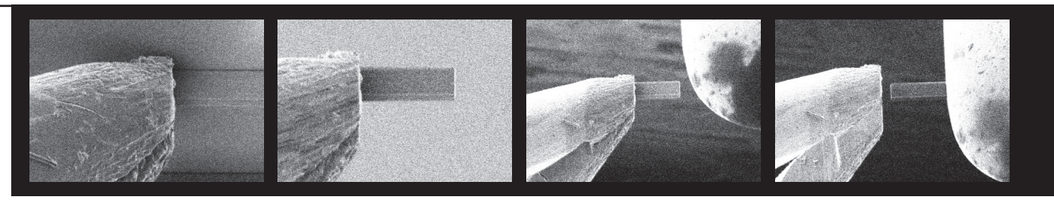
LIFT-OUT
SHUTTLE

Increasing sample preparation throughput



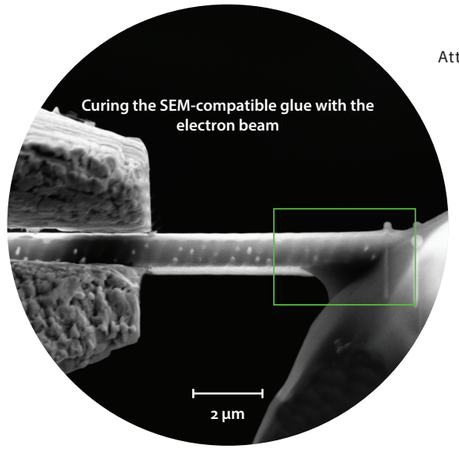
In-situ lift-out (INLO) techniques have become more reliable methods for preparation of samples requiring TEM and atom probe inspection. However, despite their new-found popularity, they remain considerably more expensive than ex-situ lift-out techniques and require lots of valuable time on the FIB. Time and cost factors call for a faster, simpler procedure without reducing the reliability of the technique. The Lift-out Shuttle is Kleindiek Nanotechnik's answer to this problem: a simple and efficient tool offering the benefits of decreased cost, increased sample throughput, reduced FIB time and reliable results.

In-situ lift-out is comprised of **three basic steps**:

- Make physical contact with the pre-cut sample.
- Free the pre-cut sample from the surrounding bulk material.
- Attach the sample to a holder (e.g. a TEM grid) for further analysis.

Contacting the sample

The Lift-out Shuttle contains a microgripper, which is used to contact the sample. The microgripper is positioned in the SEM image by using the SEM stage. The Lift-out Shuttle also contains a three-axis substage allowing cartesian movement of the sample in X, Y and Z using ultra-fine steps. The substage is used to manipulate the sample: the microgripper remains stationary while the sample is moved into place beneath it. This method, coupled with the advantage of cartesian movements, provides a far more intuitive way of manipulating objects in 3D space using 2D images. In addition, the system can include a small CCD camera at sample surface level, giving you immediate information about the distance between the microgripper and the sample. This adds the missing 3D information needed to make the vertical approach to the sample significantly easier and faster.



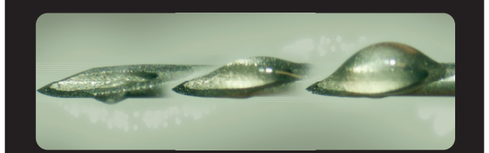
Attaching the sample

Once the sample has been freed from the bulk material, the substage is used to position the TEM grid beneath the sample. A tiny amount of high-vacuum compatible adhesive is placed on the part of the TEM grid to which the sample will be attached. The sample is brought into contact with the glue which is then hardened under electron beam irradiation by focussing on a very small area. Curing time is fast and yields an excellent bond. IBID techniques can also be used if gas precursors are available, but without them the attachment task can be done more quickly, more cost-effectively and without contanimating the sample. Ion beam cutting to detach the sample is not required, so reshaping, cleaning or replacing the microgripper is not necessary.

Kleindiek Nanotechnik's innovative Lift-out Shuttle is an intuitive and cost-effective sample preparation solution that offers greater reliability than ex-situ lift-out techniques and higher throughput than other in-situ lift-out solutions.

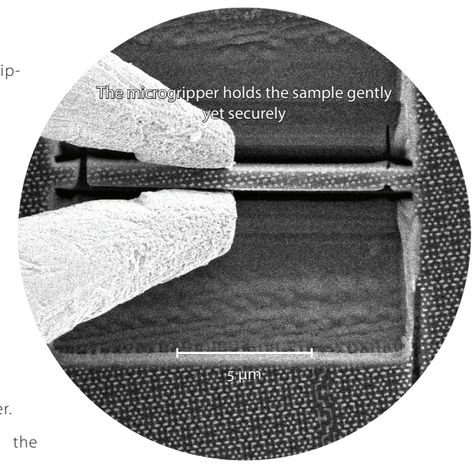
The Lift-out Shuttle's compact design makes it compatible with the load-lock systems of most SEMs and FIBs.

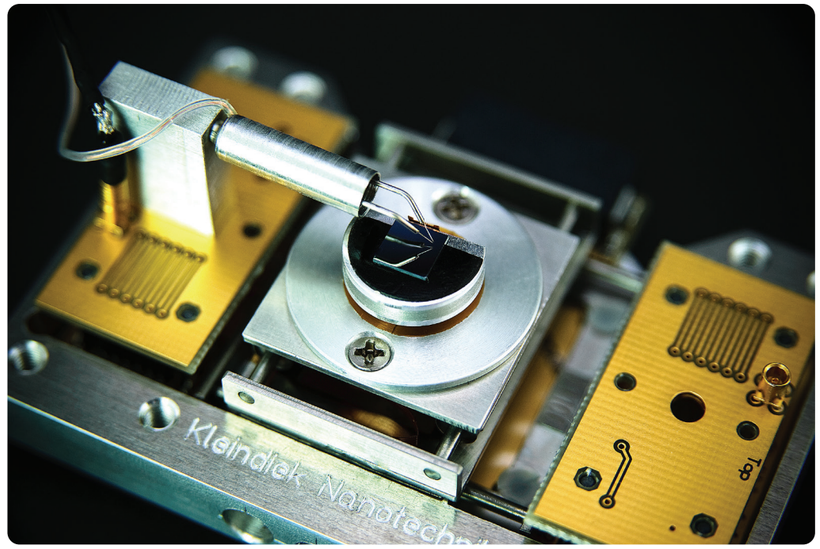
When coupled with the use of Kleindiek's SEM-compatible glue, the Lift-out Shuttle eliminates the need for gas precursors and thus the contamination of the sample associated with IBID techniques.



Freeing the sample

When using a microgripper, we no longer have to rely on the time-consuming ion beam induced deposition (IBID) associated with using a single probe tip. The sample is gripped securely and non-destructively by the microgripper. IBID contamination of the sample is avoided and the process of freeing the sample is intuitive and fast.





Preparation of the Lift-out Shuttle with new samples and a TEM grid is done *ex-situ*, usually with the aid of a light microscope. The entire setup is then introduced into the vacuum-ready SEM or FIB via the load-lock. The three steps described above can be repeated for multiple samples without breaking vaccum. Minimizing venting cycles is advantageous for SEMs or FIBs that handle whole wafers and/or have long pump down times, and it also helps preserve chamber integrity. Once all INLO processes have been completed, the Lift-out Shuttle, including the TEM grid with the prepared samples, is simply removed via the load-lock.

Options

CCD camera

Small camera at sample surface level

Allows fast approach

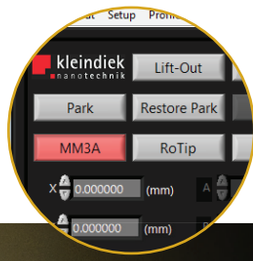
Includes monitor and LED illumination

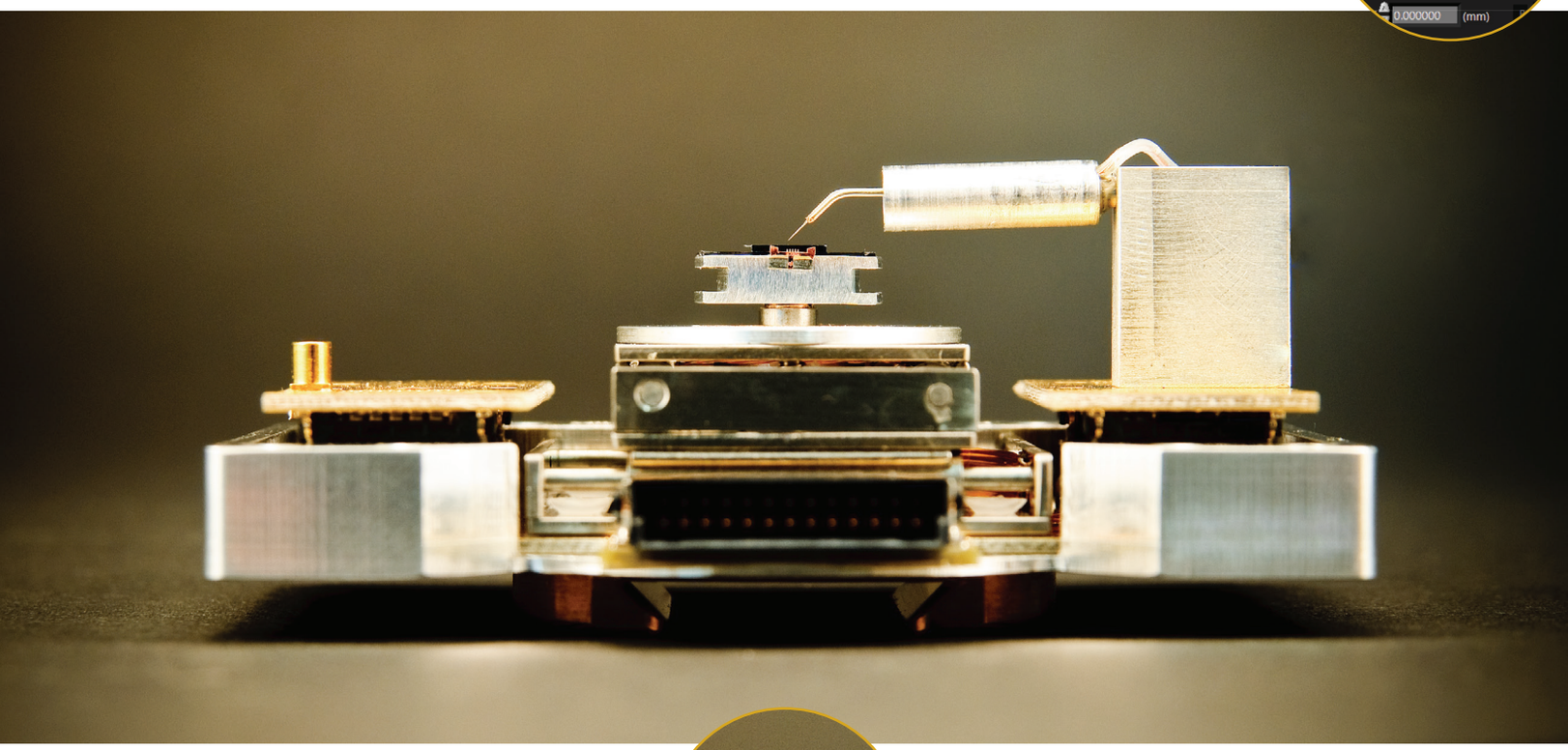
iLO software

Dynamic, two-handed, 3D control

Precision through six orders of magnitude

Runs on microscope PC or a dedicated laptop

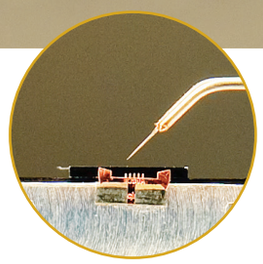




TEM grid holder

Easily accessible clip mechanism

Quick and easy ex-situ preparation



Substage

Cartesian movement

Travel XY 10 mm

Travel Z 3 mm

Travel R 360° (unlimited)

Speed up to 1 mm/s

Resolution XYZ < 0.02 nm

Resolution R < 7×10^{-9} rad

Maximum sample diameter 30 mm

No backlash or reversal play

Coarse and fine displacement in one drive

Microgripper

Gripping area (5 to 10 µm)²

Resolution 20 nm

Gripping force controlled by overdrive (µN up to mN)

Maximum span range 20 to 40 µm

Shuttle platform

Simple load-lock solutions for most SEM and FIB tools

Virtually insusceptible to vibrations

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Contact us at **info@kleindiek.com**

or find your local agent at **www.kleindiek.com**

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