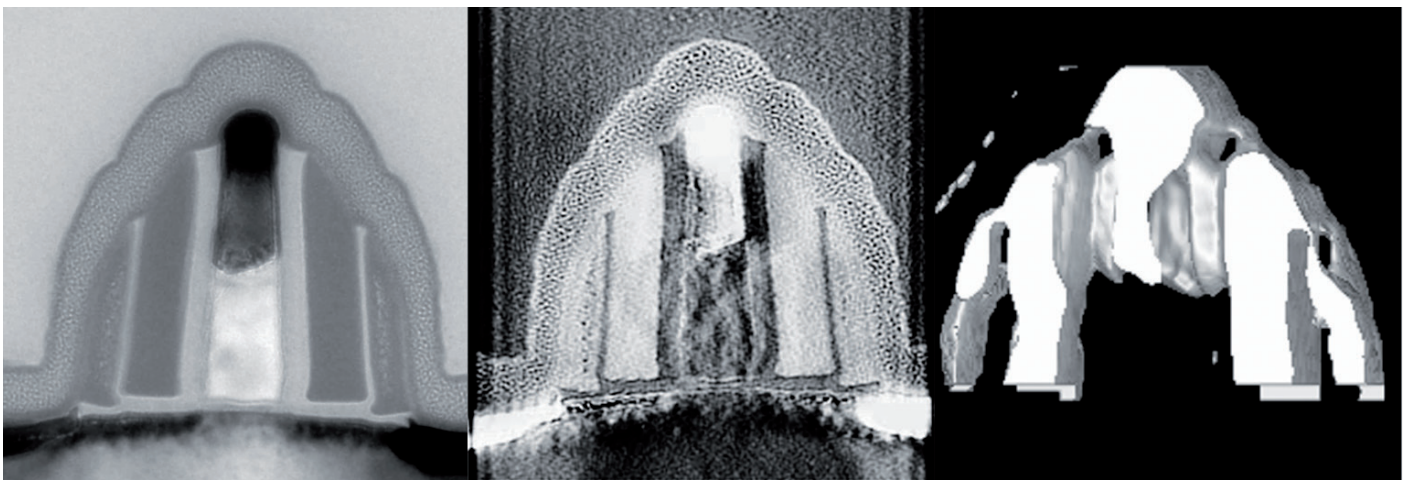


# Electron Tomography

## Automatic acquisition of tilt series for 3-D reconstruction

Electron tomography is a powerful tool to obtain three-dimensional (3-D) structural information in materials science and life sciences. A set of 2-D projections of an object recorded at different tilt angles is used for calculating the 3-D reconstruction.



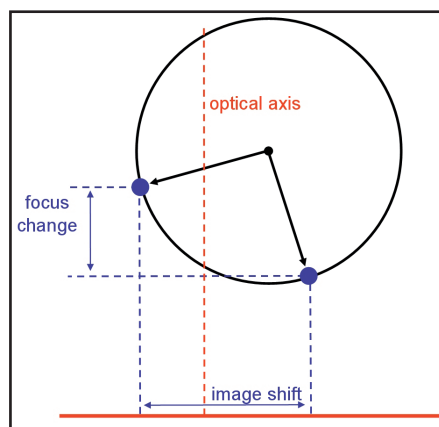
Gate contact of a MOS transistor. Zero-degree projection (left). Central slice through the reconstructed volume (middle). Filtered surface model (right).

### Exemplary applications

- **Cellular tomography:**  
imaging the interior of entire cells
- **Molecular tomography:**  
structural information of supra-molecular complexes
- **Cytochemistry:**  
3-D localization of gold labels
- **Materials science:**  
catalyst particles, nano tubes
- **Semiconductor research:**  
contact holes, interconnect lines

### Acquiring tilt series

For a typical 3-D reconstruction, 70 or more projections (depending on the desired resolution) have to be recorded. Basically, these projections



can be successively collected by tilting the specimen followed by image recording. Due to mechanical imperfections of the goniometer, the tilt axis is not perfectly stable. Moreover, a specimen which is not exactly aligned to the eucentric height or a tilt axis

which is not well adjusted to the optical axis causes movements of the object when the specimen is tilted. As illustrated in the figure, this results in:

- image displacements up to several microns
- focus changes in the same order of magnitude.

In practice, these effects, even enforced by specimen drift, require several operations such as recentering and refocusing after each tilt increment, particularly at higher tilt angles ( $> 50^\circ$ ).

A manual correction can be very time-consuming and, in case of beam-sensitive specimen, almost impossible.

# Features and benefits

## Automated Electron Tomography package

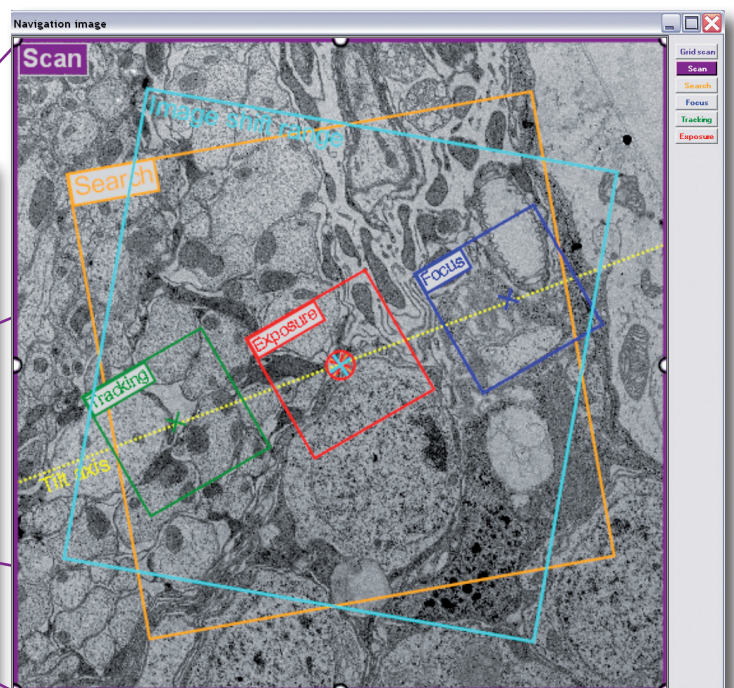
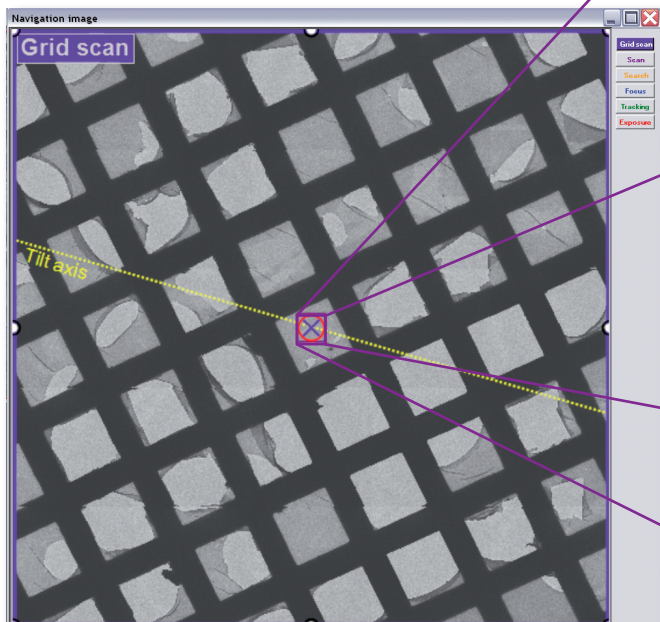
TVIPS GmbH has developed a software solution for automatic TEM alignment and acquisition of tomographic tilt series which is compatible with nearly all TEMs equipped with remote control and computer-controlled goniometer. This system includes tools for automatic focusing. A tracking routine compensates for tilt or drift induced image shifts for each projection. A low-dose utility for all alignment procedures minimizes the electron dose applied to the specimen as all corrections can be performed on adjacent areas. Thus, the area of interest is merely exposed to the dose intended for the image acquisition.

- Automated acquisition of tomographic tilt series under low-dose conditions
- Compensation of tilt-induced specimen displacement and drift using image and beam shift

- Integrated autofocus and autoeucentricity
- Automated centering of image shift (with stage movement), when image shift range is reached
- Embedded navigator, i.e. position definition starting from the whole grid up to the area of interest
- Multiple series acquisition of one tomographic position: Previously recorded tracking images can be used as „anchor images“ for acquiring the whole series from one direction
- Multiple acquisition at different tomographic positions under low-dose conditions (batch tomography)
- Continuously updated display of applied electron dose
- Turn key solutions are available for FEI/Philips, Hitachi, JEOL, and

ZEISS microscopes – also older generation TEMs are supported, e.g. CM-120/200/300, JEM-1230/2010/3010 and Zeiss LEO-910/912

- Typical execution time for one tilt step, including displacement and focus correction (depending on TEM type and number of positions): 5 - 120 sec
- Image area/resolution can be increased by tiling
- For fast recognition of problems the already acquired images can be shown as video sequence during the acquisition (tilt player)
- For faster acquisition of focus and images shifts, changes can be predicted and some positions skipped



Navigating on grid and defining tomographic positions

Please visit [www.tvips.com](http://www.tvips.com) for further information, application examples and links to 3-D microscopy homepages.

TVIPS GmbH  
Eremitenweg 1  
D-82131 Gauting  
Germany

Phone +49-89-850-6567  
Fax +49-89-850-9488  
E-Mail: [info.de@tvips.com](mailto:info.de@tvips.com)  
[www.tvips.com](http://www.tvips.com)

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