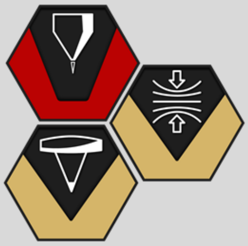
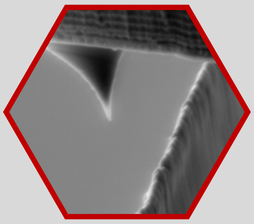
Quantum Design
MICROSCOPY

APPLICATION NOTE

Cutting edge measurements with the AFSEM®

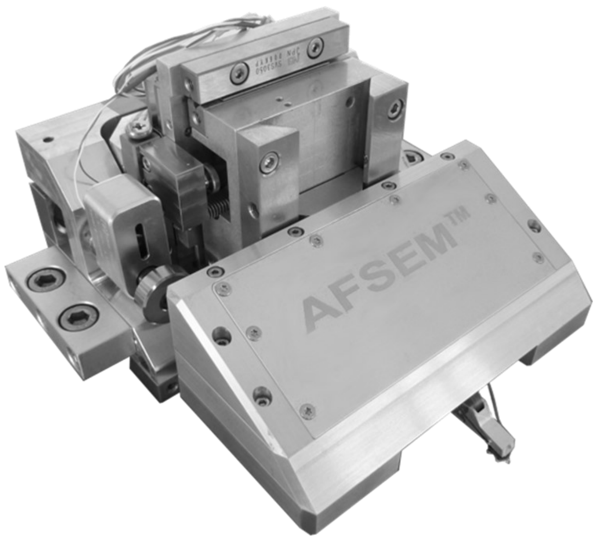


Use complementary information from SEM and AFM to image complex samples like razor blades with nanometre precision.

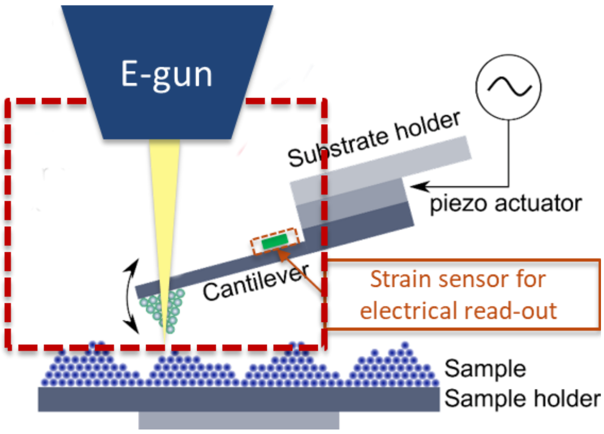


Correlative microscopy not only allows the complementary information of different types of microscopy to be used together, but also enables the analysis of unusual samples. Typically, in atomic force microscopy, measurements of very pointed sample geometries are difficult. Firstly, due to the convolution of the geometry of the tip with the topography of the sample surface, but also the correct and reliable positioning of the tip over the sample is a challenge. In the following, we show how correlative microscopy can help to meet these challenges.

The AFSEM® works as a correlative microscope. In our case, we combine the atomic force microscopy (AFM) of the AFSEM® and scanning electron microscopy (SEM). SEM is used to identify the area of interest, position the sample in the best possible way, and to monitor the AFM measurement in real time.



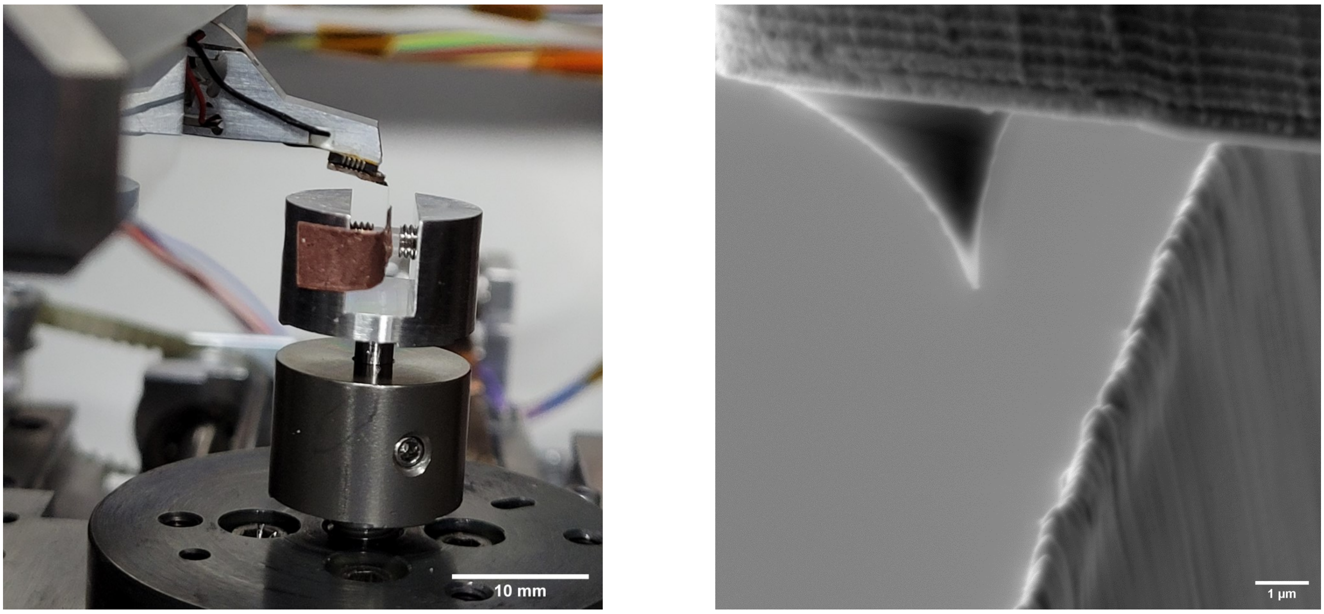
The AFSEM® system is shown. This variable setup fits into almost any SEM or multibeam instrument.



Basic working principle of the AFSEM®: The cantilever bends due to interactions between tip and sample and is measured via piezoresistive strain sensors.

The AFM essentially consists of a cantilever beam with a very sharp tip attached to the front end. The unit consisting of the cantilever beam and tip scans over the sample with nanometre precision, whereby the cantilever is deflected by interactions between the tip and the sample. This deflection is a measure of the topography of the surface of the sample. The deflection of the cantilever is detected by strain sensors attached to the cantilever. Laser optics such as a light pointer to read out the deflection are not necessary in this case. This frees up space and enables simultaneous, correlative electron microscopy.

The AFSEM® is typically mounted at the door of the SEM sample stage. This allows the AFM and SEM sample to move together in relation to the electron beam of the SEM. These two types of measurement are correlative and can be superimposed after the measurement in the same coordinate system.



(Left) AFSEM® and razor blade sample holder mounted in the SEM chamber. (Right) SEM image of the cantilever tip a few micrometres above the razor blade. The tip geometry, as well as the topography of the razor blade can be seen.

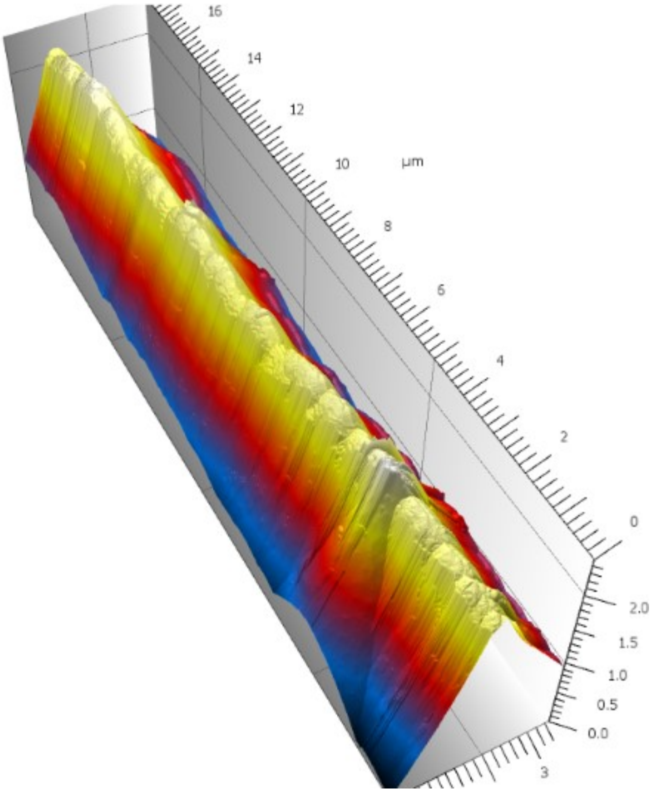
The sample can be moved in all three spatial directions on the sample stage, i.e. relative to the position of the AFM and relative to the position of the electron beam. The AFM can be moved in the same way.

A commercially available razor blade serves as the sample in this Application Note. This was installed unchanged in the sample holder and only electrically grounded to avoid electrical charging by the SEM. The aim is to image the surface of the blade with the AFM and in particular to determine the radius of the blade.

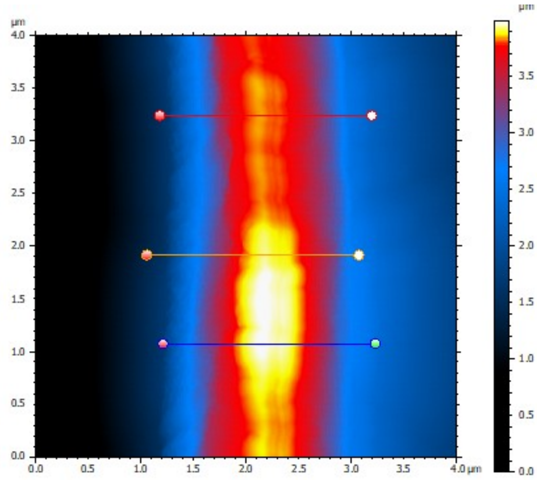
The measurement comprises several steps: the coarse positioning, the fine positioning, the approach of the tip and finally the measurement of the topography. The coarse positioning is done by hand during the mounting of the AFSEM® and the sample and enables to bring the cantilever within on millimetre of the sample surface. The SEM is used for fine positioning. Due to the high resolution of the SEM the cantilever tip can be easily positioned in close proximity to the edge of the razor blade with an accuracy of significantly less than 1 μm. In the next step, the cantilever tip can already be approached using the AFSEM® controller and the analysis of the real 3D topography can be achieved.

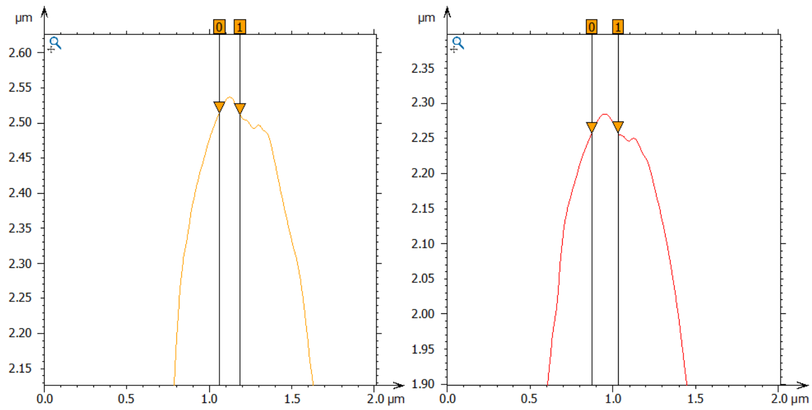
It is possible to create rectangular sections of the topography and adjust the measurement parameters during the measurement. The movement of the cantilever tip over the sample can be followed live with the SEM at any time. A sample section of 5 μm x 24 μm across the blade edge could thus be recorded with nanometre accuracy.

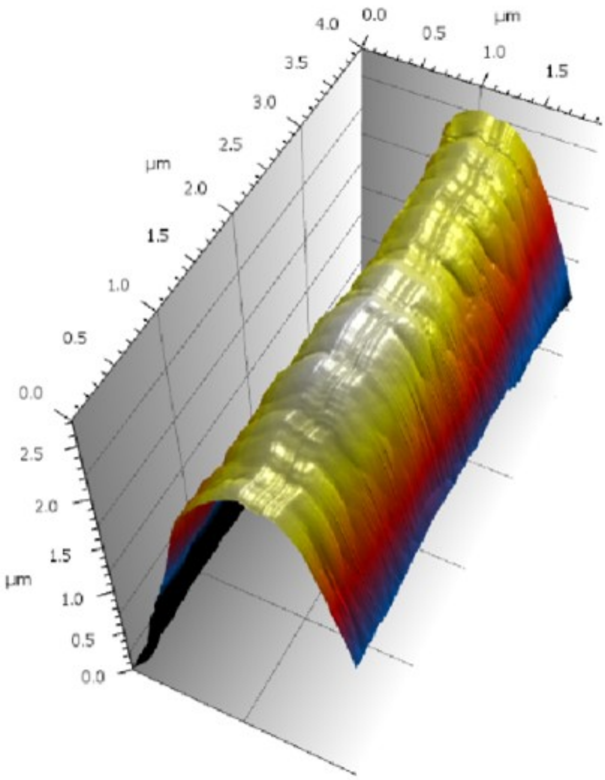
With the help of the fine positioning made possible by the SEM, different areas on the razor blade can be quickly selected and measured. In this way, variations at different points of the same sample can be examined in an easy and straight forward manner. Different material properties, such as a coatings applied to the razor blade, can be compared. An important parameter is the radius of the razor blade, as well as the roughness of the surface.



3D representation of the topography of the surface of the razor blade. The measurement has a lateral size of 5μm x 24 μm with nanometre resolution.







(Left) AFM topography image of another spot on the razor blade. A "double-groove" feature can be seen in the 3D representation. (Right) Line scans at two different positions on the razor blade that enable to analyse the blade radius with nanometre resolution.

The measurements of the real 3D surface topography makes it possible to identify unusual features on the blade surface, e.g., a "double groove" seen in the figure above. In addition, individual line scans on the blade edge can be extracted which enable to calculate the exact blade radius. Here, the end radius of the blade can be determined at each section which is 60-80 nm on average in the selected sections.

In conclusion, the AFSEM® makes it possible to measure even complex samples that are difficult to access, especially for conventional AFM. The combination of the complementary strengths of AFM and SEM enable an easy work flow to position the cantilever on the blade edge and analyse the 3D topography and the blade radius.

- Fast and easy identification of your region of interest
- Correlative in-situ SEM & AFM analysis
- Applicable to unusual and difficult to access samples
- variable setup fits into almost any SEM or multibeam instrument.

AFSEM®

The leading solution for AFM in SEM

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