Contribution submission to the conference SKM 2023

Reduction by H2 exposure at room temperature of ceria ultrathin films grown by atomic layer deposition — •Carlos Morales, Yuliia Kosto, Rudi Tschammer, Karsten Henkel, and Jan Ingo Flege — Applied Physics and Semiconductor Spectroscopy, Brandenburg University of Technology Cottbus-Senftenberg, Konrad-Zuse-Strasse 1, D-03046 Cottbus, Germany

Atomic layer deposition (ALD) exhibits a high potential for integration as a scalable process in microelectronics, allowing well-controlled layer-by-layer deposition and conformal growth on 3D structures. Yet, the ALD technique is also well known to lead to amorphous and defective, non-stoichiometric films, potentially resulting in modified materials properties that, in the case of ultra-thin deposits, can also be affected by film/substrate interaction. Interestingly, initial in situ X-ray photoemission spectroscopy (XPS) measurements of ceria ALD-deposits on Al2O3/Si, sapphire, and SiO2 substrates confirm a Ce3+/Ce4+ mixture dependent on the substrate interaction, deposit thickness, and morphology. Using near-ambient pressure XPS, we have significantly reduced ultrathin ($<$ 10 nm) ceria films grown by ALD by exposing them to different O2/H2 partial pressures at moderate temperatures ($<$ 525K). Notably, the total amount of reduction to Ce3+ is found to depend on the deposit thickness and initial ceria/substrate interaction. Furthermore, the intrinsic defects related to the ALD method seem to play a critical role in the reversible reduction at room temperature.

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Type:	**Vortrag;Talk**
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