



PRODUCT SPECIFICATIONS



The LEAP HR™ is a high-performance atom probe microscope providing 3D, atomic resolution, compositional imaging and analysis to research and industry. Materials are examined by removing and analyzing individual atoms. Atoms are removed by a combination of a high electrical field and either: (1) an ultra-fast voltage pulse or (2) an ultra-fast laser pulse. The second mode of operation requires the purchase of an optional Laser Pulse Module.

The "HR" abbreviation designates that the product offers best in class High (mass) Resolution enabling the analysis of individual atoms to be performed with unprecedented accuracy. The LEAP 3000 HR configuration provides the best voltage-pulse mass resolution ever offered on a commercial 3D atom probe. The LEAP 3000X HR configuration includes laser based atom probe capability in addition to voltage pulsing. This capability, combined with the large Field Of View makes the HR the perfect choice for material science research particularly for metallurgy and other advanced materials applications. The LEAP HR is the latest atom probe solution from Imago and complements the LEAP 3000X Si™ product family which was developed for and is targeted at semiconductor and microelectronics applications.

The LEAP HR employs patented innovations that unlock the power of the 3D atom probe to address previously unsolved measurement challenges in material science.

The ability to resolve peaks closely spaced in mass-to-charge ratio, known as mass resolution, is critical for the study of many metals and advanced materials. Prior to the development of the LEAP HR, there was no way to achieve the required mass resolution in voltage pulsing mode without sacrificing the field of view. It was an unfortunate trade off - one could either obtain poor data quality or very little data. With the LEAP HR researchers are finally free of the mass-resolution-versus-field-of-view trap. The revolutionary ion optics (Large Area Reflectron) in the LEAP HR provides the ultimate in mass resolution along with a large field of view.

The LEAP HR features a field of view of 150 nm. For materials science research, a wider field of view allows the material's atomic scale features to be understood in the context of the material's metallurgical nanostructure. In addition, the large field



PRODUCT SPECIFICATIONS



of view assists immensely when locating small nanostructures of interest. For example, when locating a grain boundary the large field of view along with careful specimen preparation allows the grain boundary to be imaged in one specimen run rather than having to make multiple specimen runs, hoping to locate the feature in the measurement volume. Finally, the large field of view provides improved statistics when attempting to detect and quantify dilute species.

Another key technical breakthrough behind the LEAP HR is the unique and patented Local Electrode™. The Local Electrode provides the ability to analyze Microtip™ specimens. Microtips are prefabricated tip arrays that facilitate sample preparation. For thin-film studies, the thin film may be deposited directly on the Microtip. For site-specific studies, Microtips are used to mount multiple FIB-extracted samples. The use of Microtips is made possible only by the LEAP Local Electrode.

The Laser Pulsing Module expands the universe of applications to low electrical conductivity materials including semiconductors and ceramics. In laser pulsing mode the LEAP electrode applies a static field to the specimen while an ultra-fast laser pulse triggers the removal of an atom. The LEAP 3000X HR Laser Pulsing Module features a high pulse-repetition rate and proprietary real-time, optical-alignment correction which together enable high mass resolution, a large field of view, and fast time to results.



LEAP 3000X HR™

PRODUCT SPECIFICATIONS



LEAP HR Atom Probe Microscope

MEASUREMENT CAPABILITIES

Specification	LEAP 3000X HR	
	Voltage Pulsing LEAP 3000 HR	Laser Pulsing LEAP 3000X HR
Pulse repetition rate (kHz)	2 to 200	10 to 200 ^a
Maximum data-collection rate (ions/minute)	2 million	2 million



^a Adjustable in discrete steps



Specification	Voltage Pulsing LEAP 3000 HR	Laser Pulsing LEAP 3000X HR
Mass resolution (FWHM) ^b	<i>not available on the web</i>	<i>not available on the web</i>
Mass resolution (FWTM) ^b	<i>not available on the web</i>	<i>not available on the web</i>
Mass resolution (FW1%M) ^b	1:300	1:300
Ion Detection Efficiency (percent)	> 35	> 35
Signal to Noise ^c	20,000:1	100,000:1
Ion mass-to-charge-ratio range (amu) ^d	1 to 200	1 to 200
Field of view ^e (nm)	150	150
Lateral resolution ^f (nm)	0.2	0.2
Depth resolution ^f (nm)	0.1	0.1
Multi-hit pulse pair resolution (ns)	<i>not available on the web</i>	<i>not available on the web</i>
FIM	Real-time digital FIM on primary AP detector (no tilt or translation between AP and FIM mode)	

^b Demonstrated on Al specimen and 27Al⁺ peak.

^c S/N determined using an Al specimen in laser pulsing mode, and calculated as the ratio of the number of ions under the Al 27 peak to the number of background noise ions in a mass-to-charge range of equivalent width (i.e. from a region with no discernable peaks).

^d *not available on the web*

^e Measured on Imago-supplied Al specimens.

^f Demonstrated on W specimens using LatticeView Spatial Distribution Maps.



PRODUCT SPECIFICATIONS



INSTRUMENT DESCRIPTION

Laser Beam Alignment

- » Patent pending automated laser beam alignment and drift compensation with submicron precision.
- » Laser pulse mode evaporation rate controlled in real time using feedback loop

User-Selectable Pulsing Mode

- » Either laser pulse mode or voltage pulse mode selectable using intuitive software interface

Field Ion Microscope (FIM)

- » UHV leak valve and manifold for three gases. Two gas bottles supplied. Third gas bottle is optional.

Facilities Requirements

- » Please refer to LEAP HR System Site Requirements Guide





PRODUCT SPECIFICATIONS



CERTIFICATIONS

The instrument has been evaluated and found to comply with all requirements of the following standards. Certificates and reports documenting compliance are available upon request.

INTERNATIONAL

IEC61010-1	Safety Requirements For Electrical Equipment for Measurement, Control, and Laboratory Use
SEMI S2-93	Safety Guidelines For Semiconductor Manufacturing
CE marking	Meets all requirements of all applicable EU directives and the applicable conformity assessment procedures have been applied
SEMI S8-95	Safety Guidelines For Ergonomics/Human Factor Engineering Of Semiconductor Manufacturing Equipment
IEC 60825-1	Safety of Laser Products – Part 1

AMERICAN

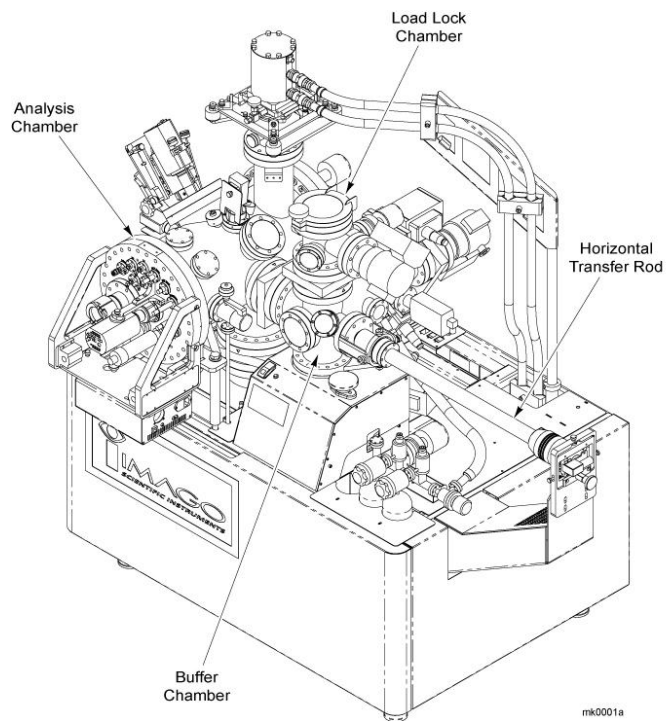
NFPA 79	Electrical Standard for Industrial Machinery (National Fire Protection Agency)
NFPA 70	National Electrical Code (National Fire Protection Agency)
CDRH ⁹	Letter of Accession on file demonstrating US FDA Compliance as a Class 1 Laser Product.

⁹A Class 1 laser is considered safe based upon current medical knowledge. This class includes all lasers or laser systems which cannot emit levels of optical radiation above the exposure limits for the eye under any exposure conditions inherent in the design of the laser product. There may be a more hazardous laser embedded in the enclosure of a Class 1 product, but no harmful radiation can escape the enclosure.





VACUUM SYSTEM



LEAP HR Vacuum System Configuration. Optional Laser Pulse Module not shown.



VACUUM CHAMBER CONFIGURATION

Load-Lock Chamber

A load-lock chamber for carousel loading is provided with the following features:

- » Three-carousel capacity, each carousel containing six specimens and/or Local Electrodes
- » Evacuated with a turbomolecular pump backed by an oil-free roughing pump
- » Dry UHP N₂ venting
- » Bakeable to 150° C
- » *Additional detail not available on the web. Contact Imago for full specifications*

Analysis Chamber

An analysis chamber used for atom probe analysis is provided with the following features:

- » Contains: three-axis specimen stage; Local Electrode, cryostat, microchannel plates; time-of-flight mass spectrometer with a position-sensitive, single-atom detector; phosphor screen assembly; and FIM imaging-gas handling system
- » Bakeable to 150° C
- » Isolated from pumping system by an interlocked gate valve. Gate valve automatically closes in event of power failure.
- » *Additional detail not available on the web. Contact Imago for full specifications*



SPECIMEN TRANSFER, MOUNTING, AND COOLING

Specimen Transfer to Analysis Chamber

Facility for transferring specimens is provided with the following features:

- » CCD cameras, illumination ports, and a linear-rotary puck manipulator
- » Interlocks provided to prevent damage to the transfer system
- » Class I laser enclosure

Specimen Alignment

Facility for aligning specimens is provided with the following features:

- » 10 mm displacement range on each of the three orthogonal axes
- » Two camera optical system monitors alignment of the specimen relative to the Local Electrode in two orthogonal axes.
- » *Additional detail not available on the web. Contact Imago for full specifications*

Specimen Stage

- » Cryogenically cooled, vibration isolated
- » Accepts interchangeable specimen pucks that hold both flat specimens and needle-shaped specimens
- » *Additional detail not available on the web. Contact Imago for full specifications*



SOFTWARE

Online Data-Acquisition Software

Data-acquisition software capabilities as follows:

- » Raw-data-file generation: information from the experiment including specimen identification; instrument parameters; specimen alignment; specimen standing and pulse voltages; flight times of each ion collected; and information related to the impact position of each ion on the position-sensitive, single-atom detector; laser pulse energy and focal spot position
- » Automated feedback system controls specimen voltage to maintain a target evaporation rate (calculated as ions detected per voltage pulse), and automatically adjusts the pulse voltage to maintain a target pulse fraction (up to the maximum pulse amplitude available)
- » Real-time display of the specimen voltages, evaporation rate, flight times, mass-to-charge ratio, and elemental identity of each ion collected
- » View accumulated mass spectra, voltage-versus-ion plots, two-dimensional atom maps, concentration profiles, and diagnostic information

Data Visualization and Analysis Software

Data visualization and analysis capabilities as follows:

- » Ability to accurately reconstruct wide Field Of View atom probe data using 3D reconstruction wizard
- » Optional density correction during reconstruction
- » Reconstruction explorer
- » Gaussian smoothing
- » High speed smoothing utilizing user selectable kernels.
- » Thermal color shading and contour plots
- » Ability to manipulate and manage atom probe projects
- » Solute analysis including envelope, precipitate, 3D Johnson and Klotz ordering, contingency table, markov chain, tracer, and LBM method
- » Ladder diagrams
- » Range file manager
- » Orthographic views



PRODUCT SPECIFICATIONS



- » Axis scale control
- » Foreground(axis) and background color
- » Projection views, clipping, and XYZ image plane rotation
- » High resolution image capture
- » Advanced image exporting
- » Isosurface definition and sorting
- » Radial distribution function
- » Ability to identify interfaces and calculate various surface roughness statistics in compliance with international standards (ASME B46)
- » Ability to export interface surfaces in a format readable by other software packages including Atomic Force Microscope software.
- » Ability to plot, export, and analyze mass spectra
- » Complex Region Of Interest manipulation, export, and analysis. Region of Interest may be cylindrical, parallelepiped, spherical, or as defined by an isoconcentration surface
- » Proximity histograms optimized for high speed calculation. Histograms may be exported to other application programs.
- » Spatial distribution maps
- » Advanced spectral analysis
- » Periodic table overlay in mass spectrum during analysis
- » Save/Restore Analysis state
- » Bulk composition panel displays statistics using atomic weighting/ionic weighting and decomposed ionic weighting (optional background subtraction).
- » Export of 1D concentration profile and proximity histogram to .CSV file
- » Choice of Lin/Log scales for all composition and histogram displays
- » Tool tips for all icons
- » View multiple datasets at the same time
- » Link orientation of multiple datasets
- » 1D and 2D concentration plots with arbitrary orientation
- » VRML export: view and manipulate 3D data atom probe data in Internet Explorer and other Microsoft office applications.
- » Full 32 bit support and included 64bit CPU/OS optimization with multi-CPU and multi Gbyte RAM optimization





PRODUCT SPECIFICATIONS



MISCELLANEOUS

Computer Hardware

Workstation meeting or exceeding the following:

- » 2.6 GHz microprocessor, 2 GB RAM, 160 GB hard disk
- » Combination CD/CD-RW/DVD-R drive
- » 100 MB Ethernet adapter
- » Windows® XP Professional operating system
- » Two 19 in. flat-panel displays

Data Analysis and Visualization Workstation (Optional)

Workstation meeting or exceeding the following:

- » 64 bit dual processor work station
- » Processor #1 (of two): quad core 2.6 GHz
- » Processor #2 (of two): quad core 2.6 Ghz
- » 8 Gbyte RAM, 250 GB hard disk
- » 20 inch monitor
- » Combination CD/CD-RW/DVD-R drive
- » 100 MB Ethernet adapter
- » nVIDIA FX500 graphics card
- » Windows® XP Professional operating system

Power

- » Instrument configurable to meet regional line-voltage requirements
- » A master emergency-machine-off (EMO) switch
- » An uninterruptible power supply (UPS) for continuous operation through minor voltage fluctuations and to allow an orderly shutdown in the event of a power loss

