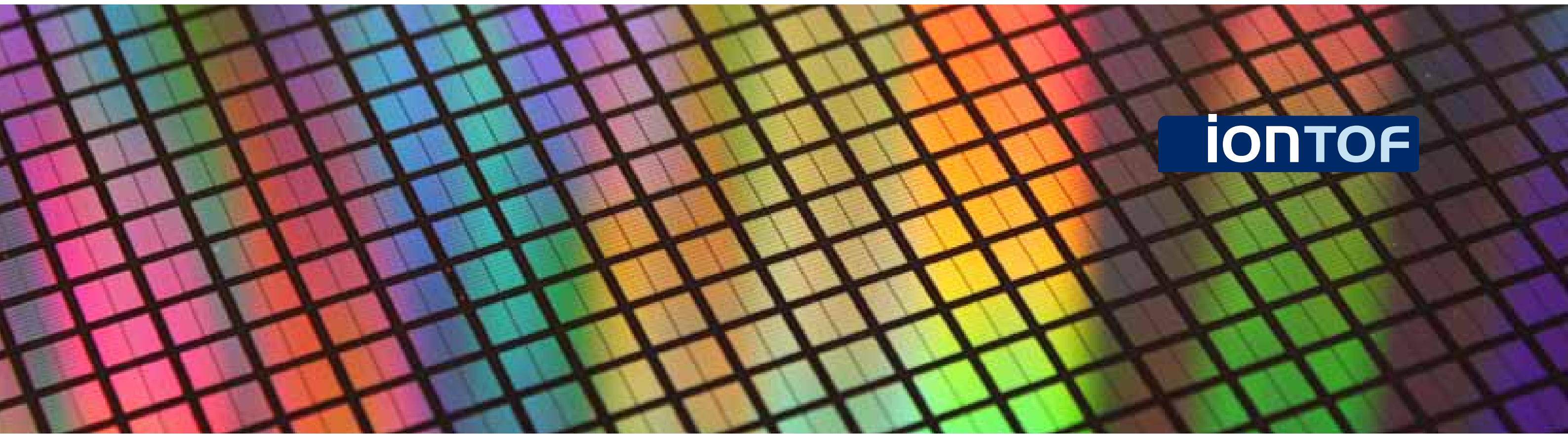

7 1

Ultra-thin Layers

Non-destructive thickness measurements

Atomic layer deposition (ALD) has become an important method for the production of ultra-thin layers.
With Low Energy Ion Scattering (LEIS) information about the composition, uniformity and thickness of these layers can be obtained. The technique also allows the detailed investigation of the growth process at a very early stage even before layer closure.

In LEIS analysis the detected ions are scattered at the outmost atomic layer or at layers below the surface. The ions which are scattered at the surface lose part of their initial energy depending on the mass of the scattering atom.
The resulting peaks in the LEIS spectrum provide quantitative information about the composition of the top atomic layer. Those ions scattered from atoms below the surface lose additional energy proportional to the depth at which the scattering occurred. By measuring the energy distribution of these ions, the elemental composition of sub-surface layers is determined non-destructively. This static depth profiling provides information down to a depth of 10 nm.

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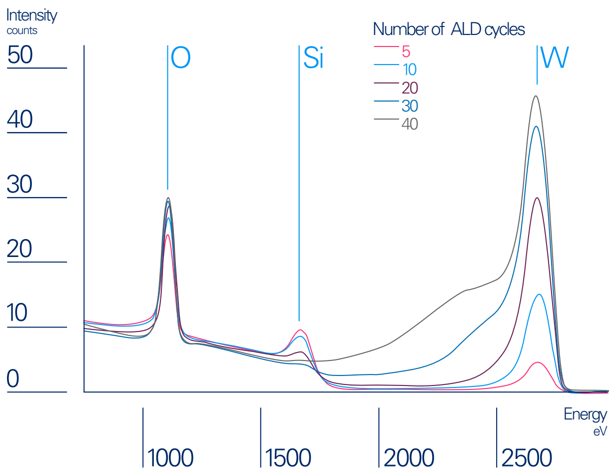
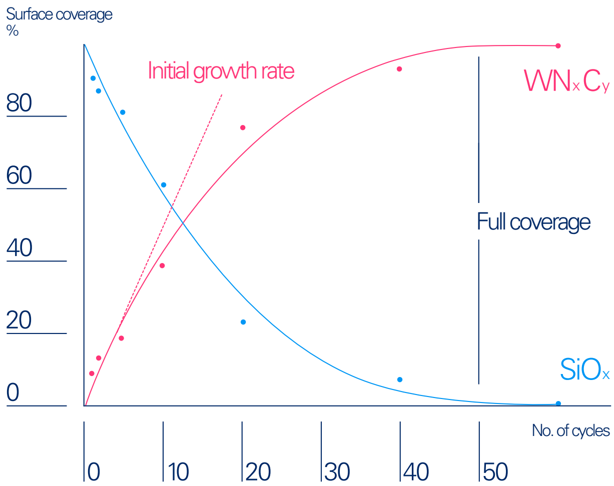
Ultra-thin ALD layer analysis

In the semiconductor industry ultra-thin films such as diffusion barriers and high-k layers are more and more often manufactured by atomic layer deposition (ALD).

The example shows five different LEIS spectra taken after an increasing number of deposition cycles of WN_xC on silicon.
By monitoring the decreasing silicon and the increasing tungsten signal it can clearly be seen that 40 ALD deposition cycles are necessary for a closed layer of WN_xC_y. The peak shape on the low-energy side of the tungsten $WN_xC_ySiO_x$ surface peak also shows the growth of multiple layer islands before reaching full coverage.
By measuring the energy loss the minimum and maximum thickness of the film can be calculated with sub-nm precision. Growth modes can be determined following the development of the in-depth signals with an increasing number of deposition cycles.



LEIS spectra taken after an increasing number of ALD cycles of WN_xC_y on silicon.



WN_xC_y and SiO_x coverage as a function of the number of deposition cycles.