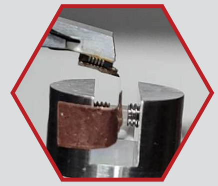
Cutting Edge Measurements with the FusionScope



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

Correlative microscopy not only allows the complementary information of different types of microscopy to be used together, but also allows unusual samples to be analyzed. 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 Note, we show how correlative microscopy can help to meet these challenges.

Figure 1: The FusionScope— The first true correlative AFM/SEM microscope.

Introduction

The FusionScope® is the first true correlative microscope that seamlessly combines atomic force microscopy (AFM) and scanning electron microscopy (SEM). SEM is used here to position the sample in the best possible way and to monitor the AFM measurement in real time.

The AFM essentially consists of a cantilever arm with a very sharp tip attached to the front end. The unit consisting of the cantilever arm 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 quantified by integrated strain sensors, so laser optics such as a light pointer to read out the deflection are not necessary. This frees up valuable space and enables simultaneous, correlative electron microscopy.

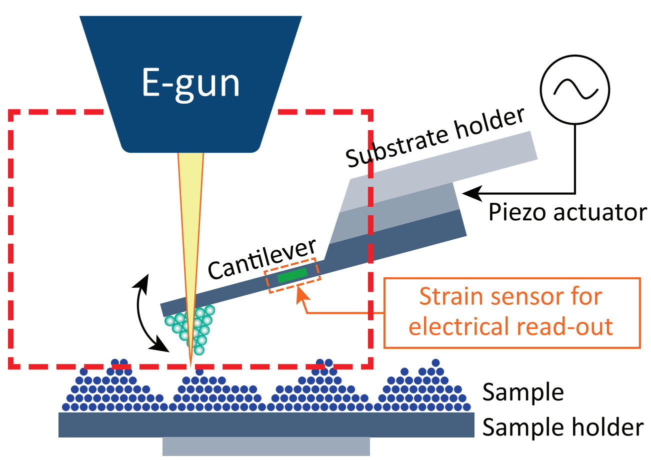


Figure 2: Sketch of the basic working principle of the FusionScope. The cantilever bends due to interactions between tip and sample and is measured via piezoresistive strain sensors.

This allows the AFM and SEM sample to move together in relation to the electron beam of the SEM. Since these two types of measurements share a common corrdinate system, they can be superimposed on one another to better resolve correlative phenomena.

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 Challenging Sample: Razor Blades

A commercially available razor blade serves as the sample in this Application Note. The unmodified blade was installed in the sample holder and grounded to avoid electrical charging by the electron beam. The aim is to image the surface of the blade with the AFM and in particular to determine the radius of the blade edge.

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 using an optical camera. First, the cantilever tip is moved to the eucentric point of the FusionScope. Since this point is already known, this positioning does not require much time. The razor blade is then moved to within about one millimetre of the cantilever tip. The SEM is used for fine positioning.

The movement of the tip and the top of the razor blade can be observed live. This enables positioning with an accuracy of significantly less than 1 μm. In the next step, the cantilever tip is moved to approach and the analysis of the real 3D topography executed.

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 is thus recorded with nanometre accuracy.

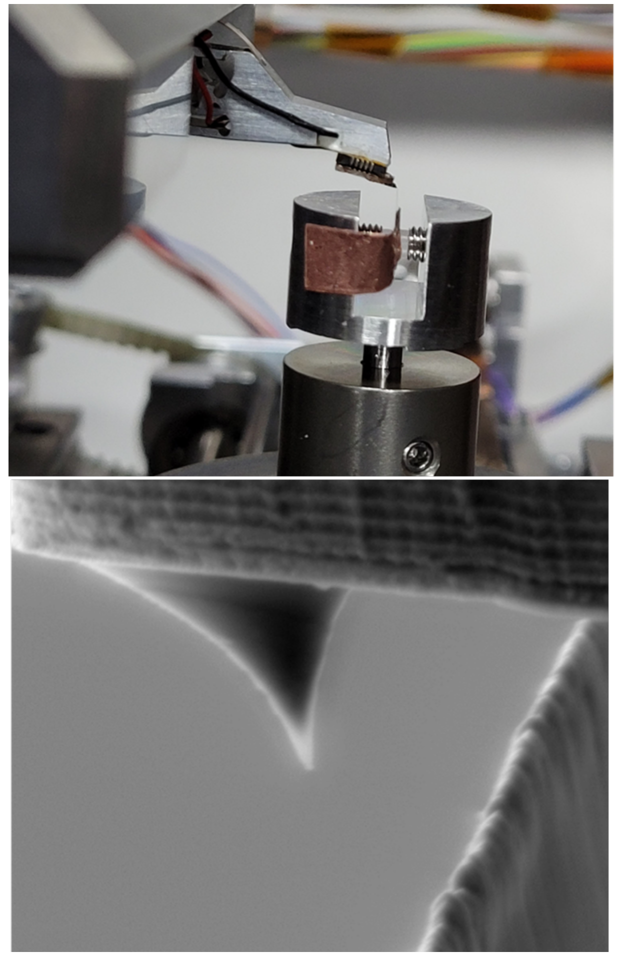


Figure 3: *(Top) FusionScope scanner and razor blade sample inside vacuum chamber. (Bottom) SEM image of the cantilever tip a few micrometres above the razor blade. The tip geometry, as well as the topography of the razor blade can be seen.*

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 straightforward 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.

Representative Data

The measurements of the real 3D surface topography makes it possible to identify unusual features on the blade surface; for example: the "double groove" seen in Figure 7. In addition, individual line scans on the blade edge can be extracted which enable the calculation of the exact blade radius. Here, the end radius of the blade is determined at each section, averaging a value between 60-80 nm in the samples sections.

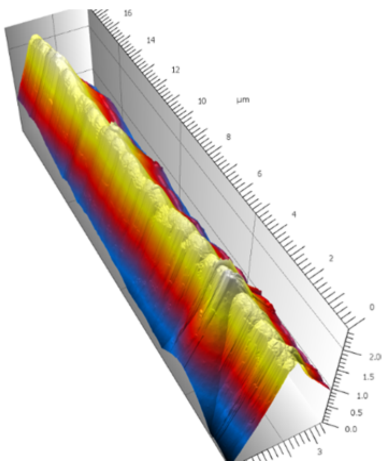


Figure 4: 3D representation of the topography of the surface of a razor blade. The measurement has a lateral size of 5 µm x 24 µm with nanometre resolution.

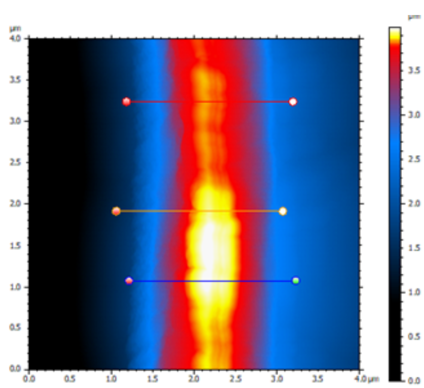


Figure 5: AFM topography image of another spot on the razor blade. A "double-groove" feature can be seen in the 3D representation (Figure 7).

In conclusion, FusionScope makes it possible to measure complex samples- even those that are difficult to access by 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.

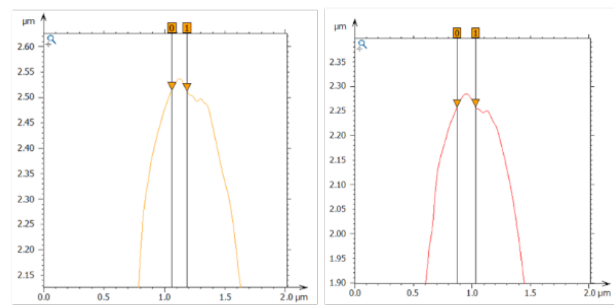


Figure 6: Line scans at two different positions on the razor blade that enable to analyse the blade radius with nanometre resolution.

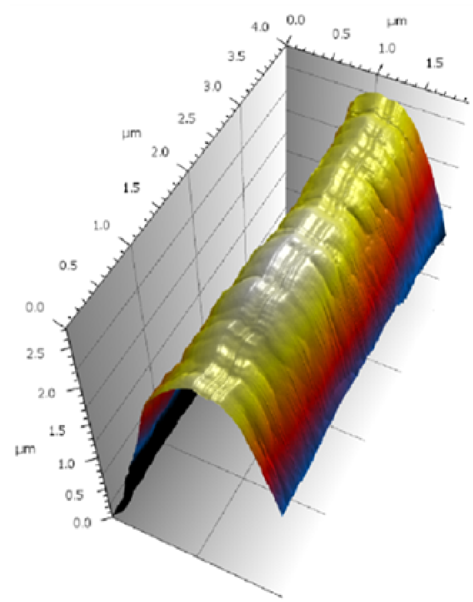


Figure 7: Three-dimensional representation of the topography from Figure 5. The double groove can be observed very well in this figure.

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