

PREPARATION OF TEM - SAMPLES

EXCISING LAMELLAS FROM INTEGRATED CIRCUITS

Electronical drop outs in integrated circuits that result from structural defects can be inspected by high-resolution transmission electron microscopy measurements. This requires to cut a very small lamella out of the drop-out-area. Using Nanomanipulators renders the complicated preparation techniques much easier.

This article was published by:



The diagnosis of defects in highly integrated semiconductor devices by transmission electron microscopy (TEM) requires complex preparation techniques. A small electron-transparent lamella has to be cut out of the integrated circuit (IC). Therefore it is convenient to use a focused ion beam technique (FIB) which allows to remove micron-sized areas of the sample by physical ion sputtering while the surface is simultaneously inspected by induced electron microscopy.

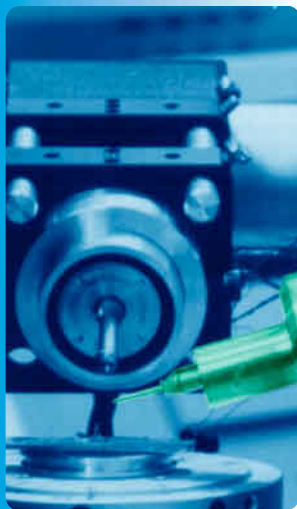


Fig. 1: Two Nanomanipulators in an electron microscope.

Using the Nanomanipulator it is possible to break the etched lamella off the Si-device, lift it and put it onto a grid for later examination in an transmission electron microscope.

Fig. 2 shows how the Nanomanipulator is mounted among the functional elements of the FIB sample chamber. The manipulator is controlled by a joystick which allows to process the sample precisely within transmission mode. A electrolytically etched tungsten needle tip is attached to the carrier tube of the Nanomanipulator and electrically contacted.

The standard method:

Since the maximum length of the TEM-sample can be three millimeters and only micron-sized



Fig. 2: The Nanomanipulator in the FIB sample chamber with gas supply (left), ion source (top middle), detector (top right) and sample stage (bottom).

areas can be carried off, the samples have to be sawn with a conventional string-saw before they can be treated. Thereby the sample is always endangered by destruction. A freestanding TEM-lamella with the thickness of the electron transmission length and a width of 5 to 50 μm is prepared out of the desired area by ion beam etching (Fig. 3).

For the subsequent diffraction contrast analysis in a TEM the sample has to be swiveled towards the incident electron beam. Up to now this requires large angles to be etched out of a prepared strip of the sample.

The elegant method:

Latterly it is possible to just etch a small area of the sample in order to prepare the TEM-lamella (Fig. 4, top). In a second step the lamella is broken out of

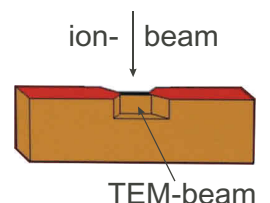
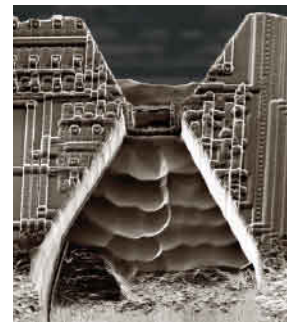


Fig. 3: Prepared lamella

PREPARATION OF TEM-SAMPLES

the Si bulk material with the Nanomanipulator which is pushing mechanically against the lamella (Fig. 4, center). Dissecting the sample with the saw is now redundant. The approximation of the tip of the Nanomanipulator towards the lamella is controlled by means of the ion-optical imaging system.

The lamella broken out of the IC is picked up with the Nanomanipulator (Fig. 4, bottom). It is held at the

tip of the manipulator by a DC-voltage of 15 V which interferes with the imaging system of the FIB – thus the lamella seems to be glowing brightly. The Nanomanipulator transports the lamella to a grid coated with Formvar which has been put into the sample chamber. After positioning the tip over the grid the power is switched off to drop the sample onto the grid (Fig. 5, top right corner). For further examinations the grid is removed from the chamber .

This project was realized at:
Fraunhofer Institut für Werkstoffmechanik Halle
F. Altmann, D. Katzer, L. Lauterbach
Heideallee 19
D-06120 Halle

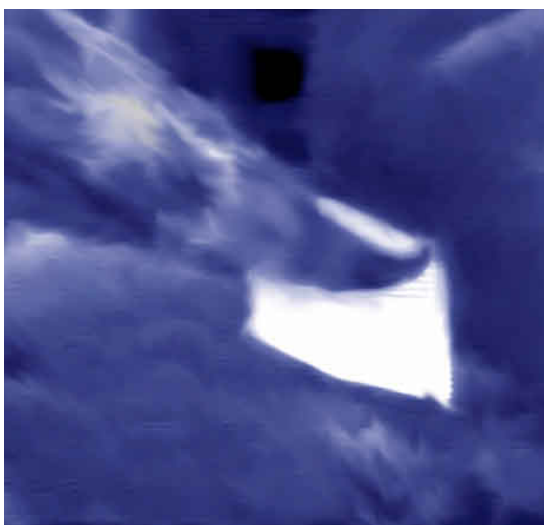
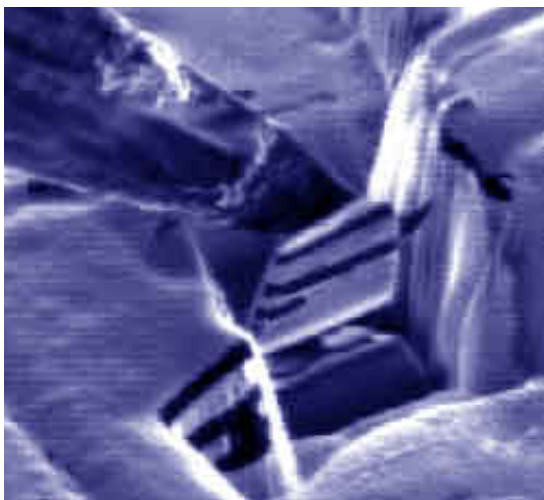
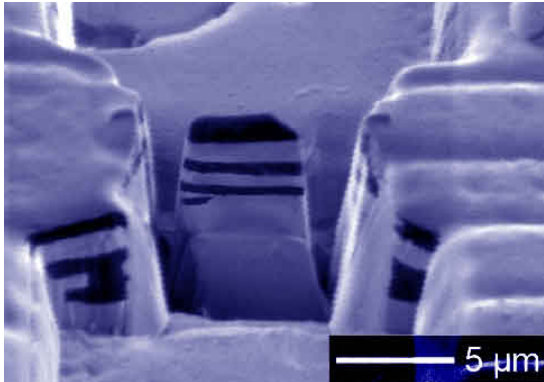


Fig. 4:
Breaking and lifting the etched lamella with the Nanomanipulator

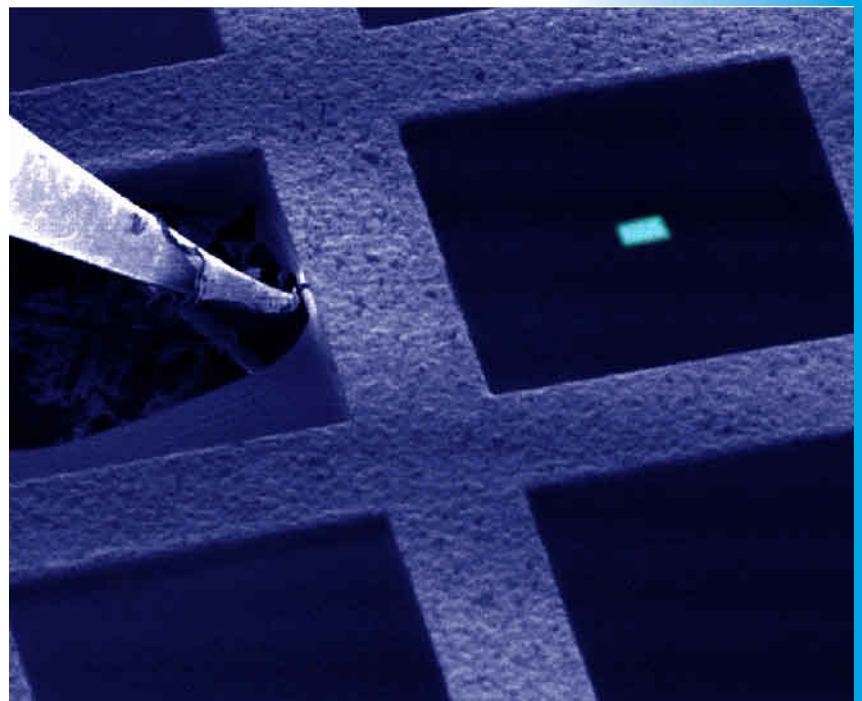


Fig. 5:
Transporting a lamella and dispose it onto the grid

*Precision
made in Aachen:*

Klocke 
Nanotechnik

GERMANY:
Pascalstr. 17
52076 Aachen

Phone: +49-2408-95099-20
Fax: +49-2408-95099-26

www.nanomotor.de
info@nanomotor.de