

X-ray Fluorescence Spectrometer for Thin Film Evaluation

Wafer X 300

1. Introduction

The history of dedicated wafer analyzers began in 1977 with the debut of a Rigaku X-ray system capable of handling 2" wafers for the analysis of PSG films. Rigaku kept pace with the semiconductor industry's advancements by introducing systems capable of handling 4" wafers in 1980 and 6" wafers in 1983. By that time, the system hardware included a distribution measurement function and a Cassette-to-Cassette robot. And, its application expanded to include metallic films.

By 1985, Rigaku Wafer Analyzers were capable of handling 8" wafers. The advancements in computing technology also made possible the practical use of Fundamental Parameters (FP) allowing the analysis of Boron (B) in BPSG films and the analysis of memory disks. By 1992, the Rigaku Wafer/Disk Analyzer became an indispensable assessment tool in the analysis of semiconductor thin films. Its new FP method, special B goniometer and WSix film goniometer expanded its application further.

By 1995, Rigaku's Wafer/Disk Analyzer, 3640 was introduced to handle next generation memory, ferroelectrics. With the strength and experience of over 400 Rigaku dedicated Wafer/ Disk Analyzers working the world over, Rigaku has continued to keep pace with the semiconductor industry's growth. Rigaku recently introduced the Wafer X 300, capable of handling 300 mm wafers, and incorporating an array of new system hardware and software features that again expand the applicability of Rigaku Wafer/Disk Analyzers, The Wafer X 300 will serve as the world's standard system for thin film evaluation to support the on-going innovation of LSI technologies.

2. Features

1. 300 mm wafer capability



The Wafer X 300 is capable of handling both 300 mm and 8" wafers. It also handles 6" wafers to allow use of existing standard reference and monitor samples.

2. Ease of sample transfer

A horizontal driving system ensures safe and easy sample transfer along with a cassette-to-cassette robot.

3. Elimination of sample errors

When wafers are as large as 300 mm, the wafer bend due to its own weight is not negligible in analysis. To minimize this potential bend, an upper surface irradiation system is adopted to allow overall support on the wafer's rear side. Also, to eliminate measurement error caused by wafer thickness when using an upper surface irradiation system, the Wafer X 300 is equipped with a sample height correction device, designed to keep the sample height constant without contact.

4. High-precision analysis

A high-sensitivity, 4 kW X-ray tube and a high-frequency X-ray generator are combined to enhance measurement precision for ultralight elements such as B and P in BPSG films.

5. Next generation memory measurement function

The X-Y- θ stage is indispensable for the analysis of next generation memory. This patent pending stage mechanism eliminates diffracted X-rays which can interfere with accurate analysis. This is the same stage mechanism found in the Wafer/Disk Analyzer 3640.

Diffracted X-rays cause particular difficulties when measuring heavy elements on a Si wafer substrate. Thus, the elemental analysis of metallic films and ferroelectric memory can suffer interference with the overlap of diffracted rays from the Si wafer substrate, resulting in difficulties performing accurate analysis.

In order to eliminate this problem, the XY- θ stage is fixed at the θ -angle, an angle unaffected by the diffracted rays from the Si substrate. Additionally, the X-Y driving capability allows intraplanar distribution measurements of the wafer with no effect from diffracted rays.

With the Rigaku cassette-to-cassette transfer system, orientation flat/notch alignment is carried out on all wafers; therefore, even if the wafer direction within the cassette differs, every wafer will invariably be fed into the analyzer at a fixed direction. Thus the resultant data obtained is completely free from the diffracted rays.

6. Small footprint

Even though the system is capable of measuring 300 mm wafers, the basic unit is compactly designed to minimize its installation area: 1100(W) x 1900(D) mm.

7. Broadening application field

The latest developments in the spectrometric system and software (FP), based on Rigaku's extensive experience in the technology of X-ray analysis and its application in the semiconductor industry, continue to expand the utility of the Wafer/ Disk Analyzer. The analysis of tungsten silicide on Si wafers and the concentration of P in polysilicon are now possible.

8. Multipoint distribution measurement function

Distribution measurement in the sample plane can be made by designating optional positions, up to 100 points maximum. Each measurement spot size can be selected from is also selectable from 10-20-40 mm diameters.

9. Easy-to-view CRT display

The status of each section of the system can be observed by viewing illustrations on the monitor screen. Also, operational productivity is enhanced through optimization of the multijob and multiwindow functions.

10. Full safety mechanisms

If the cover at the sample introduction section is accidentally opened during operation, the sample transfer system will instantly stop. Consideration to safety is given throughout, including parts selection and X-ray proofing measures.

3. Application

The Wafer X 300 is applicable to a variety of thin films used for DRAM and ferroelectric memory.

Device name	Object of analysis (thin film material)
Ferroelectric memory	YI, PZT, BST, Pt, Ir, etc.
DRAM	BPSG, PSG, Ge-BPSG, SiO ₂ , Si ₃ N ₄ , Polysilicon, Wsix, Al-Cu, Al-Si-Cu, TiN, TiW, Ta ₂ O ₅ , etc.

4. Specifications

Item	Content
Sample size	300 mm, 8", 6", dia
Elements for simultaneous analysis	Max. 16 elements, fixed type (Be~U), scanning (Ti~U)
X-ray tube	Rh target, max. Rating: 4kW
Collimator	Automatic exchange (10, 20, 40 mm dia.)

Sample stage	XYZθ
Sample spinning mechanism	Available for center area measurement
Cassette-to-cassette	300 mm dia: 13 slots or 25 slots open cassette 8", 6" dia: 25 slots or 26 slots open cassette Orientation Flat/Notch alignment
Vacuum pump	Two dry pumps (main and preliminary evacuation)
Heat exchanger	Distilled water recirculation system
Operating System	OS/2
Options	FOUP (SMIF, 13/25 slots pods), Through-the-wall

External dimensions	Basic unit X-ray generator	1100 (W) x 1900 (D) x 1700 (H) mm, 700kg 550 (W) x 650 (D) x 600 (H) mm
Installation environment	Room temp. Humidity	15~28°, daily variation: ± 2°C Relative humidity below 75%
Utility	Power requirement Earth ground Cooling water for heat exchanger Cooling water for dry pump Gas for purge Gas for detector Vacuum for chuck	Three-phase, 200 V, 60 A (50/60 Hz) Grounding resistance: Less than 30 Ω (exclusively) 11 lit./min, below 30 °C 3.5 lit./min, below 30 °C Clean N ₂ gas, 10 lit./min, 3~7 kg/cm ² PR gas 25 cc/min, 1.5 kg/cm ² -0.04 ~ -0.08 Mpa

5. Exterior View

