

# PHI *710*

Scanning Auger Nanoprobe

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## A SUPERIOR SCANNING AUGER NANOPROBE FROM THE RECOGNIZED WORLD LEADER

The PHI 710 Scanning Auger Nanoprobe is a unique, high performance Auger Electron Spectroscopy (AES) instrument that provides elemental and chemical state information from sample surfaces and nano-scale features, thin films and interfaces. Designed as a high performance Auger Nanoprobe, not a SEM with Auger capabilities, the PHI 710 provides the superior Auger imaging performance, spatial resolution, sensitivity and the spectral energy resolution needed to address your most demanding AES applications.



High Spatial Resolution Auger Imaging

Superior Imaging of Real World (rough) Surfaces

Cylindrical Mirror Analyzer with High Energy Resolution Capability

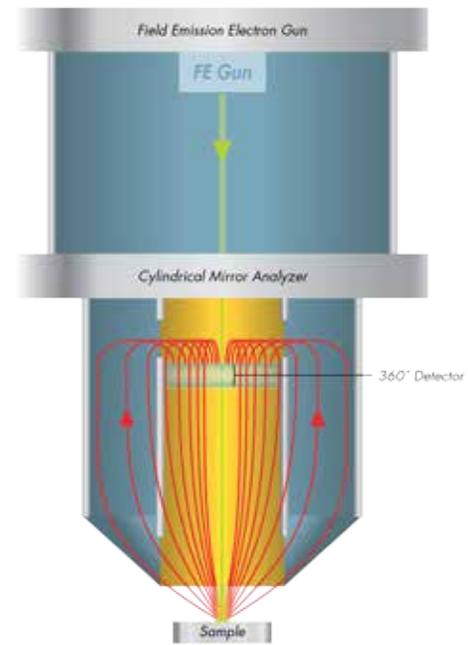
Robust Insulator Analysis Capability

Highest Performance Auger Sputter Depth Profiling

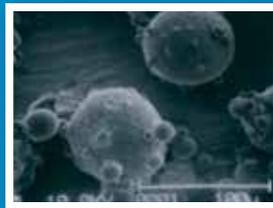
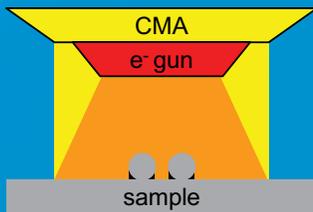
Modern, Easy-to-Use Software Platform

# Coaxial Geometry

## UNOBSTRUCTED VISION



## COAXIAL ANALYZER / ELECTRON GUN GEOMETRY



SE image



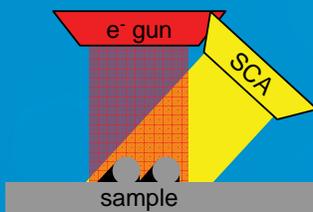
Ni map



In map

PHI's coaxial electron gun and analyzer geometry provides the sensitivity and unobstructed vision needed to fully characterize the microstructures that exist on most real world samples. In this example, Auger data is obtained from all sides of particulates and between particles with equally high sensitivity.

## NON-COAXIAL ANALYZER / ELECTRON GUN GEOMETRY



SE image



Ni map



In map

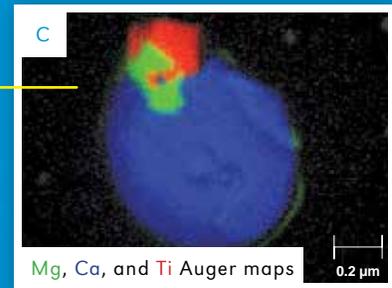
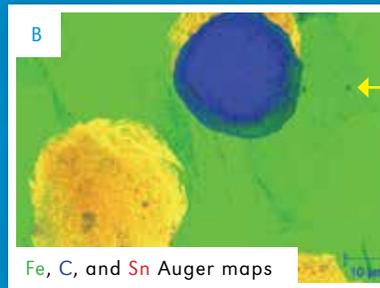
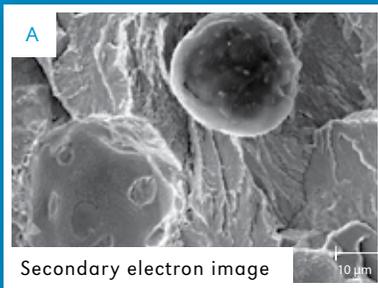
Instruments with non-coaxial geometry suffer from geometric effects that dramatically reduce instrumental sensitivity and even create shadows that prevent any analysis in some locations. In this example, high sensitivity is only observed on areas of the particles that face the analyzer, while the back side of the particles and the areas between particles are inaccessible because of analyzer shadowing that occurs in an instrument with non-coaxial geometry.

# Auger Mapping

## A COMPLETE COMPOSITIONAL PICTURE

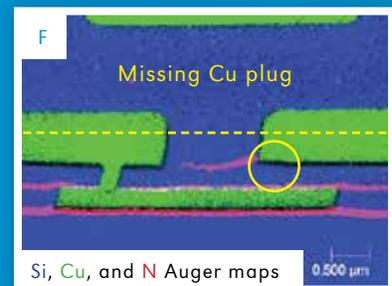
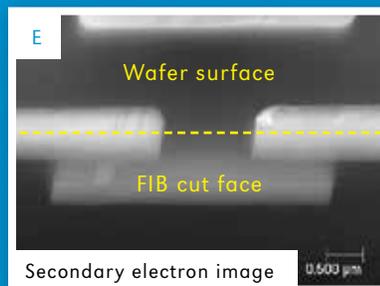
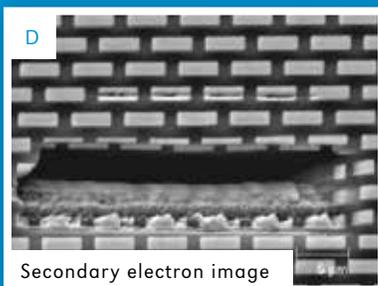
The coaxial analyzer and electron gun geometry provided by the PHI 710 produces a complete compositional picture of the area selected for analysis. The analyzer will provide data from every location the electron gun probes. Black areas in maps are usually not caused by sample roughness and analyzer shadowing, but instead indicate the presence of another element.

## MATERIALS CHARACTERIZATION



The secondary electron image in figure A shows the microstructure of a ductile iron fracture surface including graphite nodules and craters where graphite nodules have fallen out as a result of the fracture. The AES maps in figure B show the ability to map across the graphite nodule and the crater where Sn has segregated to the nodule / iron interface. AES maps in figure C show the complex composition of a small precipitate observed in figure B. Only PHI Auger instruments with coaxial electron gun and analyzer geometry provide such a complete compositional picture of a rough sample surface.

## FIB CUTS

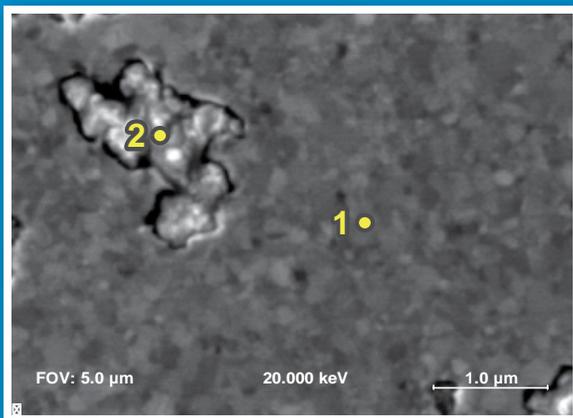


Focused Ion Beam (FIB) cuts are routinely used in the semiconductor industry to characterize buried defects and device structures. The coaxial geometry of PHI Auger instruments provides high sensitivity over a broad range of emission angles which allows spectral data and maps to be obtained from FIB cuts with uniform and high sensitivity across the face of the cut. The images above show that a Cu plug (interconnect) is missing and the cause of an electrical open circuit in the device.

# Nanoscale Thin Film Analysis

## SUPERIOR THIN FILM ANALYSIS

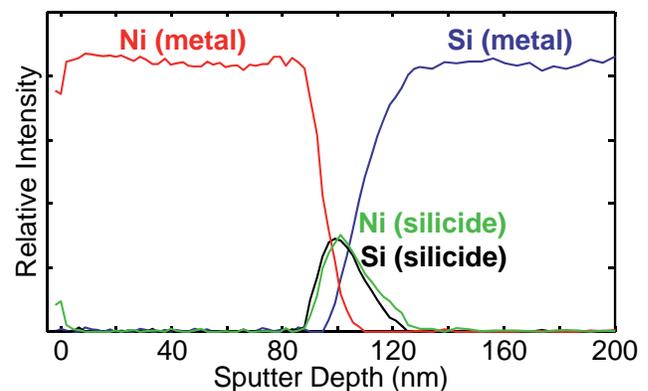
The PHI 710's floating column ion gun provides a broad range of depth profiling capabilities. At higher ion beam energies (2-5 keV) structures several microns thick can be routinely depth profiled. For thin and ultra thin films (< 5 nm) the floating ion column can be used to efficiently sputter with ion beam energies of 100-500 eV. The use of lower accelerating voltages reduces sputter mixing that could broaden the observed interfaces in an ultra thin film structure.



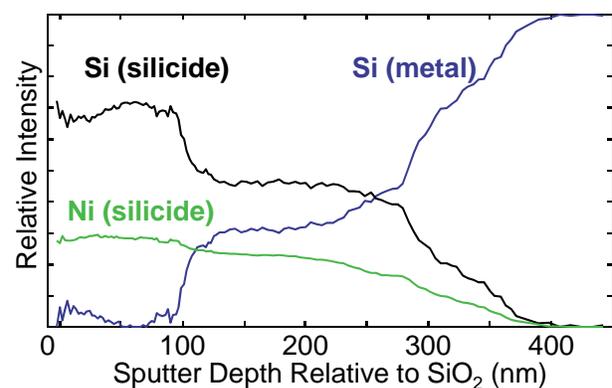
The sample shown in the SEM image above contains a defect that appeared in a thin nickel film deposited on silicon substrate after it was annealed to form a nickel silicide at the interface. Multi-point depth profiles obtained with a 20 nm diameter electron beam for analysis and a 500 V Ar ion beam for sputtering were acquired using high energy resolution (0.1%) on and off of the defect. Linear least squares fitting software was used to isolate the Ni metal and Ni silicide as well as the Si metal and silicide spectra.

It can be noted that Ni silicide is found only at the interface and not in the Ni film or in the Si substrate at point 1 which is off of the defect. However, in the defect area at point two, a complex multi-phase Ni silicide is observed throughout the defect in the Ni coating that formed after annealing.

### Point #1: Off Defect



### Point #2: On Defect



# Spatial Resolution

## HIGH STABILITY NANOSCALE ANALYSIS PLATFORM

High performance electron optics, precision sample handling and advanced vibration and thermal isolation provide a superior environment for nano-scale Auger imaging and analysis at working magnifications of 500,000 X and higher. A robust image registration capability ensures long term image stability when it is needed.

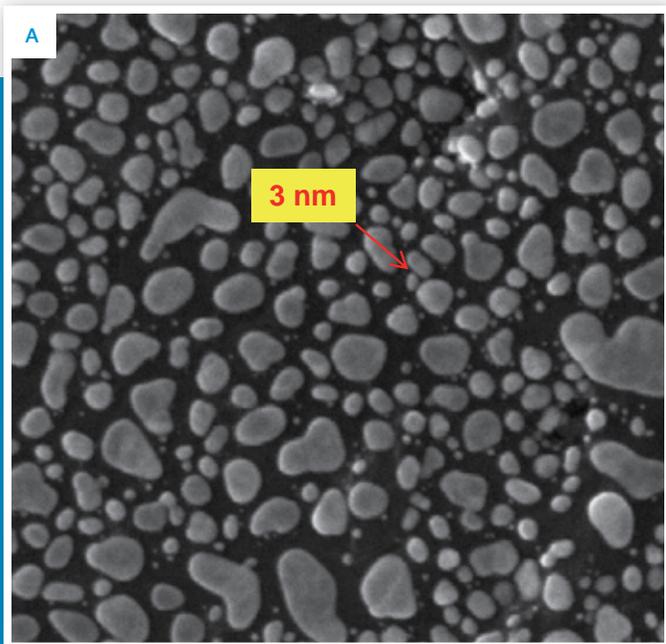
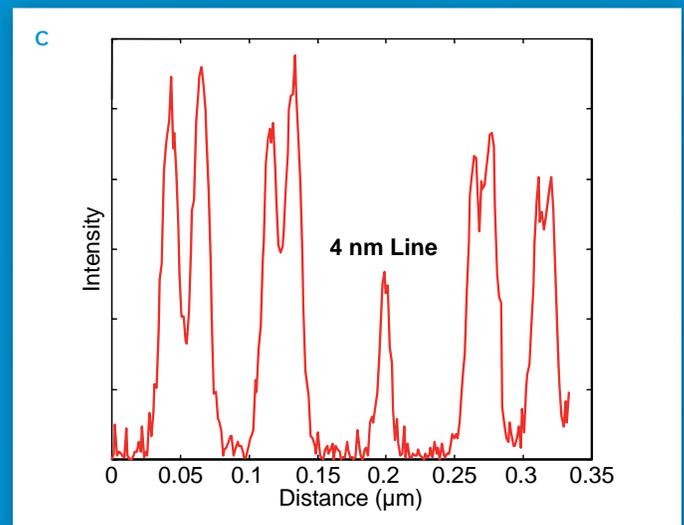
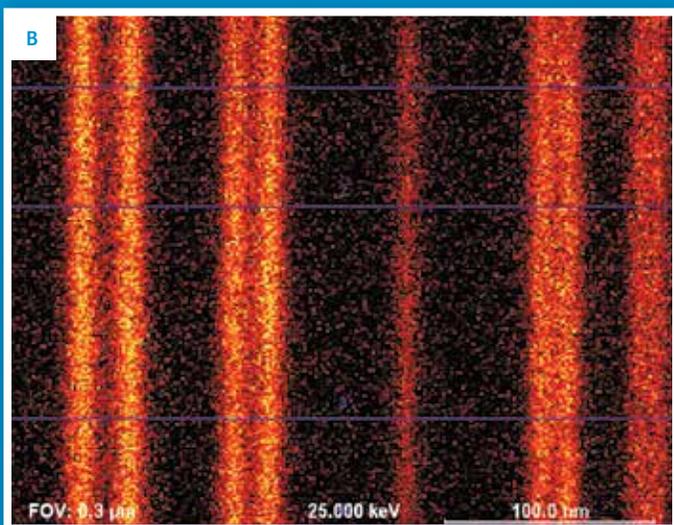


Figure A is a secondary electron image from a gold on carbon spatial resolution sample that demonstrates the 3 nm dark space resolution performance of the 710.

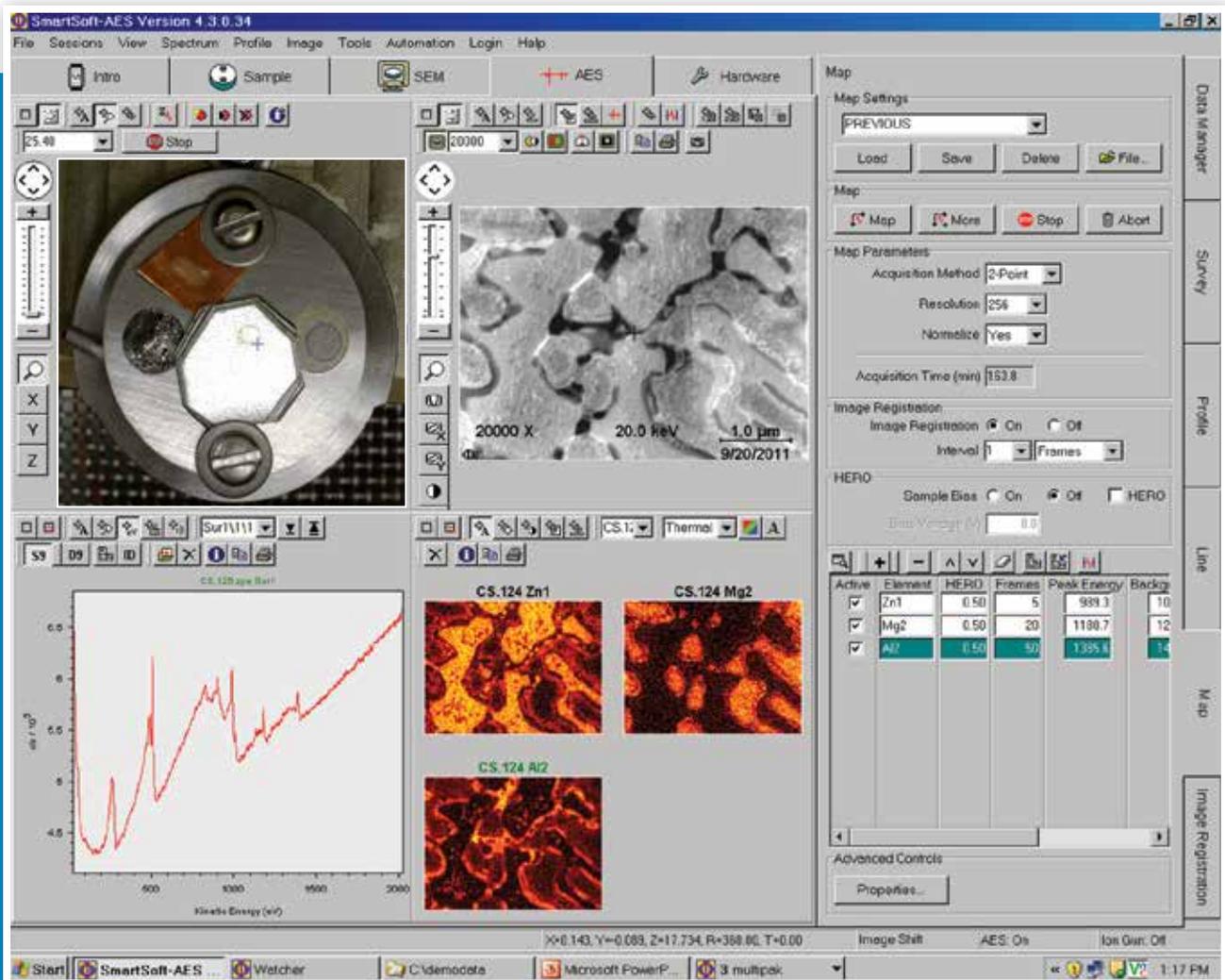
Figures B and C are data from a BAM L-200 lateral resolution reference sample. The sample presents the cross-section of alternating layers of GaAlAs and GaAs of known thickness. Figure B is an Al Auger map and figure C is an Al line scan that was extracted from the map data. The map was acquired for 24 hours to demonstrate long term stability and the effectiveness of the image registration software. The shape of the single 4 nm line demonstrates the high stability of the 710 and the effectiveness of its image registration software.



# SmartSoft-AES

## PHI'S NEXT GENERATION USER INTERFACE

*SmartSoft-AES* displays a single full screen window with five session tabs focused on key instrument tasks: Sample Introduction, Sample Navigation, SEM Imaging, Data Collection and Sputtering. Each session provides convenient access to sub-task tabs located on the right side of the window. *SmartSoft-AES* provides a fully integrated, Windows™ based, task oriented user interface for managing all hardware and analysis capabilities provided by the PHI 710 Auger Nanoprobe.

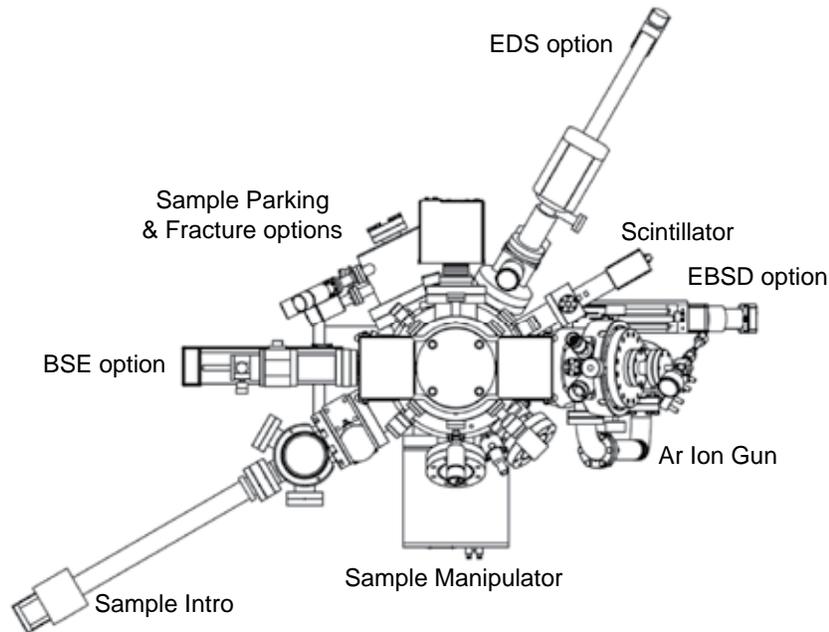


PHI *SmartSoft-AES* analysis session with the Map tab selected. In a single full screen window: sample information, SEM image, spectra and maps are conveniently displayed.



**PHYSICAL  
ELECTRONICS**

A DIVISION OF ULVAC-PHI



## PHI 710 Scanning Auger Nanoprobe

### STANDARD CONFIGURATION

Cylindrical mirror analyzer (CMA)  
Coaxial 25 kV field emission electron gun  
Scintillation secondary electron detector  
High energy resolution module  
5 axis sample stage  
5 kV floating column Ar<sup>+</sup> ion gun  
*SmartSoft-AES* instrument control software  
*MultiPak* data reduction software  
Acoustic enclosure  
Ion pumped main chamber

### OPTIONAL ACCESSORIES

*In situ* sample parking  
*In situ* sample fracture apparatus  
Sample transfer vessel  
Intro camera  
EDS Detector  
EBSD Detector  
BSE Detector  
FIB gun

#### Physical Electronics

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**Phone:** 952-828-6100  
**Fax:** 952-828-6176  
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