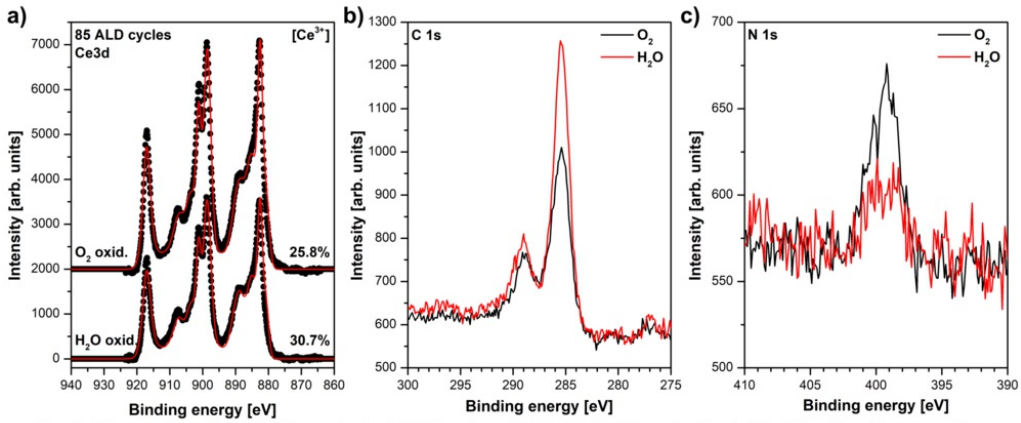

Fig. 1 a) Comparison of Ce3d XPS spectra for 85 ALD cycles of CeO_x/Si with different oxidants (black lines) and the respective Ce^{3+}-concentration determined from fitting (red lines), b) C1s XPS spectra and c) N1s XPS spectra for 85 ALD cycles of CeO_x/Si with different oxidants