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FEI Connectivity Solutions Deliver Ultimate Imaging with Ultimate Throughput

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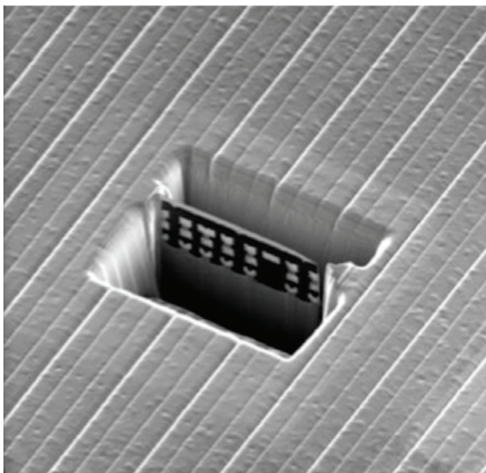
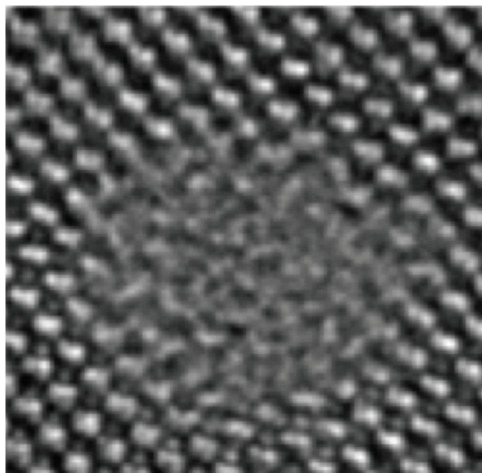
Shrinking device geometries are driving semiconductor labs to rely even more on transmission electron microscope (TEM) systems for better support of the development and monitoring of advanced semiconductor manufacturing processes. However, atomic-scale imaging and analysis of barrier layers, critical interfaces, gate structures, dopant profiles and silicon strain require ultra-thin samples that can take days to prepare using conventional techniques.

The new FEI® Connectivity Solutions for Ultimate Throughput and Ultimate Imaging greatly reduce any lab's "time to image" from days down to hours. This innovative new methodology accelerates the preparation, lift-out, transfer and loading of TEM samples by linking operation of the following FEI systems:

- **CLM-3D™ Wafer DualBeam™ System**
- **TEMLink™ 150 Sample Extraction System**
- **Helios NanoLab™ 400S DualBeam System**
- **Titan³™ 80-300 Scanning/Transmission Electron Microscope**



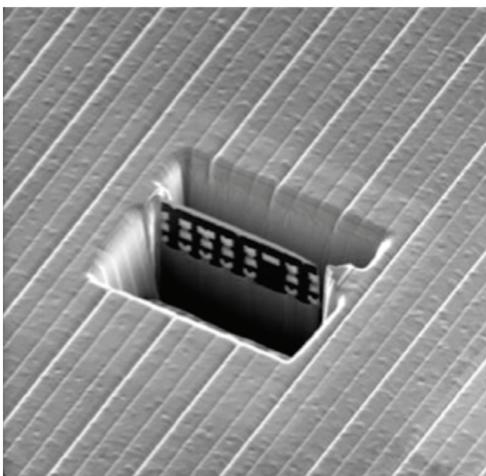


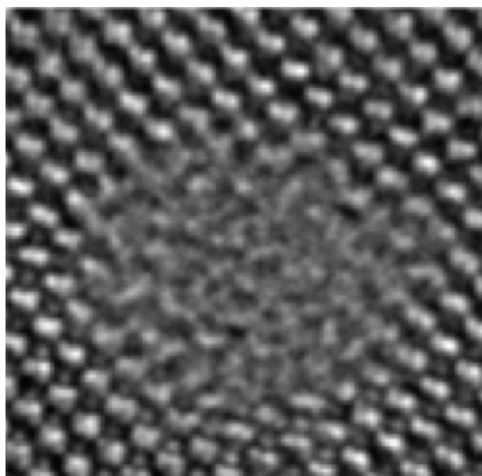
From wafers to atoms: a newly created TEM sample (left) is ready to be lifted out of a wafer; an atomic-scale TEM image (right) shows a cross-section view of a silicon nanopipe.

Ultimate Imaging: Improving Process Development and Monitoring

The FEI Ultimate Imaging solution optimizes the sample thinning and sample transfer steps to help labs employ the high resolution of their FEI TEM.

Capturing the right structure in an ultra-thin lamella is the crucial first step to achieving the best quality image in a TEM. The Helios NanoLab 400S offers the highest performance thinning available in a small-stage DualBeam system. For ultimate defect localization and minimal sidewall damage, a fast, simultaneous milling and imaging feature permits real-time monitoring of the sample during thinning. Once the sample has been thinned, the user can collect high-resolution, high-material-contrast images via an integrated STEM detector at operating voltages as high as 30kV. Alternatively, the user may transfer the lamella to a TEM for higher resolution imaging at higher operating voltages





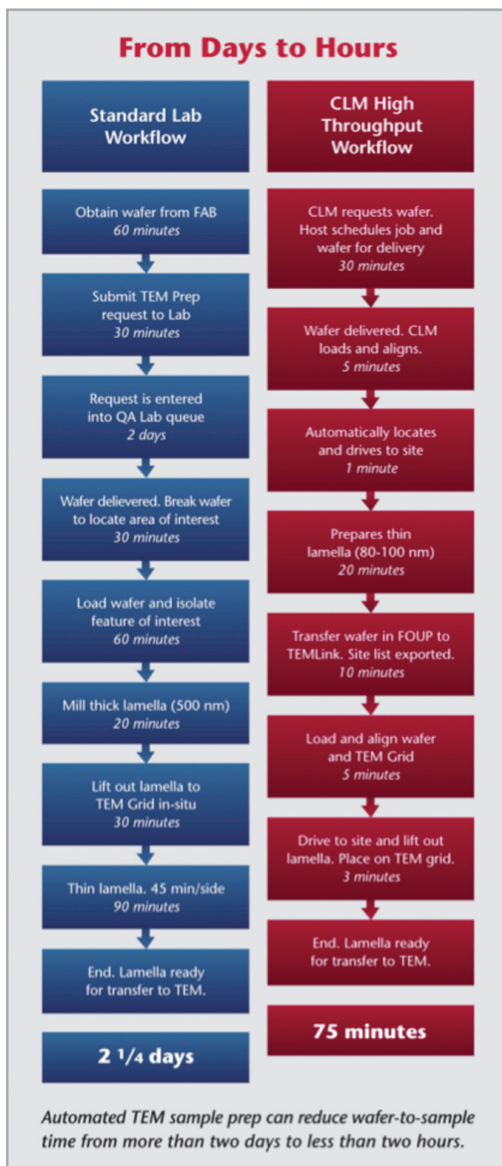
(left) Lamella created on a 300 mm wafer by the CLM-3D Wafer DualBeam system (right) Silicon atoms viewed with a Titan S/TEM at 0.8 Ǻ resolution

Sample transfer becomes less risky and less time-consuming by using the FEI Multi-Loader™ Transfer Gripper. This tool accelerates the extraction of loaded sample cartridges into and out of both the small-stage DualBeam system and the higher-voltage S/TEM imaging and analysis system. By significantly reducing vacuum pump-down delay, the Multi-Loader tool speeds up the process to achieve stable S/TEM imaging and data collection. It accommodates FEI cartridges and a variety of TEM sample grids and holders. This "tweezer-less" transfer solution supports workflow flexibility and while increasing overall lab productivity.

Once the sample is loaded, the Titan^3 80-300 S/TEM delivers the ultimate high-resolution imaging and analysis tool that labs need. With a voltage range from 80 to 300 kV, the Titan^3 provides a wide range of materials contrast and analytical capability. The system is completely enclosed to dampen acoustic, electro-magnetic and temperature variations. This enclosure makes it possible to maintain sub-angstrom resolution even in noisy lab environments.

Ultimate Throughput: Prepare, Extract and Transfer TEM Samples in 75 Minutes

For advanced semiconductor manufacturing, a single day of unnecessary delay can cost millions of dollars. Reducing TEM sample preparation time from two days to less than two hours clearly has a significant impact on the bottom line. The FEI Ultimate Throughput solution prepares high-quality samples for an automated sample-extraction system, virtually eliminating sample transfer risk.



Automated TEM sample prep can reduce wafer-to-sample time from more than two days to less than two hours.

The CLM-3D Wafer DualBeam forms the starting point for the Ultimate Throughput solution. In addition to its role in automated cross-sectional metrology, the CLM-3D DualBeam provides fully automated, programmable TEM sample preparation, wafer after wafer. A soon-to-be-released upgrade to the CLM-3D+ will provide for even greater performance in throughput, cut placement and sample thickness. In short, semiconductor manufacturers can prepare TEM samples faster and easier.

The TEMLink 150 extraction system provides secure, automated sample lift-out of lamella created by the CLM-3D Wafer DualBeam system. It rapidly extracts TEM samples from full wafers and places them onto standard TEM grids for ex-situ imaging and analysis. Users can then use the Multi-Loader Single Cartridge Cassette to move samples from the TEMLink system to the FEI Cartridge Transfer Station (FCTS). From the FCTS, users can take cartridges of samples to the Helios NanoLab 400S for additional thinning, or to the TEM imaging and analysis system.

FEI's Ultimate Throughput solution can slash wafer-to-atoms time from more than two days to less than two hours.

Connectivity Solutions Reduce "Time to Image" and Boost Bottom Line

TEM systems are becoming even more important to semiconductor labs to drive development and monitoring of advanced semiconductor manufacturing processes. The FEI Connectivity Solutions for Ultimate Throughput and Ultimate Imaging accelerate sample preparation, lift-out, transfer and loading. As a result, they can greatly reduce the "time to image" of the required ultra-thin lamella from days down to hours, eliminating unnecessary delays and boosting the manufacturer's bottom line.

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