



Application Note #150

Characterization of Advanced Semiconductor Materials and Processes with Nanoscale IR Spectroscopy

Submicron and nanoscale chemical identification of semiconductor materials, specifically those that are organic, is a significant challenge in the research of devices, as well as in process control and failure analysis environments. Because of this, there are a multitude of techniques used by semiconductor manufacturers to identify chemical components.

Scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM/EDX) is the industry standard in surface analysis, and offers nanometer-scale spatial resolution with semi-quantitative elemental analysis. While this elemental analysis offers useful chemical insight into surface defects and contaminations, it is fairly limited in identifying organic materials.

Infrared (IR) spectroscopy is a powerful technique for chemical characterization of organic species that cannot be readily identified by SEM/EDX. However, traditional IR spectroscopic techniques are limited by Abbe diffraction laws to spatial resolutions between 3–10 μm , depending on the technique used.

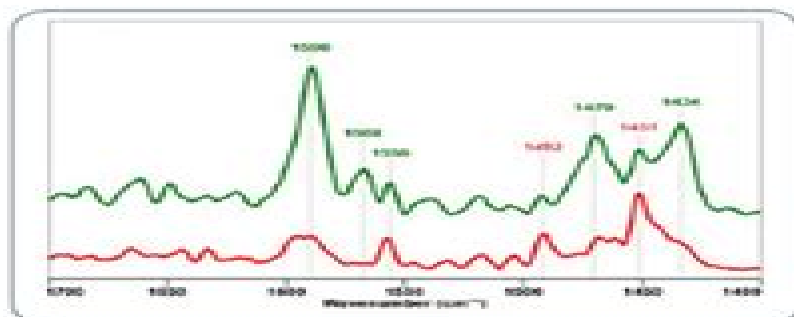
Atomic force microscopy (AFM) is a widely used nanoscale imaging technique which provides the user with a high spatial resolution topographic map of a sample surface. Until now, the major drawback of AFM has been its inability to chemically characterize the material underneath the tip.

Resonance-Enhanced AFM-IR and Tapping AFM-IR

Nanoscale IR spectroscopy overcomes these limitations by combining AFM and IR techniques to achieve nanoscale FTIR spectroscopy using photothermal IR spectroscopy (PTIR). Nanoscale IR spectroscopy combines the precise chemical identification of IR spectroscopy with the nanoscale capabilities of AFM to chemically identify sample components with a spatial resolution below 10 nm and with monolayer sensitivity, breaking the diffraction limit by > 100x. AFM-PTIR absorption spectra are direct measurements of sample absorption, independent of other complex optical properties of the tip and sample. As such, AFM-PTIR spectra correlate well to conventional bulk IR spectra.¹

Nanoscale Organic Contaminants

To demonstrate nanoscale chemical characterization capabilities on the nanofl₃, contaminated silicon wafers were first prepared using known materials typical of those found in semiconductor fabrication environments, and then analyzed. For each sample, high-resolution tapping mode



Tapping AFM-IR spectra clearly identifying each chemical component of a block copolymer material.

Nanoscale Spectroscopy And Its Applications To Semiconductor Research

Peter W. Hawkes



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Direct and Inverse Methods in Nonlinear Evolution Equations Robert M. Conte, Franco Magri, Micheline Musette, Junkichi Satsuma, Pavel Winternitz, 2003-10-21 Many physical phenomena are described by nonlinear evolution equation Those that are integrable provide various mathematical methods presented by experts in this tutorial book to find special analytic solutions to both integrable and partially integrable equations The direct method to build solutions includes the analysis of singularities la Painlevé Lie symmetries leaving the equation invariant extension of the Hirota method construction of the nonlinear superposition formula The main inverse method described here relies on the bi hamiltonian structure of integrable equations The book also presents some extension to equations with discrete independent and dependent variables The different chapters face from different points of view the theory of exact solutions and of the complete integrability of nonlinear evolution equations Several examples and applications to concrete problems allow the reader to experience directly the power of the different machineries involved

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Hofer, Federico Rosei, 2006-05-03 Within nanoscience an emerging discipline is the study of the physics and chemistry of single molecules. Molecules may be considered as the ultimate building blocks and are therefore interesting for the development of molecular devices and for surface functionalization. Thus it is interesting to study their properties when adsorbed on a suitable substrate such as a solid or crystal surface and also for their potential applications in nano or

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