

Further development of electron tomography



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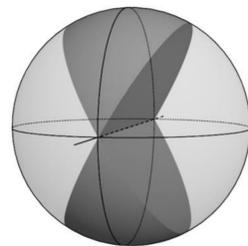
Motivation: High-angle-annular-dark-field scanning transmission electron microscopy tomography is still a well-established method in semiconductor industry. But Single-axis electron tomography does not show an adequate resolution and reconstruction artifacts because of the restricted tilting range and the resulting missing wedge. The effect can be limited by using the Dual-axis electron tomography.

Single-axis electron tomography

Dual-axis electron tomography

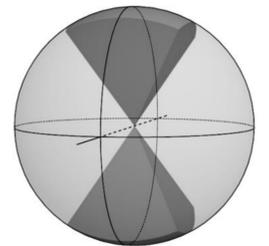
Approach

One tilt series is acquired in a tilt range of $\pm 70^\circ$. Because it is not possible to obtain information from the specimen beyond the maximum tilt the *missing wedge* appears.



missing wedge¹

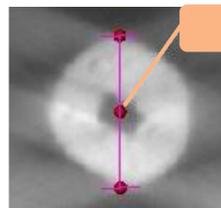
Two tilt series are acquired in a tilt range of $\pm 70^\circ$. The tilt axis is rotated about 90° . After merging the datasets only a *missing pyramid* appears.



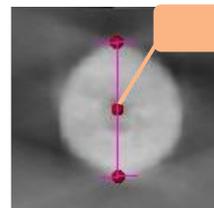
missing pyramid¹

Examination of contacts with an *axial* spatial extent in general

Virtual slice in xz-plane of a contact



52,59 nm



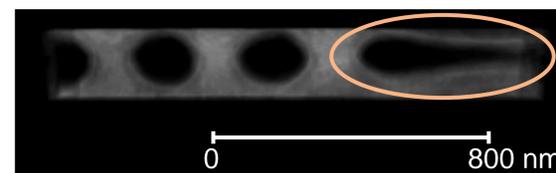
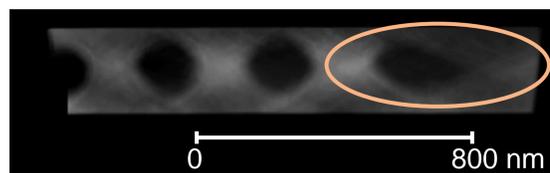
46,44 nm

Elongation in z-direction is reduced

Examination of vias with a *lateral* spatial extent in general

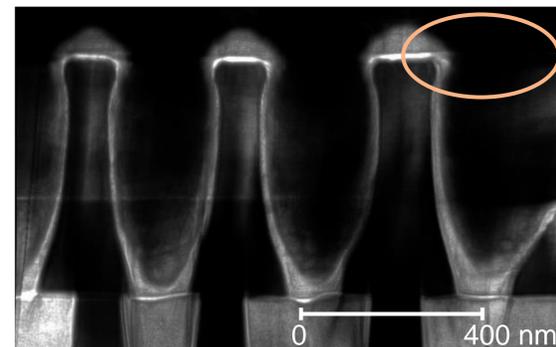
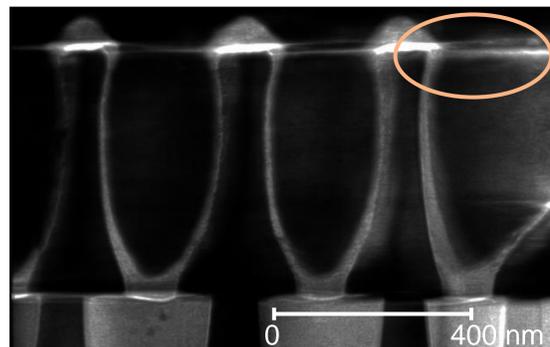
Results

Virtual slice in xz-plane of vias



More defined structures

Virtual slice in xy-plane of vias



Artifacts are reduced

Conclusion:

Dual-axis electron tomography should be used, especially when the three-dimensional metrology of semiconductor components is required. Moreover, it is

useful to inspect contours like the Cu seed barrier of vias more precisely and to receive more exact three-dimensional rendering, due to the fewer artifacts.