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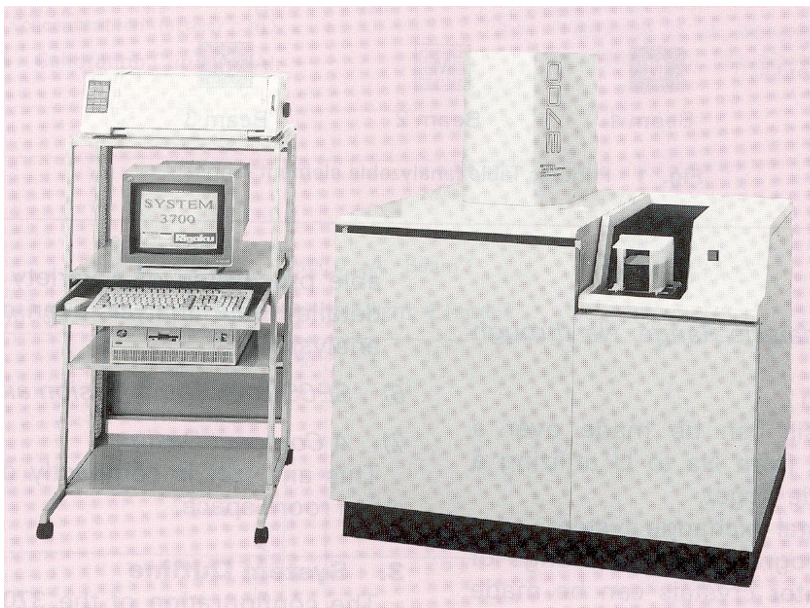
TOTAL REFLECTION X-RAY SPECTROMETER

SYS 3700LE

– Designed for the analysis of light elements –



1. Introduction

Total reflection X-ray spectrometers (TXRF) are actively used today for the analysis of impurities present on the surface and in the near surface of silicon wafers. Because of the capability of rapid, nondestructive measurement and wafer mapping, it is making remarkable achievements in elemental analysis including S, Zn, W, Au, Pb, etc. The Emphasis in using the TXRF has been primarily focused on the analysis of transition metals; there are detection limits for light elements, such as Na and Al. The TXRF has not been optimum with respect to the LSI process.

The "System 3700LE", a newly developed TXRF model is capable of producing long wavelength X-rays for excitation using the same type of rotating anode X-ray tube. This new model has improved the excitation efficiency for Na and Al by nearly two orders of magnitude. At the same time, the interfering X-rays from the substrate wafer have been substantially reduced. Further, a programmable 3-crystal monochromator is employed for selecting the excitation X-rays. Therefore, the analysis capabilities for transition metals are fully retained.

For light elemental analysis of Na to Al, the VPD/AAS and the ICP/MS have primarily been used. However, those analysis techniques are destructive and lack reproducibility; they also require considerable analysis time. Because of these limitations there has been a growing interest in the System 3700, Rigaku's existing TXRF model, to extend its performance to include nondestructive element analysis of Na to U.

These capabilities are now possible with the introduction of the TXRF "System 3700LE", a versatile analysis tool for light, medium and heavy elements. Improvements in performance and function are also incorporated in this Model.

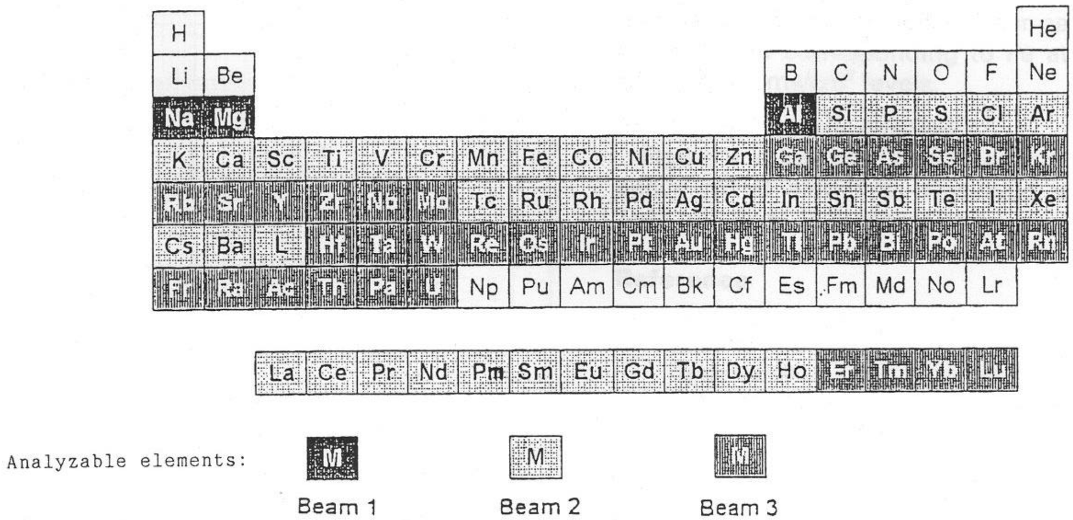


Fig. 1 Periodic Table (analyzable element range).

2. Features

1) Wide Element Analysis Range: Na through U

- Single beam system
  Elemental analysis can be made over a wide energy range from Na to U utilizing a single rotating anode target.
- Programmable crystal exchange system
  The computer programmable exchange of three monochromator crystals can be made with high reproducibility allowing automatic analysis over a wide elemental range. (See Fig. 1 Periodic Table)

2) High Sensitivity Analysis

Combined use of a tungsten target and a synthetic multilayer monochromator permits high sensitivity analysis of light to heavy elements.

3) Easy Sample Loading

Once a cassette holder is installed, a clean cassette-to-cassette robot conveyor is used for automatic runs. Emergency interrupt analysis can also be made.

4) Accurate Positioning for Analysis

The position for analysis can be determined accurately through flat plane orientation, notch matching and wafer center location. Accurate positioning for particle analysis is also possible.

5) Simple Operation

- The routine analysis mode makes operation very simple.
- The Windows operating system is used to enable processing of a variety of jobs such as detailed data analysis even during automatic analysis.

6) SECS Data Transmission and Control

7) A Compact Design

This analyzer is compactly designed to save clean room space.

3. System Outline

The configuration of the 3700LE is based on the System 3700 [1, 2]. The use of an improved rotating anode source and a vacuum system X-ray spectrometer assembly enables light to heavy elemental analysis. Moreover, a unique measuring system for the total reflection position makes feasibility to analyze of various film-coated samples, their rear side, patterned wafers, liquid crystal glass, etc.

4. Application Examples

1) Light Element Analysis

Figure 2 shows a calibration curve for Al prepared by the Dip method on a Si wafer substrate. Compared with the current Au-Lα X-ray and W-Lβ X-ray excitation, an improvement of 200 times is achieved for the signal-to-noise ratio, thus attaining detection limit values in the E10 atoms/cm^2 level.

Figure 3 shows an analysis example of an actual sample. The respective concentration levels

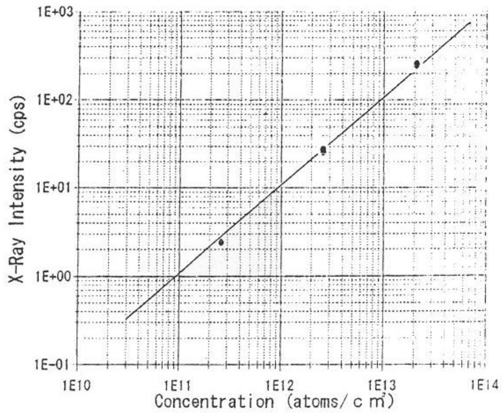


Fig. 2 Calibration Curve for Al.

are 1E12 for Al, 2E11 for Mg and 3E12 atoms/cm^2 for Na.

2) Bare Wafer Analysis

Figure 4 shows an analysis example of transition metals on a bare wafer. Clear peak profiles are obtained corresponding to Fe at 1E10 and Ni at 3E9 atoms/cm^2 levels.

3) Heavy Element Analysis

Figure 5 shows an example of the analysis of heavy metal elements. Observed were W at 7E 11 and Br at 1 E 11 atoms/cm^2.

Reference

[1] The Rigaku Journal Vol. 11. No.2, 1994, "HIGH SENSITIVITY TOTAL REFLECTION X-RAY SPECTROMETER System 3700".

[2] T. Yamada, et. al., Advances in X-ray Chemical Analysis, JAPAN, Vol. 26s, 53 (1995).

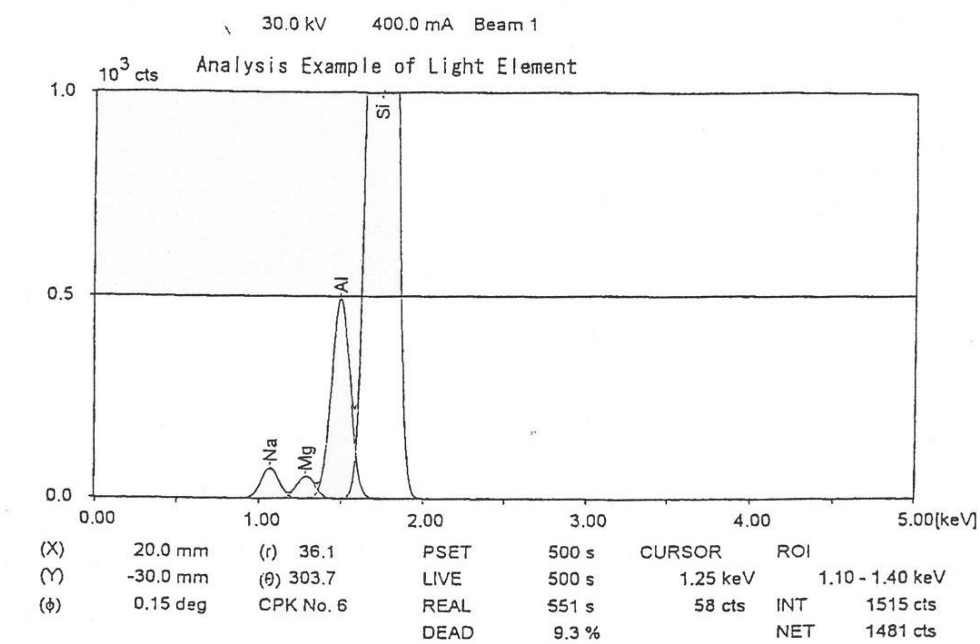


Fig. 3 Analysis Example of Light elements on a Si wafer.

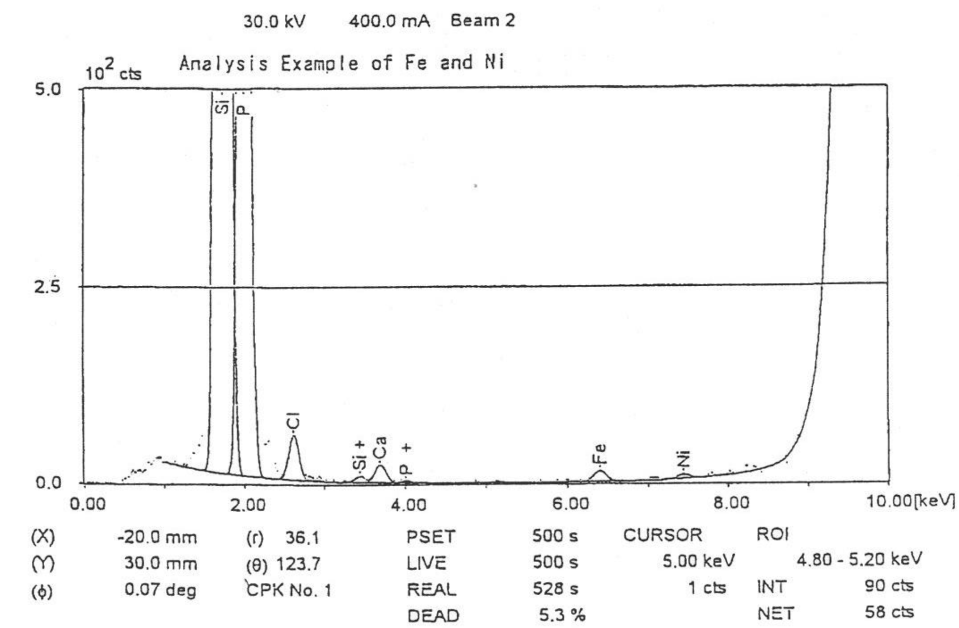


Fig. 4 Analysis Example of the Transition Metals Fe and Ni.

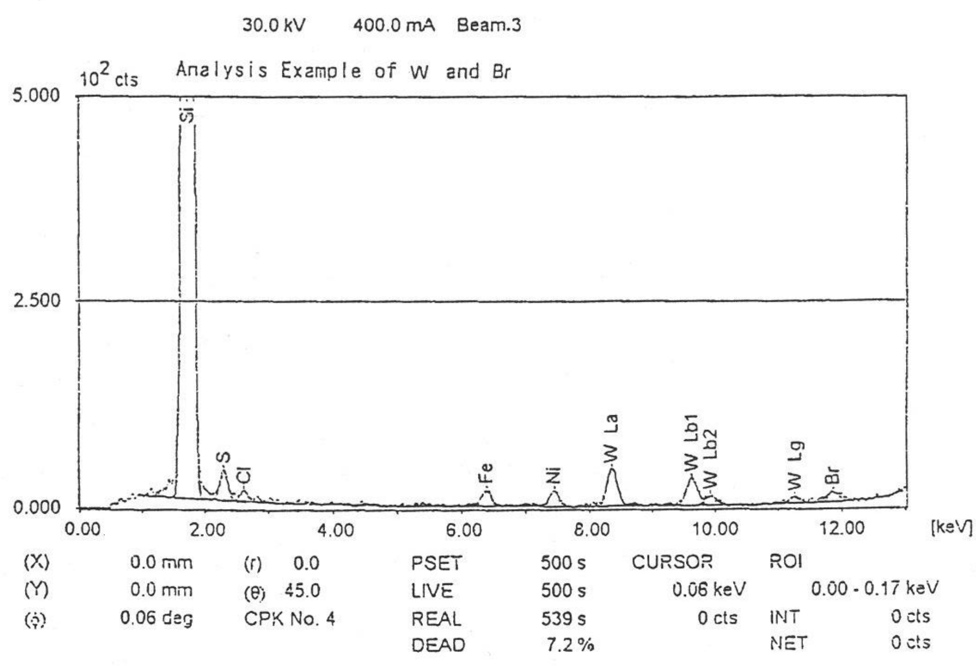


Fig. 5 Analysis Example of the Heavy Metals W and Br.