Auto Scanning System
Fully Automated VPD-ICP-MS
Expert ™

Indispensable tool for analysis of metallic impurities in Si wafer

Expert™ is designed for analysis of metallic impurities in Si wafers. There are three models in the family : ***Expert_FAB, Expert_PS and Expert_LAB***. FAB and PS models can be integrated with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and LAB model is for standalone use.
Analysis of metallic impurities in Si wafer is one of important items in semiconductor manufacturing. The concentration of metallic impurities to be controlled has been lower and lower as the integration has been higher. Total Reflection X-Ray Fluorescence (TRXRF) has been used in production lines (FAB) because of its non-destructive feature. However, the detection limit of TRXRF could not satisfy the requirement, and VPD technique was developed as a sample pre-concentration method. As a result, the detection limit was improved around two orders of magnitude, but TRXRF is no longer a non-destructive technique. In addition, the chemical solution prepared by VPD can be directly analyzed by ICP-MS with much lower detection limit including lighter masses such as Li, Na and Mg. Consequently, ICP-MS with VPD becomes a common technique to control metallic impurities in Si wafer.
There are several VPD equipment in the market, but they were developed for preparation of TRXRF and not designed for ICP-MS analysis.

[*Expert_PS*]
This model has been in the market for more than 10 years. It is used in both labs and FABs and It can be used with ICP-MS for full automation or without ICP-MS for standalone. ICP-MS is installed right next to the main frame of *Expert_PS*. Two load port locations and an optical aligner from 6” to 12” are standard.

[*Expert_FAB*]
This model is a fully integrated model including ICP-MS for semiconductor FAB. ICP-MS is located inside the main frame of *Expert_FAB*. Many options for PS model are included in FAB model as standard. Two load port locations and an optical aligner from 6” to 12” are standard.

[*Expert_LAB*]
This mode is designed for laboratory use. All wafer treatment such as VPD, Dry and scan can be done automatically and a scanned solution is recovered in a vial, which should be manually transferred to ICP-MS for analysis. Only one load port location and a gravity aligner for three consecutive wafer sizes are standard.

Features of Expert

- **Load port**

  Expert has one or two load port locations depending on the model and various combinations of wafer sizes such as 300 mm (12”) FOUP or FOSB, 200 mm (8”) SMIF, 150 mm (6”) or 200 mm adaptor are available.

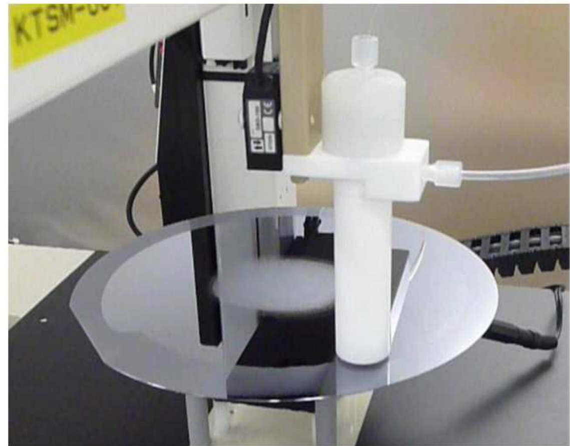
- **HF vapor generation**

  A PFA nebulizer is used for generation of HF vapor used for VPD. A bubbling technique has been commonly used for generating HF vapor, but the concentration of HF changes with time that causes different etching time.

  On the other hand, the PFA nebulizer generates constant concentration of HF vapor and improves the etching speed.

- **Dual scan nozzle**

  A scan nozzle holds scan solution and scans desired area of wafer to collect metallic impurities remained on a wafer after VPD. However, surface of wafer becomes hydrophilic after the bulk etching or dry etching because the wafer surface gets rough after the bulk etching and organic residue remain on a wafer after dry etching. As a result, it was difficult to hold the scan solution with the conventional scan nozzle. The Dual scan nozzle with vacuum can hold the scan solution inside the nozzle very well and allows the scan of hydrophilic surface.

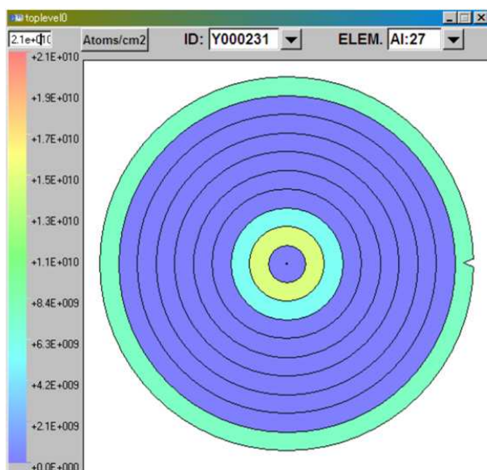


Scan by Dual Scan Nozzle

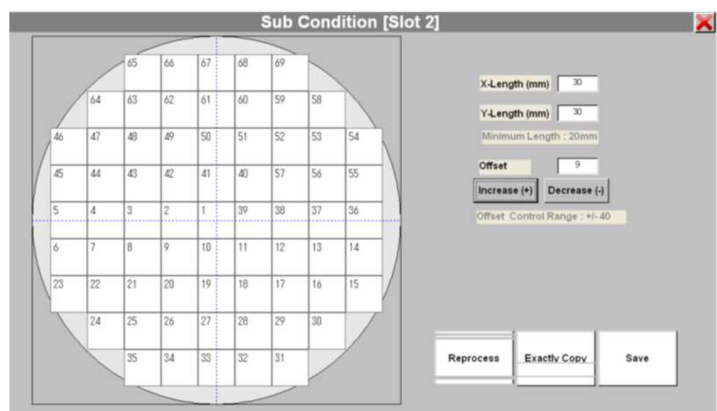
Edge Scan

- **Scan mode**

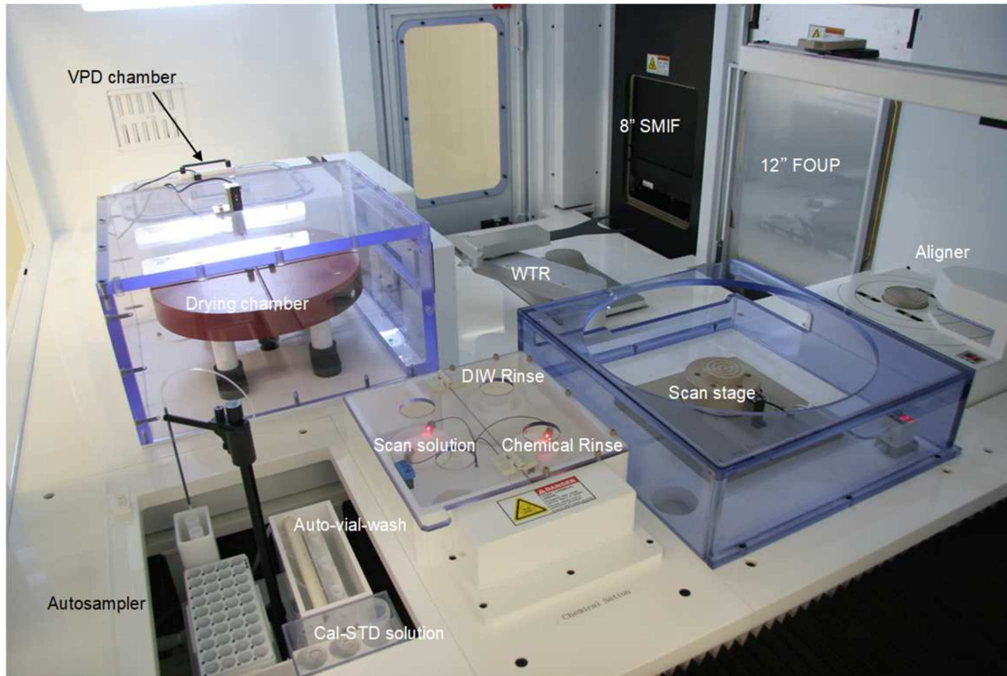
  The Expert can do various scan patterns such as full, radial, sector, radial-sector and bevel as a standard function. The Expert can also do the edge scan that scans around 1 mm from edge of backside wafer together with the bevel part.



Radial scan results on VIS



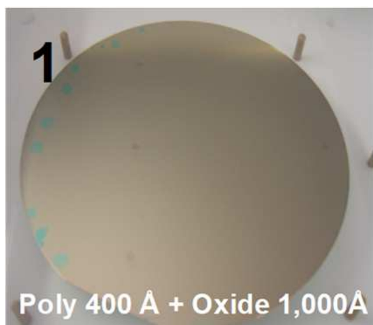
Sector scan set up window

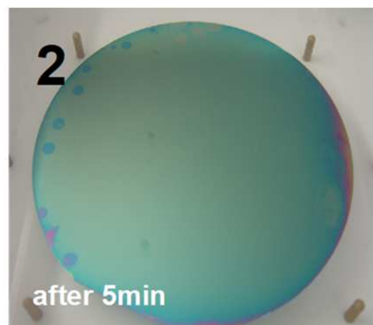


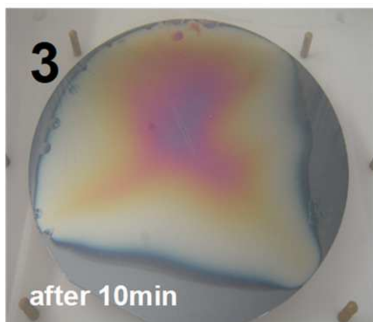
Inside of *Expert_PS*

- **Bulk etching and depth profile measurement**

  A special gas is introduced into the VPD chamber together with HF vapor, which allows etching of bulk-Si, Poly-Si, WSi and Ti films that cannot be etched by only HF.
  Using this function, metallic impurities diffused into Si substrate from deposited films can be analyzed and profile measurement of dopant and metallic impurities in implanted wafer is possible.
  The etching speed and depth can be controlled by optimizing the amount of HF vapor and special gas. The maximum etching speed is over 1.5 um/hr with ±10% uniformity.







Poly-Si layer etching

PFA nebulizer

- **Drying module**

  The drying module is used to dry a wafer before returning to a cassette.

  The Expert measures the volume of recovered scan solution. If the recovered volume is smaller than the original volume, the scan solution may remain on the wafer, and it is dangerous if the wafer returns to the cassette with the remaining scan solution. To avoid such a risk, the wafer is transferred to the drying module before returning to the cassette. The drying module can also be used for a local bulk etching and preparation for TRXRF measurement.

- **Intelligent VPD-ICP-MS** software has been developed to interface *Expert* ^{TM} system and ICP-MS.

  The followings are fully automated VPD-ICP-MS procedure:

  1. Mapping sensor identifies the location of wafer.
  2. A preset recipe number automatically sets up VPD time, scanning mode and volume of scan solution for each wafer.
  3. The first wafer is transferred to Aligner where wafer position such as centering and notch or flat is adjusted without touching a bevel part.
  4. The wafer is carried into VPD chamber, and HF vapor generated by a PFA nebulizer is introduced and then a layer such as oxide or nitride is decomposed. The etching is terminated by time or EPD.
  5. The wafer is transferred to Scan stage and the special scan nozzle aspirates the scan solution (max. 1.5 mL).
  6. The nozzle moves on the wafer and around 100uL of scan solution is pushed out from the nozzle and the wafer is scanned according to the method set in the recipe.
  7. The nozzle recovers the scanned solution from the wafer and the solution is collected into a vial.
  8. Simultaneously, the VPD interface software (VIS) controls ICP-MS, and the standard solution and QC check solution are analyzed.
  9. When all criteria pass, the collected VPD samples are analyzed automatically.
  10. All wafer information is transferred to VIS and the impurities found in the decomposed layer are obtained.
  11. VIS provides automated QA/QC function that checks correlation coefficient of calibration curves, minimum sensitivity, and QC recovery. Sample results are checked against the pre-defined criteria and user selectable actions can be taken place automatically if the results are over the limit.
  12. The VPD for the second wafer is performed while the scanning of first wafer is in operation.
  13. QC check solution is analyzed every specified samples such as10 wafer samples.
  14. When the concentration is higher than the specified value in a sample, the scan nozzle is cleaned for an extended rinse time, then the blank solution is checked whether the scan nozzle is clean or not.
  15. When the scan solution is contaminated, another scan solution is used automatically.

- **Integration with OHT and ICP-MS for fully automated operation**
  The Expert can be installed in FABs and integrated with CIM-HOST using the protocol specified by SEMI for fully automated operation. FOUP is transferred to the Expert by Overhead Hoist Transportation (OHT) using SEMI-E84 protocol, and the Expert treats wafers in the FOUP according to the information on wafers and recipes sent from CIM-HOST, and the scanned solution is analyzed by ICP-MS and the results of ICP-MS are sent to CIM-HOST. After the analysis of all wafers in the FOUP, the FOUP is removed by OHT automatically.
  The Expert was installed in a FAB of major semiconductor device manufacturers and has been running 24-7 since 2008. More than 60 systems were installed around the world.
  The VIS (VPD Interface Software) has intelligent functions that checks the status of ICP-MS and allows unattended operation of ICP-MS for 24-7.
- **Safety certificate**
  The Expert has SEMI-S2, SEMI-S8 and CE certificates to meet with strict safety regulations required for FAB use.

Standard configuration

- Two load ports (selection from the option).
- Wafer transfer robot module with mapping sensor.
- Fully automated VPD chamber and HF vapor generation system.
- High speed, precise aligner for 6” to 12” wafer (FAB and PS model).
- Gravity aligner module (LAB model).
- Fully automated wafer scanning stage and accurate X-Y-Z scanning arm and nozzle module.
- 2 Sample racks (40 vials/rack).
- Class 1 environment with Teflon® ULPA filter media.
- Intelligent Expert™ operating software.
- Desktop PC with Windows 10 ®.

Option

- PP panel upgrade
- 6” or 8” manual cassette module with position sensor.
- 12” FOUP opener module.
- 6” and 8” adaptor for 12” FOUP
- RFID or barcode reader
- 8” SMIF loader module.
- Bulk-Si and poly-Si etching module.
- Wafer drying module
- VPD and ICP-MS integration module including autosampler and software.
- Automated calibration module for ICP-MS
- Auto vial washing system
- Auto chemical supply system
- Edge scan module
- Microscope for edge scan
- Wafer weight measurement module
- AMHS, Integration with OHT (E84)
- FAB interface/CIM using SECS
- (ASAS) Automated Standard Addition System
- Hydrophilic wafer scan with N_2 wall.
- Wafer flip.
- Aqua regia solution supply module
- Scan solution dilution module
- CCD camera
- Sample vial rack cover (LAB model)

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April/2022