



kSA MOS UltraScan

Flexible,
High-Resolution
Curvature, Stress,
Thickness, and
Reflectance Mapping,
All in One Tool!



kSA MOS UltraScan is a flexible, high-resolution scanning curvature, stress, thickness, tilt, and absolute reflectance measurement system. Based on the proven technology of our standard in-situ kSA MOS system, the kSA MOS UltraScan uses a two-dimensional laser array to simultaneously measure the sample curvature in two orthogonal directions and performs XY scanning to generate complete measurement mapping of semiconductor wafers, optical mirrors, lenses, or practically any polished surface.

kSA MOS UltraScan provides high resolution XY scanning with uniform spatial scan resolution over the entire wafer/sample surface as small as 1µm. Scans are fully programmable for line scans, selected area maps, and full area maps, perfect for circular, square or patterned samples. The system also provides quantitative film stress analysis by first scanning the sample and then re-scanning the sample post-process.

Measures:
Curvature
Bow height
Thin film stress
Tilt
Absolute reflectance
Film thickness and spectral reflectance (Optional)

Materials:
Wafers
Optical Mirrors
Lenses
Glass
Polished/Smooth Surfaces



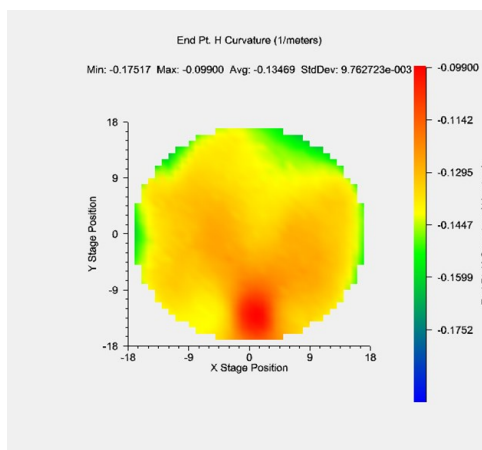
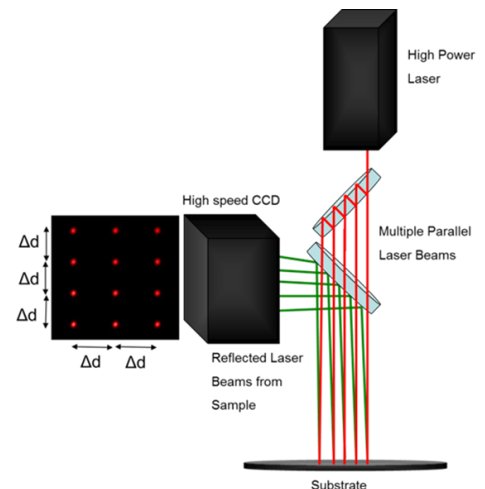
kSA MOS UltraScan Measurement Technologies

kSA MOS: The kSA Multi-beam Optical Sensor, or kSA MOS, technology is based on a patented approach which uses a single laser to generate a two dimensional laser array. This laser spot array is then reflected off the sample surface and into a high resolution CCD imager. Changes in the reflected laser array spot spacing at each point on the sample are used to determine the localized sample curvature in both the X and Y direction. In this way, the system directly measures the curvature and stress in two dimensions simultaneously, something that single or dual beam curvature and stress tools simply cannot capture.

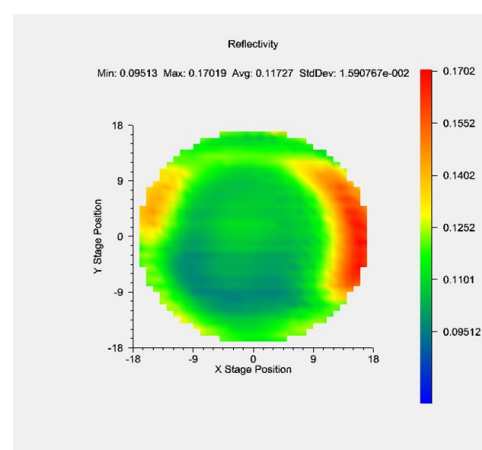
Simultaneous detection of the laser array also makes the measurement inherently less sensitive to sample vibration compared with systems that rely on scanning the laser spot on the surface of the sample to measure the local curvature, leading to kSA MOS's increased curvature resolution capability. Since all the laser spots move together at the same frequency, movement or tilt is not incorrectly detected as a change in sample curvature.

XY Scanning: kSA MOS UltraScan is equipped XY scanning over a 300mm x 300mm area. This provides the advantage of uniform spatial data resolution over the entire sample, rather than losing spatial resolution at large diameters, which is typical in linear scanning systems equipped with rotation stages. Moreover, it provides easy measurement set up for rectangular samples or for mapping limited areas of a sample.

Curvature: kSA MOS UltraScan is equipped with both flat and curved reference mirrors for quick and easy curvature calibration. As such, the absolute curvature of your sample is measured directly from the absolute laser spot spacing, resulting in high accuracy single point and scanning curvature measurements. Through the use of sophisticated image processing and data analysis algorithms, the kSA MOS UltraScan can easily detect



kSA MOS UltraScan curvature map of a commercial GaN on sapphire template.



kSA MOS UltraScan reflectance map of a commercial GaN on sapphire template.

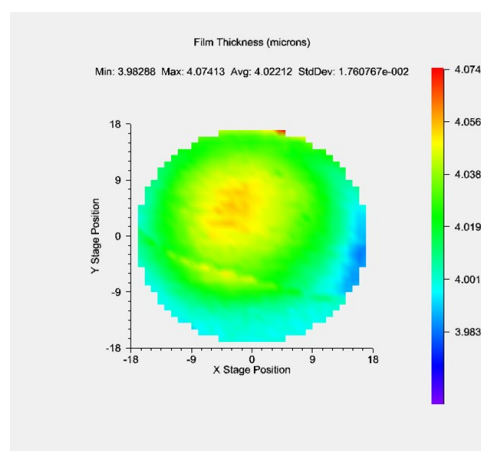
sub-micron changes in spot position due to changes in sample curvature, which translates to the highest curvature/stress resolution metrology tool available.

Absolute Reflectance: Absolute reflectance of the sample at the laser wavelength is determined by measuring the integrated intensity of the laser spots on the detector and can be calibrated with a mirror or sample reference. This provides useful information with respect to the quality or film uniformity of the measured sample.

Bow Height: When a laser is reflected off a bowed sample, the reflected angle will differ at different points on the sample. The automated laser tracking in the kSA MOS UltraScan optics not only keeps the laser array centered on the detector but also measures the changes in the angle of reflection of the laser array in order to determine the local sample bow height.

Film Stress: To generate a thin film stress map of a sample, the local curvature of the sample must be determined both pre- and post-deposition. Based on the change in the local curvature from the pre- and post-process curvature maps, as well as the substrate thickness, the biaxial modulus of the substrate and the film thickness, the thin film stress is determined. The changes in stress of a thin film after processing may also be determined from the curvature maps measured after the subsequent processing steps.

Spectral Reflectance and Film Thickness (optional add-on): Equipping the kSA MOS UltraScan optics with a light source and a fiber coupled spectrometer, the spectral reflectance of the sample can be measured at each point on the sample. Using the proprietary kSA metrology software, the extrema positions in the spectral reflectance data together with knowledge of the film's dispersion curve, the kSA MOS UltraScan can determine the thickness of a single layer semitransparent thin film on a substrate with a different index of refraction at each point on the sample. This data can be mapped along with other measurement parameters such as wafer curvature and film stress. Alternatively, the spectral reflectance data can be exported to other programs for multi-layer thickness or device modeling.



kSA MOS UltraScan thickness map of a commercial GaN on sapphire template.



kSA MOS UltraScan Models

Standard Package	
Model	Description
kSA MOS UltraScan <i>MOS-US</i>	<ul style="list-style-type: none"> Complete curvature, film stress, tilt, bow, and absolute 660nm reflectance measurements as function of sample position. System includes: <ul style="list-style-type: none"> Standard detector, laser, optics, servo-motor mirror controller, computer controller, kSA software, complete steel frame enclosure with lockable wheels, and uninterruptable power supply with voltage regulation Built-in flat and 10m radius of curvature reference mirrors Standard sample holder for 50mm, 75mm, 100mm, 150mm, 200mm, and 300mm diameter samples Fully programmable XY scanning stage with options for line scans, selected area mapping, and full area mapping kSA 2-D and 3-D mapping and analysis software One kSA analysis only software license (M-AOS) for offline data analysis on a separate computer
Options	
Options	Description
NIR Spectral Reflectance and Film Thickness Module <i>M-SR-1670/U</i>	<ul style="list-style-type: none"> Provides additional integrated hardware for absolute spectral reflectance measurement in the range of 870-1670nm with an integrated software module for the calculation of total film thickness.
405 nm Laser and Optics <i>M-405/U</i>	<ul style="list-style-type: none"> Replaces the standard laser and optics in the MOS-US with a 405nm laser and suitable optics for greater surface sensitivity.
4" Optics <i>M-4inch/U</i>	<ul style="list-style-type: none"> Replaces standard optics with 4" optics to accommodate a large degree of wafer bow on large wafers/samples.
Custom Sample Holders	<ul style="list-style-type: none"> Custom sized sample holders available and quoted separately. <ul style="list-style-type: none"> Examples: 10mm x 10mm square samples, flat insert for odd sized samples, etc.
Custom Large Area Panel Scanning	<ul style="list-style-type: none"> Custom scanning systems from 300 x 300mm up to 2m x 2m samples.
Large Diameter Mirror Curvature Mapping (up to 1.5m diameter)	<ul style="list-style-type: none"> See kSA MegaMOS Product Specification for details.
Thermal Process Chamber	<ul style="list-style-type: none"> Allows for curvature and stress mapping as a function of temperature. See kSA MOS ThermalScan Product Specifications for details.

kSA MOS UltraScan Functional Specifications

Standard MOS-US Specifications	
Sample Requirements	A smooth surface with >1% reflectivity at laser wavelength ¹
Standard Sample Holder	Holds 50, 75, 100, 150, 200, 300mm diameter samples; custom samples sizes upon request
Scan Range	Up to 300mm in diameter, user programmable X and Y measurement range
XY Stage Resolution	1 μ m, user programmable measurement step size
Average Curvature Resolution	4x10 ⁻⁵ m ⁻¹ (Defined as the standard deviation of 100 consecutive measurements at the center of the included reference mirror.)
Average Curvature Repeatability	2x10 ⁻⁵ m ⁻¹ (Defined as standard deviation of the average curvature of 10 line scans with a minimum of 16 measurement points per line scan.)
Radius of Curvature Range at Center ²	Minimum Concave: 2.0m Minimum Convex: -2.0m Maximum Concave: 50km Maximum Convex: - 50km
Stress Accuracy ³	1% or 0.32MPa whichever is greater
Stress Resolution ³	0.32MPa (Based on measured curvature resolution.)
Average Stress Repeatability ³	0.32MPa (Defined as standard deviation of the average stress from 10 scans.)
Stress Range at Sample Center ^{2,3}	Minimum Concave: 7800MPa Minimum Convex: 7800MPa Maximum Concave: 0.32MPa Maximum Convex: 0.32MPa
Maximum Bow Height ^{2,3}	0.67mm at the edge of 300mm diameter wafer
Bow Height Resolution	2x10 ⁻² μ m (Defined as standard deviation of the average bow height from 10 scans.)
Bow Height Repeatability	<0.2 μ m
Reflectivity Accuracy	<=0.1% of calibrated value (from reference mirror)
Thickness ⁴	Measures single layer semi-transparent films between 1-10 μ m in thickness with a 2nm resolution.

All measurements require a suitable measurement environment; large changes in ambient air temperature and air currents can impact tool performance.

¹For samples with low reflectivity and/or roughness, k-Space suggests testing of a representative sample to ensure measurement compatibility.

²For radius of curvature, stress, and bow height ranges at a given diameter and/or application, please contact your k-Space representative.

³ Assumes 725 μ m Si substrate thickness, 180GPa biaxial modulus for Si substrate, and 1 μ m film thickness. Specifications vary with substrate material, thickness, and film thickness.

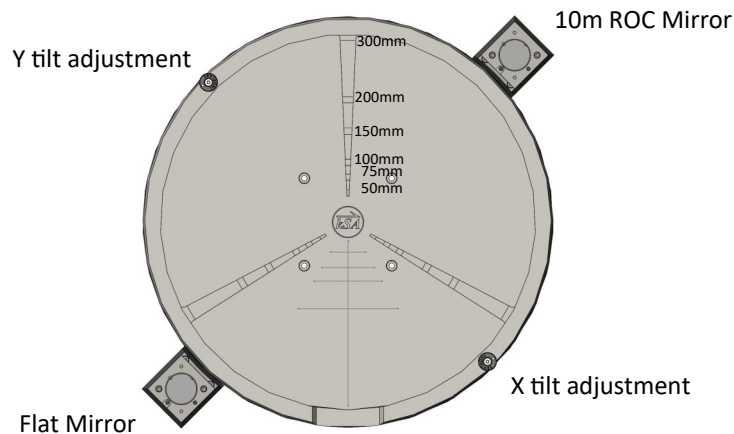
⁴ Available with M-SR-1670/U option. Thickness specification based on a single layer GaN film on sapphire substrate. Note layer and substrate must be different materials for thickness measurement.



kSA MOS UltraScan System Specifications

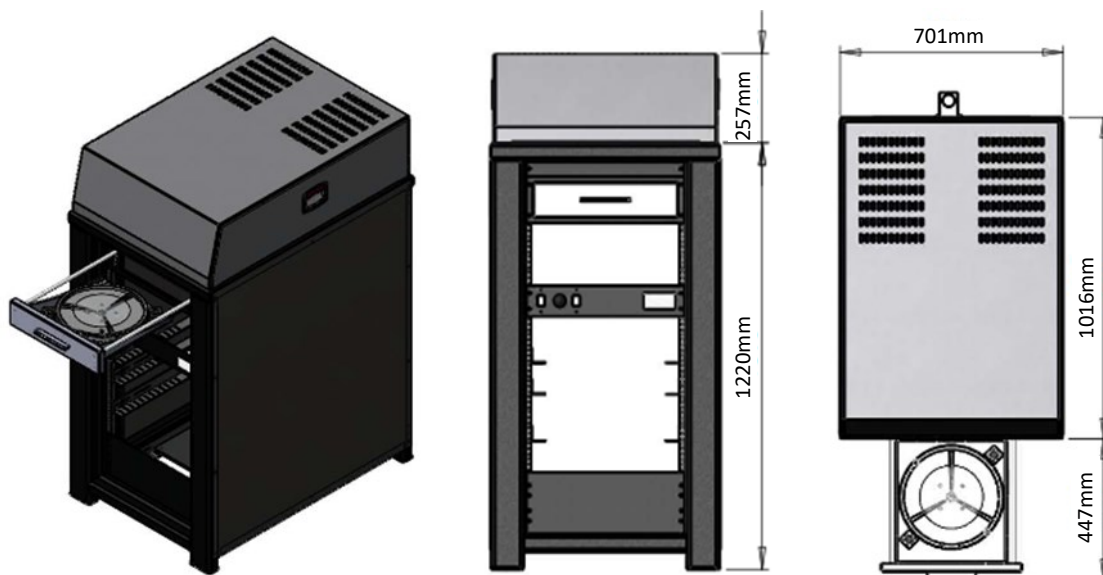
Sample Holder:

Wafer holder machined from solid aluminum block for mechanical stability. The standard stage holds 50, 75, 100, 150, 200, and 300mm diameter samples. Stage is equipped with both a flat reference and a 10m radius of curvature mirror for automated, easy, and reproducible system calibration. Custom sample holders quoted separately.



System Frame:

A robust welded steel frame houses the entire wafer holder, control electronics, and metrology system, so there is no need for an expensive vibration isolation table to house this stand alone unit. The frame has retractable castors so that the system can rest on vibration isolation pads if desired.



kSA MOS UltraScan

Controller:

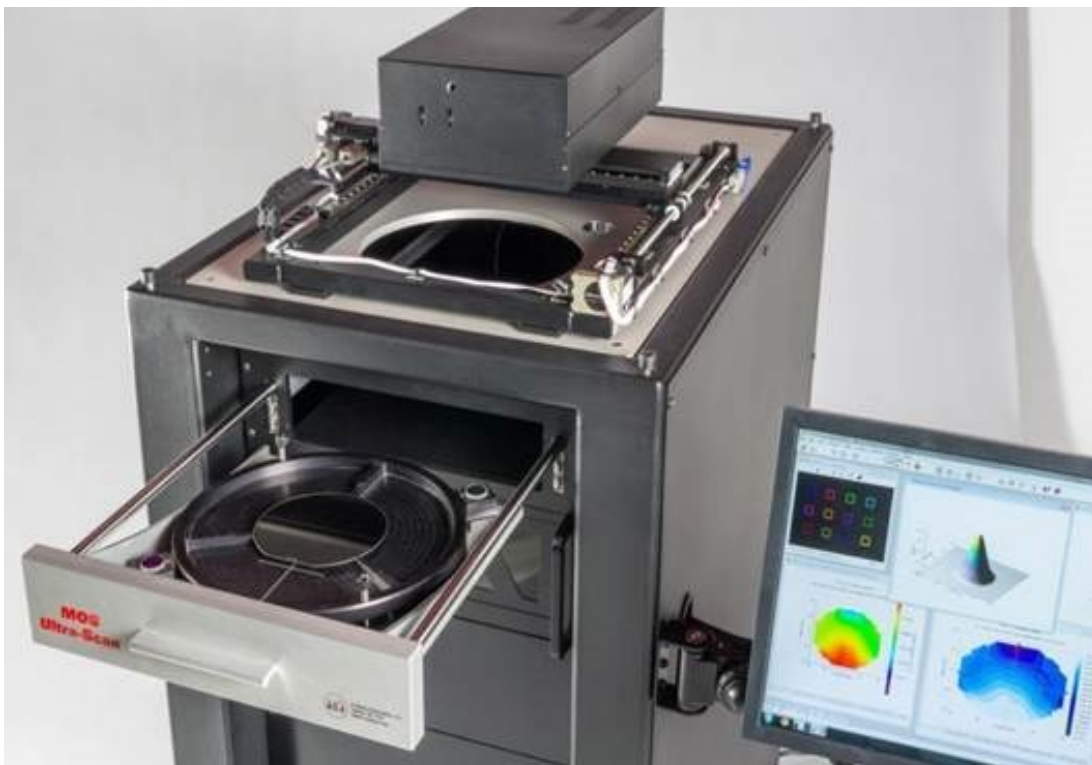
The kSA MOS UltraScan system is supplied with a fully configured, Windows 10, multi-core CPU, A4 rack mounted computer system with a 22" LCD Monitor on a frame mounted swing arm. Please refer to the kSA Computer Product Specifications for the latest computer configuration. k-Space does not recommend or encourage customers to substitute or update their own computer for the controller. The kSA MOS UltraScan system uses several data acquisition boards that require specific bus slots and additional I/O slots on the back plane of the computer chassis.

Facility Requirements

System Power: 110 or 220V, at 220V it draws 3 - 4A.

System Dimensions: W=70cm L=101.6cm H= 156cm to 160cm depending on feet adjustment. Sample drawer extends an additional 45cm when opened. Monitor arm can attach to the left or right side, and extends to side.

System Weight: 295kg (650lbs).



Photograph of kSA MOS UltraScan with MOS optics, scanning stage and sample holder exposed.



Detectors

The MOS UltraScan system utilizes a CCD detector for imaging the laser array.

	Standard Detector
Model	k3300-14
CCD Format	4/3 type, KAI-08050 Progressive scan
Resolution	3296 x 2472 pixels (8MP)
Pixel size	5.5µm
Sensing area	18.13mm x 13.6mm
Bit depth	14-bit
Dynamic Range	62dB
Exposure time	Variable from 10µs to 26.8s
Output format	GigE
Power	12V DC (internal from computer) or external 120/240V 210mA current consumption

Lasers

The kSA MOS UltraScan system utilizes fiber-coupled, Peltier-cooled laser diode packages with integrated current controller and temperature controller for generating the laser array. A different laser wavelength and associated optics may be required/desirable for some applications. Note: All high-power beams are confined within the kSA MOS UltraScan housing even when the cover is removed for alignment. The cover is not interlocked, but may be upon request. Direct access to the main beam is necessary during alignment.

	660 nm (MOS-US Standard)	405 nm (with M-405/U)
Operation Mode	Constant current	Constant Current
Spot Size	~ 0.8mm spot diameter, typical array is 6x4mm (4x3 spot array)	~ 0.8mm spot diameter, typical array is 6x4mm (4x3 spot array)
Power	> 70mW (<10µW exits the optical enclosure)	> 50mW (<10µW exits the optical enclosure)
Stability	≤ 0.2%	≤ 0.2%
Lifetime	10,000 hours (mean time before failure), 1 year warranty	10,000 hours (mean time before failure), 1 year warranty

kSA MOS UltraScan Analysis Only Software Sentinel Key

M-AOS option is an analysis-only software sentinel key that allows complete kSA MOS UltraScan functionality, with the exception of data acquisition. It is designed for users who want to perform post acquisition, display, processing and analysis away from the laboratory.

Installation and Training

A minimum of 1-2 days of on-site customer installation are required with system purchase.

Warranty

All kSA systems and integrated components are warranted against defective materials and workmanship for a period of ONE YEAR from the date of delivery to the original purchaser.

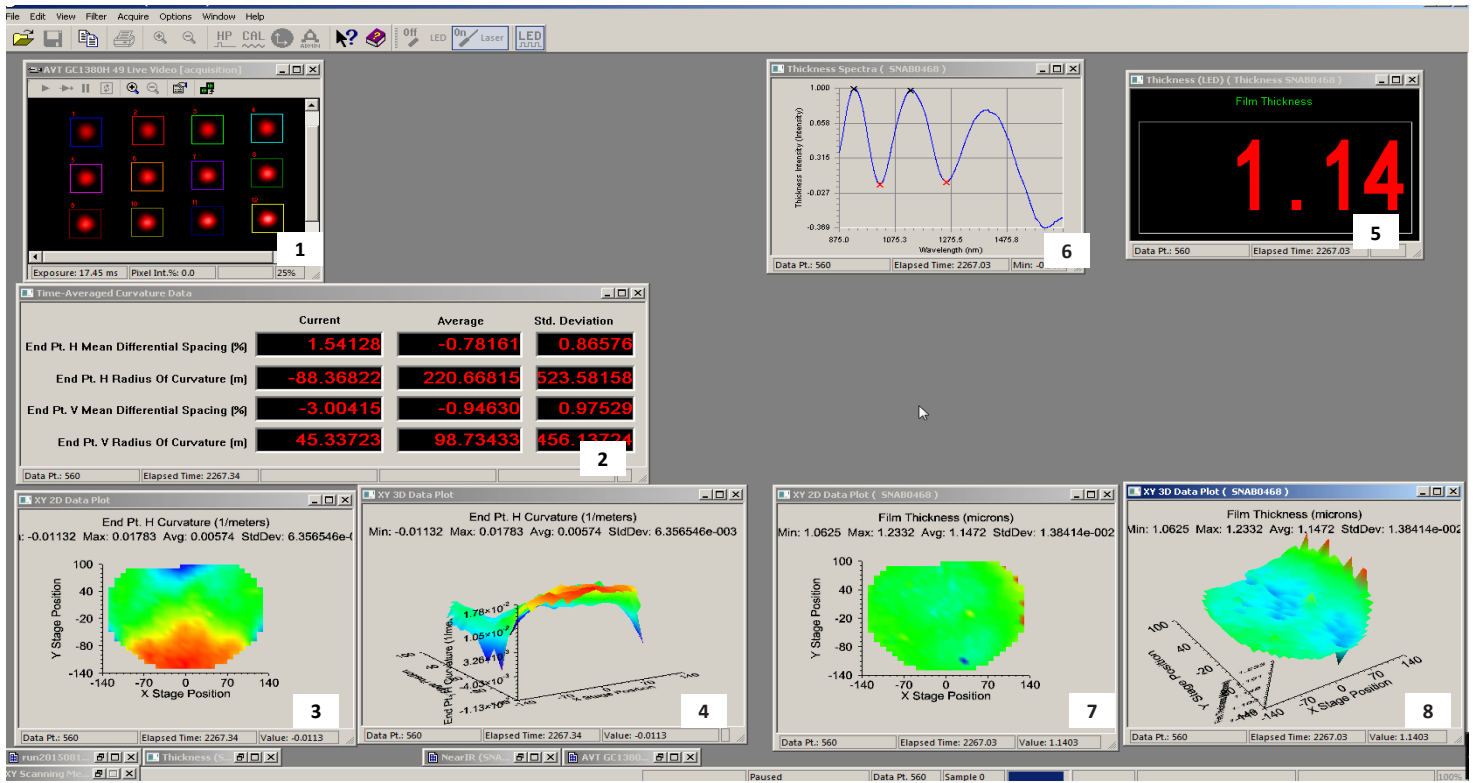


kSA MOS UltraScan Integrated Software

The kSA MOS UltraScan data acquisition software controls and monitors all applicable hardware including laser, CCD detector, servo-motor control mirror, XY scanning stage, and data acquisition boards. The software automatically detects the laser array, controls the CCD detector exposure time to ensure no saturation as the surface reflectivity changes, and continuously centers the reflected array via real-time adjustment of the servo-controlled fold mirror as the sample is scanned.

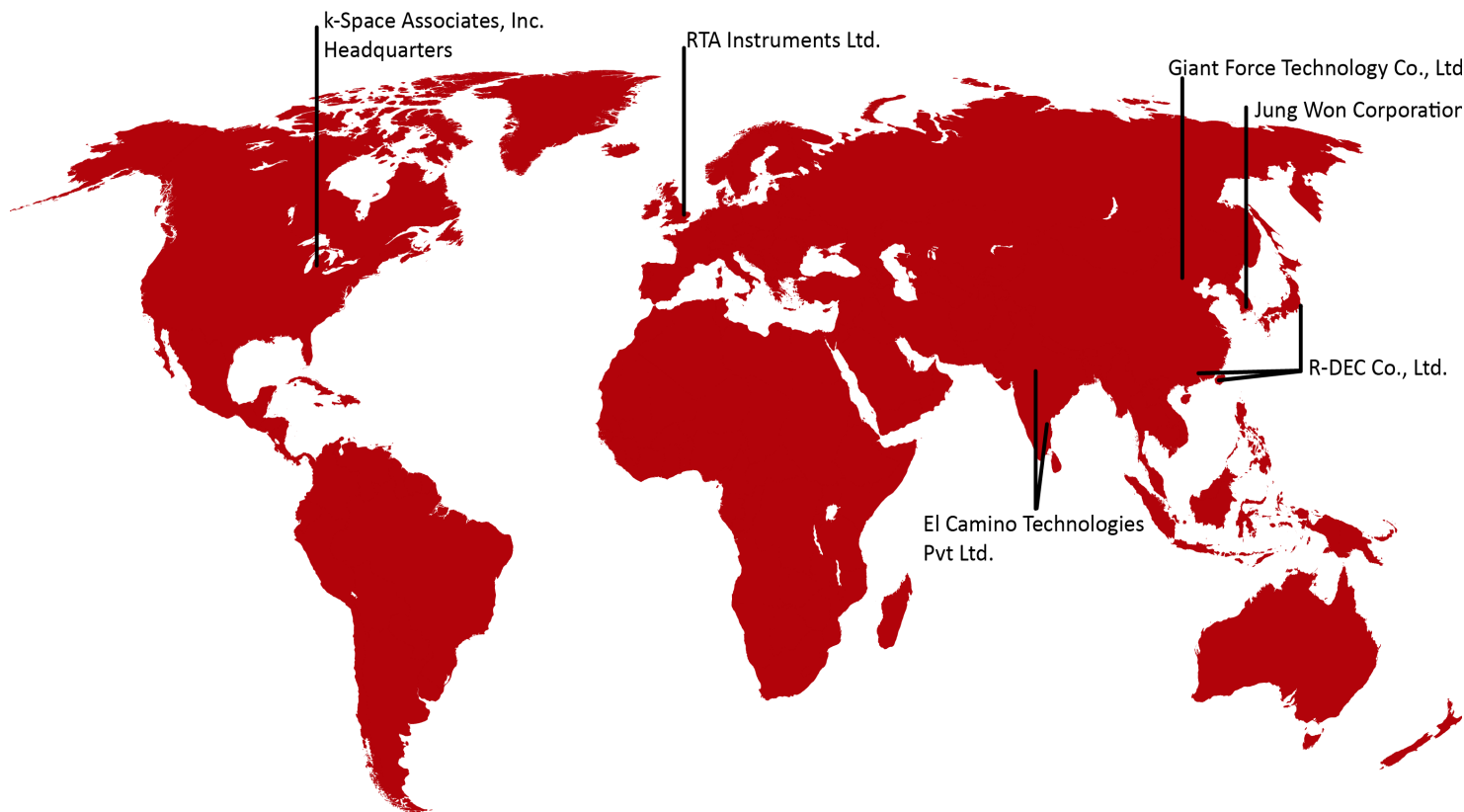
The kSA MOS UltraScan software provides real-time plotting of differential spot spacing, curvature, reflectivity, bow height, film thickness (optional), film stress, and spectral reflectance (optional). Scanning recipes may be saved for easy measurement setup. For system calibration, the kSA MOS UltraScan automatically measures the calibration mirrors before sample scanning for fast, easy, and consistent calibration run after run. The multithreaded architecture of the kSA MOS UltraScan software allows you to analyze previously acquired data while a current scan is being performed. In addition, the complementary analysis only software license for post-deposition/acquisition analysis allows the user to analyze data at a separate location, if needed.

All kSA metrology software has a user-friendly Windows-standard environment with extensive error checking and file handling. It is user configurable so that each user's preferred window layouts and acquisition/analysis preferences can be saved for future use. kSA metrology software allows data storage in ASCII, Excel or binary file formats, facilitating alternative data analysis if desired. Included in all kSA metrology software are high-quality 2D and 3D graphics for data display and analysis, as well as numerous image and graphics editing capabilities, including false coloring using pre-loaded or user-defined color palettes, and label editing. Transport graphics directly to the Windows clipboard, or export to wmf, png, tiff, or bmp formats. For integration with other computer systems, complete TCP/IP interface for custom, real-time data transfer and program control, and data transfer to SQL databases is included.



1	Live video image showing twelve reflected laser spots from the sample
2	Time-averaged curvature data
3	Real-time curvature map updated as data is taken, represented as a 2D data plot
4	Real-time curvature map updated as data is taken, represented as a 3D surface plot
5	Latest measured film thickness value (in microns)
6	Real-time spectral reflectance data with extrema identification for thickness determination
7	Real-time film thickness map updated as data is taken, represented as a 2D data plot
8	Real-time film thickness map updated as data is taken, represented as a 3D surface plot

kSA software screen shot of multiple real-time measurements on a commercial GaN on Sapphire template



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MOS UltraScan Product Specs 08DEC21