A Novel Tool for Combined AFM, SEM, and Electrical Probing of Nanostructures

Chris Schwalb[1], Mr. Hajo Frerichs[1], Mr. Darshit Jangid[1], Mr. Sebastian Seibert[1], Mr. Lukas Stühn[1], Mrs. Marion Wolff[1], Mr. Andrew Jonathan Smith[2], Mr. Andreas Rummel[2]
[1]Quantum Design Microscopy GmbH, Pfungstadt, Germany, [2]Kleindiek Nanotechnik GmbH, Reutlingen, Germany

Combining different complementary analytical methods into one instrument is a powerful technique for the contemporaneous acquisition of both structural and functional sample properties. Especially the combination of atomic force microscopy (AFM), scanning electron microscopy (SEM), and electrical nanoprobing can yield completely new insights for the study of various samples and nanostructures.

In this work, we introduce a highly integrated correlative microscopy platform, that seamlessly combines AFM and SEM within a unified coordinate system. In addition, a three-axis sample stage and a trunnion provide unique experimental capabilities such as profile view – an 80-degree tilt of the combined sample stage and AFM giving full SEM access to the cantilever tip region. This microscopy platform can easily be combined with a nanoprobing system that enables precise electrical characterization of nanoscale structures, offering insights into device functionality and performance. [1-2]

We present a variety of novel case studies to highlight the advantages of this new tool for interactive, correlative, in-situ nanoscale characterization of different materials and nanostructures. Initial results will focus on the analysis of mechanical and electrical properties of individual nanowires. The combination of SEM and nanoprobes enables easy manipulation and positioning of individual nanowires, whereas the in-situ AFM allows the characterization of topography, surface roughness, mechanical and electrical properties of the nanowire.[3-4] Using the SEM's high-resolution the AFM cantilever tip can be precisely positioned on an individual nanowire that is attached to the nanoprober and the topographical and mechanical properties can be determined (see Figure).

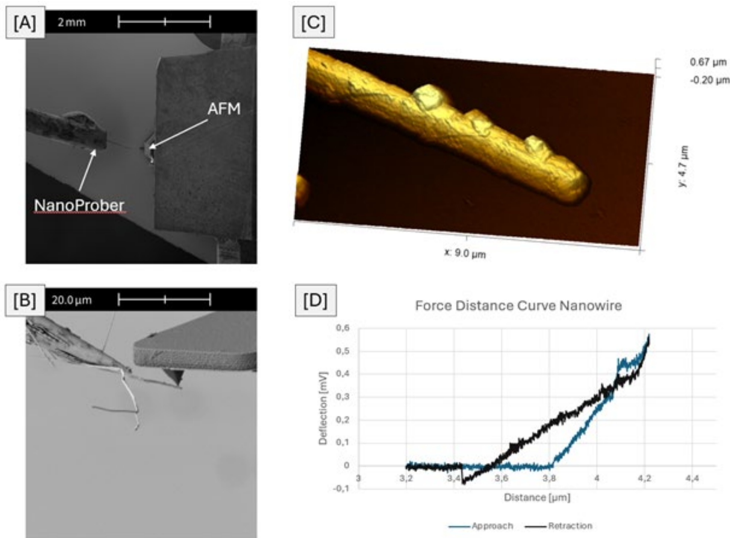
In addition, we will show results for electrical nanoprobing of semiconductor devices in combination with conductive AFM measurements. A semiconductor device can be electrically probed by simultaneous use of two nanoprobers while the AFM provides detailed information on the 2D conductance map of the device itself.

Based on the broad variety of applications regarding the inspection and process control of different materials and devices, we anticipate that this new

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

inspection tool will be one of the driving characterization tools for correlative analysis on the nanoscale.

Graphic:



Keywords:

AFM, SEM, NanoProbing, Correlative Microscopy

Reference:

[1] M. Dukic, et al., Scientific Reports, 5 (1), 16393 (2015).
[2] J. M. Prohinig, et al., Scripta Materialia, 214, 114646 (2022).
[3] A. Alipour, et al., Microscopy Today 6, 17-22 (2023).
[4] Reisecker, et al., Adv. Funct. Mater. 2310110 (2023).