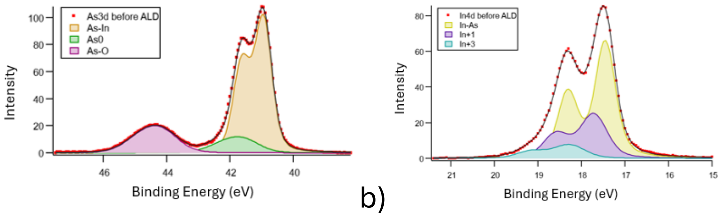
Time evolution of chemical reactions during aluminium oxide atomic layer deposition on InAs

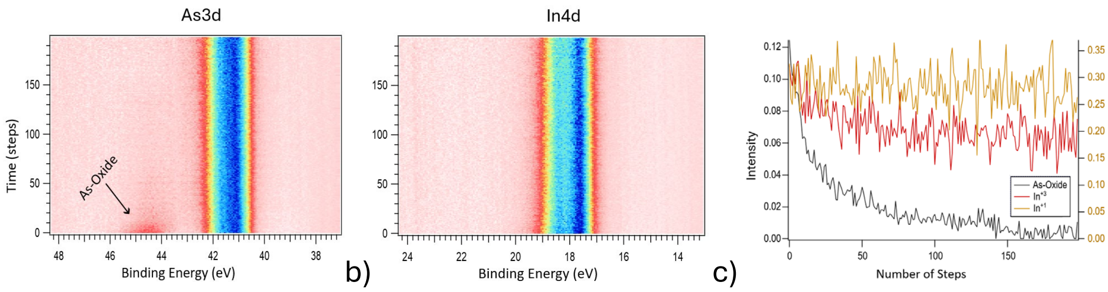
Supplementary Images



a) b)

Figure 1: High resolution XPS data of a) As3d and b) In4d core levels.

Figure 1 illustrates the initial state of the As3d and In4d core levels before the ALD. The As3d is fitted with three components, of which the lowest binding energy (BE) corresponds to the As-In bond from the bulk of the material. The peak at the highest BE is due to the layer of native oxide on the material's surface. The peak at about 41.6 eV corresponds to the As^0 chemical state, indicating the presence of interface defects due to the formation of a metallic bond during oxidation[1]. Also, the In4d core level is fitted with three doublet components. The In-As peak occurs at 17.46 eV, and the other two peaks are located at +0.26 eV and +0.82 eV, which correspond to different oxidation states In^{+1} and In^{+3}, respectively[2].



a) b) c)

Figure 2: Time-resolved AP-XPS spectra of a) the As 3d core level and b) the In 4d core level during TMA deposition. c) Time evolution of the intensities of their oxidation states.

The time-resolved measurements of the As3d core level indicate that the As-Oxide is completely removed during the TMA half-cycle, as observed also in **Fig. 2c** (black curve). The intensity of the As-Oxide decreases rapidly from the beginning of TMA deposition and becomes zero by the end of the reaction. **Fig. 2b** depicts the In4d core level time-resolved spectra, where the intensity of the In-As remains constant during the ALD. Initially, the In4d peak is broader, due to the +3-oxidation state of In, as indicated in **Fig. 2c** (red curve), which decreases during the ALD, but some amount of In^{+3} remains in the interface. Finally, the intensity of the In^{+1} oxidation state remains approximately stable during the TMA deposition.

1. Troian, A. *et al.* InAs-oxide interface composition and stability upon thermal oxidation and high-k atomic layer deposition. *AIP Advances* **8**, 125227 (2018).
2. Brennan, B. & Hughes, G. Identification and thermal stability of the native oxides on InGaAs using synchrotron radiation based photoemission. *Journal of Applied Physics* **108**, 053516 (2010).