

## In-situ Correlative Analysis of electrical and magnetic properties of Ion-beam treated surfaces by combination of AFM and FIB

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Combining different analytical methods into one instrument is of great importance for the simultaneous acquisition of complementary information. Especially highly localized probing of mechanical, electrical, magnetic, chemical and crystallographic properties on the nanoscale represents a key success factor for gaining new insights into the micro and nano-world. Here, the in-situ combination of scanning electron or scanning ion microscopy (SEM/FIB) and atomic force microscopy (AFM) presents a unique possibility to characterize ion-beam treated surfaces and extract novel information.

In this work, we present an AFM system that can be seamlessly integrated into FIB or Helium microscopy systems. Its open design and the use of self-sensing cantilevers with electrical readout allow for simultaneous operation of FIB and AFM inside the vacuum chamber to perform in-situ correlative analysis of ion-beam treated surfaces.[1-3]

We will present a variety of case studies to highlight the advantages of interactive correlative in-situ nanoscale characterization for different materials and nanostructures. We show results for *in-situ* electrical characterization by conductive AFM for 2D materials as well as electrostatic force microscopy (EFM) at grain boundaries of piezoceramic films. In a further step, we demonstrate how in-situ correlative analysis with the AFSEM in an SEM can be extended into the third dimension to measure nanomechanical properties of soft material. To achieve this, FIB slicing and mapping of nanomechanical properties using the AFSEM is performed in repetitive steps to build up a 3-dimensional elasticity map.

Finally, we will present first results for the characterization of helium beam treated magnetic multilayer structures as well as dose-dependent characterization of helium bubbles on silicon, copper and steel surfaces

Based on the broad variety of applications regarding the nanoscale characterization of different materials and devices we anticipate that correlative analysis by combination of in-situ AFM and SEM/FIB will be one of the driving characterization tools in the future.

### References

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