

FEI® Connectivity Solutions
Ultimate Imaging with Ultimate Throughput

Better Data. Faster.

Shrinking device geometries drive greater transmission electron microscope (TEM) use at semiconductor labs—to better support the development and monitoring of advanced semiconductor manufacturing processes. But atomic-scale imaging and analysis of such things as barrier layers, critical interfaces, gate structures, dopant profiles and silicon strain requires ultrathin samples that can take days to prepare using conventional techniques.

Enter FEI Connectivity Solutions for Ultimate Throughput and Ultimate Imaging.

They can reduce a lab's "wafers-to-atoms" time from days to hours by accelerating and improving the preparation and imaging of TEM samples—linking preparation, lift-out, transfer, loading and imaging/analysis operations performed by the following FEI tools:



- *Titan³™ 80-300*
Scanning/Transmission
Electron Microscope



- *TEMLink™ 150 Sample*
Extraction System



- *Helios NanoLab™ 400S*
Small-Sample
DualBeam™ System



- *CLM-3D™ Wafer*
DualBeam™ System

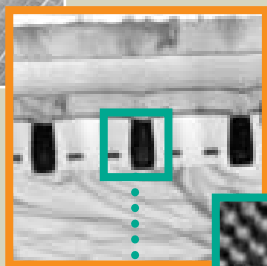
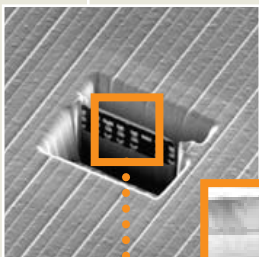


The Multi-Loader sample transfer tool slashes the time needed for stable S/TEM imaging.

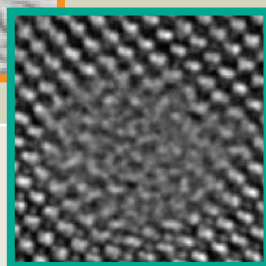
Benefits

There are several ways that FEI's connectivity solution accelerates development of advanced processes:

1. **Increases** the sample rate of S/TEM imaging and analysis by increasing throughput of sample preparation on 300 mm wafers.
2. **Ensures** consistent isolation of features of interest and defects under review with high-precision, high-quality sample preparation.
3. **Reduces** the risk of losing one-of-a-kind samples with secure, easy-to-use tweezerless sample extraction and transfer.
4. **Improves** performance of S/TEM imaging and analysis.



From wafers to atoms: a newly created TEM sample (upper left) is ready to be lifted out of a wafer; an atomic-scale TEM image (bottom) shows a cross-section view of a silicon nanopipe.



Ultimate Imaging

Precise control of thinning, transfer, imaging and analysis

Imaging and Analysis

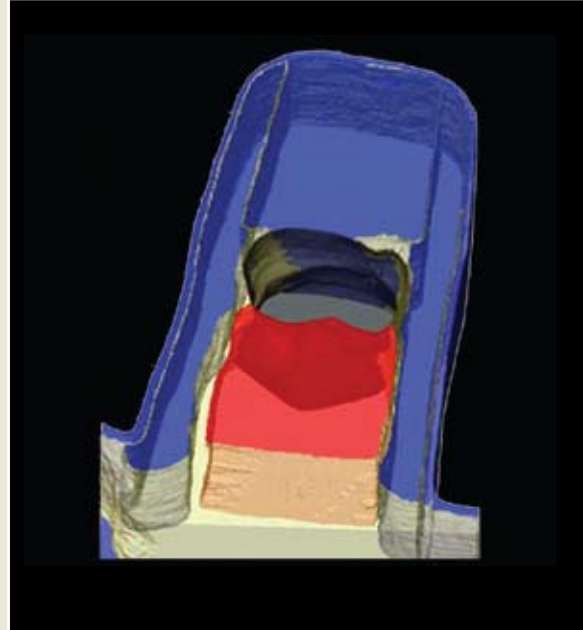
Once on board, you will gain the ultimate in high-resolution imaging and analysis with the Titan³ 80-300 S/TEM. With a voltage range of 80–300 kV, the Titan³ is completely enclosed to dampen acoustic, electro-magnetic and temperature variations. The lab-proven enclosure not only enables the system to transfer information below 1 μ m, it also allows the system to easily reach atomic-scale resolutions in a noisy environment.

Sample Thinning

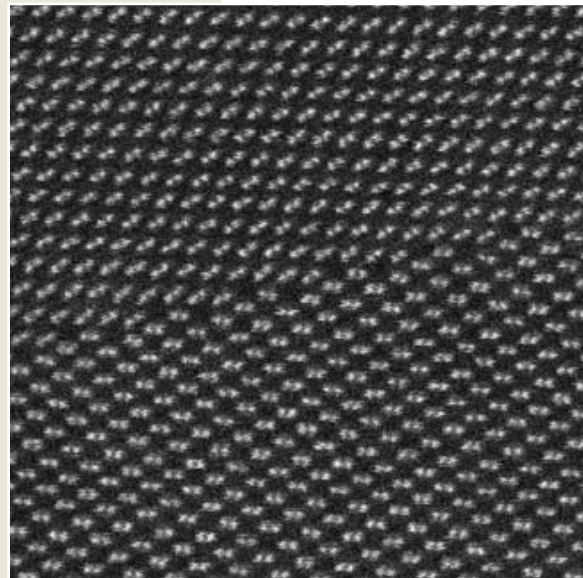
Achieving critical thinness in lamella prep is the crucial first step in ultimate imaging to yield quality image resolution and data for analysis. The Helios NanoLab 400S small-sample DualBeam system offers high-precision thinning. It permits real time monitoring of the image during thinning, for ultimate control of the preparation process and localization. Once the sample is thinned, you can accelerate voltages up to 30kV for scanning transmission electron microscope imaging and analysis, or transfer the sample to high voltage system for the ultimate level of high-resolution imaging and analysis.

Sample Transfer

Sample transfer is made less risky and less time-consuming with the FEI Multi-Loader sample transfer tool. It allows hands-free extraction of loaded sample holders into and out of the small-sample DualBeam thinning system and the high-voltage Scanning Transmission Electron Microscope (S/TEM) imaging and analysis system. By significantly reducing vacuum pump-down delay, the Multi-Loader tool speeds-up the time to stable S/TEM imaging and data collection. The Multi-Loader tool accommodates FEI cartridges and a variety of TEM sample grids and holders. With the safest sample handling available, it supports workflow flexibility and increases system productivity.



3D reconstruction layer TEM image at ~1.5nm thickness



Silicon atoms viewed with a Titan S/TEM at 0.8 resolution

Ultimate Throughput

High quality samples in a matter of hours

Reduce Wafer-to-Sample Time from Two Days to Less Than Two Hours

For advanced semiconductor manufacturing, a single day of unnecessary delay can cost millions of dollars. Speeding-up TEM sample preparation from two days to less than two hours clearly has a significant impact to the bottom line. The FEI tools that form the Ultimate Throughput solution also improve the quality of TEM sample preparation, while virtually eliminating sample transfer risk.

The CLM-3D Wafer DualBeam system prepares TEM samples with ease, faster. In addition to its other role in automated cross-sectional metrology, the CLM-3D DualBeam provides fully-automated, programmable TEM sample preparation, wafer after wafer. An upgrade to CLM-3D+ allows for even greater performance in throughput, cut placement and sample thickness.

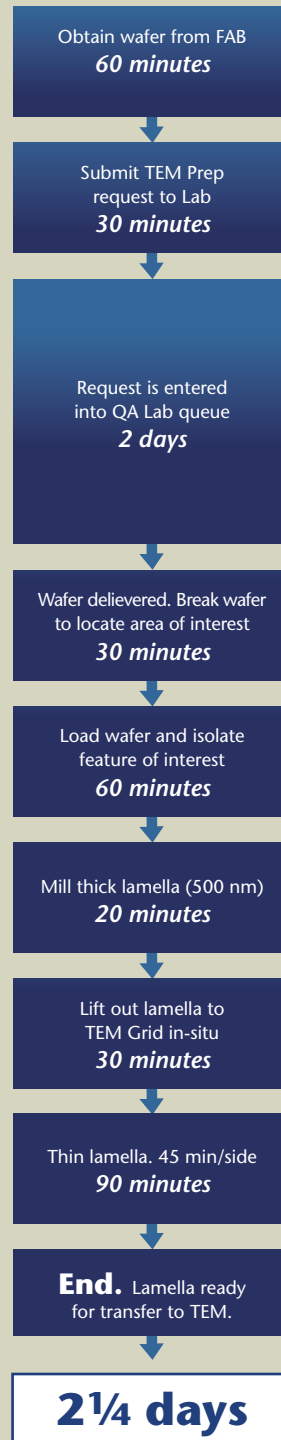
Rapid Ex-Situ TEM Sample Extraction

The TEM Link 150 extraction system provides secure, ex-situ sample liftout. It rapidly extracts TEM samples from standard wafers and places them onto standard TEM grids for ex-situ imaging and analysis.

The Multi-Loader sample transfer tool is used to move samples from the TEMLink system to the FEI Cartridge Transfer Station (FCTS), and from the FCTS to the Helios NanoLab 400S for additional thinning, or to the TEM imaging and analysis system.

From Days to Hours

Standard Lab Workflow



CLM High Throughput Workflow



FEI Connectivity Solutions for Ultimate Throughput and Ultimate Imaging



**CLM-3D Wafer
DualBeam System**

- Automated, digital 3D analysis and TEM sample preparation
- Full wafer autoloading for higher throughput
- Programmable recipes for precise and repeatable location and milling of samples, wafer after wafer
- Combines advanced FEI electron column and high-current ion column for high precision cross-sectional metrology and TEM sample preparation
- Designed to operate in a clean room environment



**TEMLink 150
Sample Extraction System**

- Reduces the time and risk associated with sample lift-out
- Tightly integrated with FEI CLM-3D and Certus™ DualBeam systems
- EFEM option for autoloading from industry standard FOUPs
- Extracts TEM samples from any standard semiconductor or data storage wafer, to 3mm TEM grids—accommodates 200mm, 300mm semiconductor wafers, and 100mm, 125mm, 150mm, and 200mm data storage wafers
- Simple and reliable sample extraction via a user-friendly wizard interface
- Throughput up to 20 samples/hour
- Compatible with FEI Multi-Loader™ transport system for hands-free, tweezer-less sample transfer



**FEI Cartridge Transfer Station
(FCTS)**

- Provides compatibility between the TEMLink system and the Multi-Loader transport system
- Provides compatibility between Multi-Loader cartridges and traditional 3mm TEM grids
- Modular flexibility with any combination of the following component modules:
 - Transfer anvil and mounting module
 - Cassette indexer
 - Transfer gripper base
 - Transfer gripper
 - Storage container
 - Receptacle
 - Grid mounting block
 - Cartridge transfer bull



**Helios NanoLab 400S
Advanced DualBeam**

- Exclusive FlipStage™ for integrated sample preparation and STEM imaging
- High-performance Elstar™ electron column for sub-nanometer SEM and STEM image resolution
- Sidewinder™ ion column for high-speed, high-resolution milling and cross sectioning
- Low kV ion beam clean-up minimizes sample preparation damage
- Five-axis piezo-driven stage with loadlock provides full coverage of 80 mm sample
- Advanced design provides unprecedented stability and immunity to environmental interference
- Automated setup and operation for ease-of-use and reduced training
- Comprehensive preparation, imaging and analysis capabilities maximize utilization and reduce cost-of-ownership



**Multi-Loader Sample
Transfer Tool**

- Easy-to-use sample extraction, transfer and loading capabilities with the industry's first double tilt prep-to-analysis system connectivity solution, for proper silicon substrate orientation and alignment
- A more secure, high-throughput tweezer-free sample management solution with reduced manual handling steps when transferring and loading samples
- The ability to accommodate multiple samples per cartridge for each load cycle
- Ultra low thermal mass FEI cartridge technology improves efficiency by minimizing time to stable operation, therefore reducing the time to image/data collection
- Universal compatibility with a variety of sample grids (3 mm, half-moon, etc.)



**Titan³ 80-300
Scanning/Transmission
Electron Microscope**

- Increase your imaging and analysis capabilities with two CS-correctors and/or a monochromator in one instrument
- Maximize the quality of the results by choosing the optimum acceleration voltage between 80 to 300 kV
- Increase your lateral resolution to the sub-Ångström level with a large objective pole piece gap for 'space to do more'
- Maximize throughput and stability with the new cold trap design holding up to one week of nitrogen supply
- Minimize the influence of the environment on your experiments with the new revolutionary concept of an enclosure
- Explore the freedom of full remote control functionality with the new high-speed remote camera suite
- Maximize flexibility with the capability of retro-fitting of corrector technology (probe CS- and image CS-corrector)
- Decrease the installation requirements for acoustics and temperature variation

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