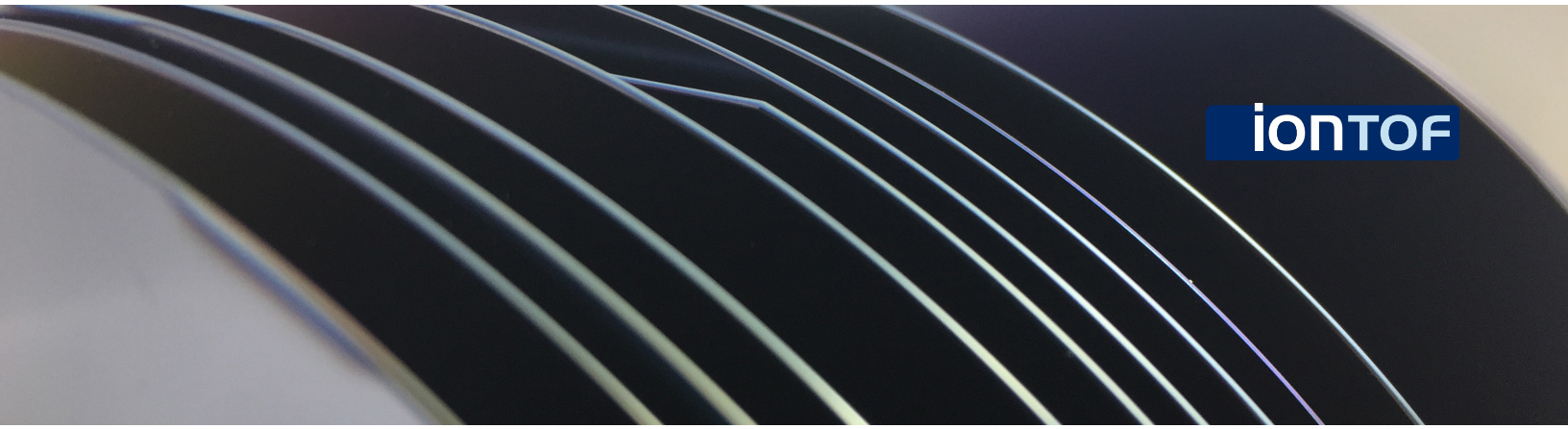

7 5

Atomic Layer Deposition

Composition analysis during early stages of film growth

Atomic Layer Deposition (ALD) has excellent properties which lead to the growth of high quality films, especially of non-trivial stoichiometry. However, it can show some interesting behaviour during the early stages of film growth. Once a complete film is formed, the surface chemistry is constant and the growth proceeds under steady state conditions.

For an incomplete film however, the surface composition (film/substrate ratio) changes, and therefore the composition of the deposited material can vary depending on the adsorption behaviour of the precursors. The example of ALD deposited GaSb films is such a case.

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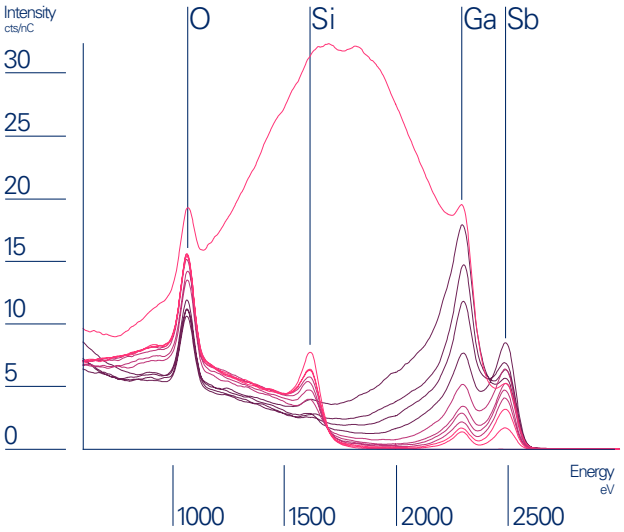
The 3 keV He scattering spectra below show a high purity film with no unexpected elemental peaks present in the outer atomic layer.

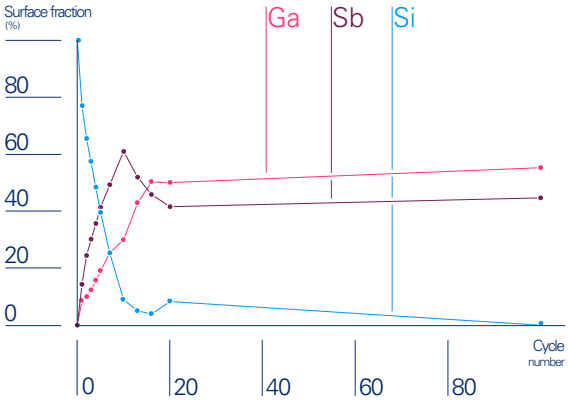
Using 5 keV Ne scattering together with the TOF mass filter, the composition of the film can be determined quantitatively. In contrast to the simple assumption of co-deposition of both metals, the results show a more complex behaviour. In the first few cycles, Sb is preferentially deposited while Ga is deposited at a slower rate. Interestingly, the absolute Sb coverage of the surface goes through a distinct maximum at 10 cycles, reaching 61 % surface coverage before dropping again to the steady state value of 44 % (Sb/Ga ratio of 0.81).

The capability to analyse the compositional changes during the growth process helps to understand and optimize the ALD process conditions.
(Samples courtesy of Tom Blomberg, ASM Microchemistry)

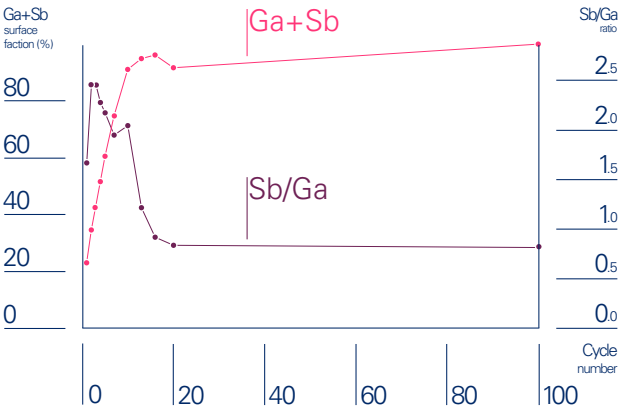
Top Atomic Layer Sensitivity



Series of LEIS spectra after 1, 2, 3, 4, 5, 6, 10, 13, 16, 20, 100 ALD cycles



Variation of the surface fraction of the three main components Si, Ga, and Sb with the number of ALD cycles



Surface fraction of Ga+Sb and the composition ratio of Sb/Ga as a function of the cycle number