

Mechanical and chemical mapping at the nanoscale

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Atomic-force microscopy (AFM) is principally a three-dimensional nanoscale imaging tool, but it can also be used for nanoscale mechanical and chemical mapping. In this talk, I shall explain some mechanical and chemical mapping modes and provide recent examples. If time allows, I shall alert the listeners to example artifacts.

One can think of mechanical mapping as using the tip of an AFM as a nanofinger to indent, vibrate, and measure the adhesion of materials. As an example of mechanical mapping, one can monitor the stiffness and viscosity of cells as they are exposed to the neurotoxin Vipoxin [1].

Concerning chemical mapping, combining AFM with infrared spectroscopy (AFM-IR) is a potent combination, providing both topographical and chemical information at high resolution. Two examples: the first study is the investigation of the nanoscale chemical evolution of rubber-oil modified asphalt binder during aging, revealing that aging leads to increased carbonyl and sulfoxide compounds in para domains, a process reduced by rubber and bio-modified rubber [2]. This demonstrates AFM-IR's ability to correlate chemical changes with specific nanoscale features and aging conditions in complex materials. Second, AFM-IR was successfully applied to quantitatively study ligand exchange in electrohydrodynamically printed PbS quantum dot microstructures [3]. This allowed for the monitoring and quantification of ligand exchange efficiency and the identification of degradation processes at the nanoscale. Finally, when evaluating AFM-IR data, one should be alert to various artefacts [4,5].

Collectively, these studies illustrate AFM's value in mapping mechanical properties and chemical compositions and changes in diverse nanoscale systems, from cells to asphalt to quantum dots, while also underscoring the need for careful methodology and artefact awareness for accurate interpretation.

1. [The phospholipolytically active neurotoxin Vipoxin induces changes of the mechanical properties of breast epithelial cells \(2025\).](#)
2. [Nanoscale Evolution of Rubber-Oil Modified Asphalt Binder after Thermal and UV Aging \(2023\).](#)
3. [Quantitative Ligand Exchange Assessment at the Nanoscale: AFM-IR on EHD-Printed Structures of PbS Quantum Dots.](#)
4. [Towards artefact-free AFM image presentation and interpretation \(2023\).](#)
5. [Atomic Force Microscopy: A Concise Introduction \(2026\).](#)

“Nano” Bio

Nancy Burnham graduated from the University of Colorado at Boulder in 1987 with a Ph.D. in Physics. Her dissertation concerned the surface analysis of photovoltaic materials. As a National Research Council Postdoctoral Fellow at the Naval Research Laboratory, she became interested in scanning probe microscopy, particularly its application for detecting material properties at the nanoscale.

At Worcester Polytechnic Institute since 2000, where she continues nanomaterials studies, she also directs the Lausanne, Zurich, and Fribourg Project Centers, through which WPI undergraduates conduct immersive science-and-society and senior theses.

She has taught a summer block course on atomic force microscopy at ETH Zurich since 2015. In 2022-23, she took a full-year sabbatical at Empa Dübendorf, where she continues a summer visiting scientist.