

Wavelength dispersive x-ray fluorescence under white x-ray

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Introduction

In recent semiconductor fields, many new materials have been introduced in the electric devices. Unintentional contamination of such materials in the other processes introduces a degradation of electric performances and a low production yields. A high-sensitive detection of these contaminations including the light elements adsorbed at the sample surface during the fabrication processes are the key issues for the production of the devices.

Experiments

To date, conventional total reflection x-ray fluorescence (TXRF) equipments has been introduced at many production factories for the detection of trace impurities. However, the lower limit of detection (LLD) in addition to the energy resolution, which is important for the unambiguous identification of elements, is not sufficient for developing the advanced products.

Recently, we constructed the new TXRF equipment at beamline 17C aiming for the high-resolution and the high-sensitivity detection of trace impurities on wafer surfaces. In the equipment, a state-of-the-art parallel optics WD spectrometer, similar to the one installed at SPring-8 [1],[2] made by Rigaku, is attached. The wafer samples are mounted vertically and the fluorescent x-rays emitted horizontally are detected by the spectrometer. The spectrometer holds 4 analyzer crystals that can be changed automatically depending on the energy range of the measured fluorescence x-rays.

To improve the LLD, we applied the high flux white x-ray from the bending magnet only with the Rh coated toroidal mirror for the focusing and to remove the unnecessary high energy x-ray above 16 keV.

Figure 1 and 2 shows the sample chamber and the WD spectrometer of the equipment where these are evacuated by the dry-pump. To estimate the LLD, we measured a standard wafer intentionally contaminated with the Ni and Al and we obtained the LLD of 3.6×10^9 (atoms/cm²) and 1.4×10^{12} (atoms/cm²), respectively. These LLD looks same as the conventional TXRF, but the energy resolution of 50eV is much better compared to the 150eV for the SSD. In addition to the metal elements, we found the LLD for the light elements like S, P, Cl, and O are fairly low, although the quantitative estimation are still underway.

Conclusion

The new WD-TXRF equipment, under white x-ray, constructed at beamline 17C provided a highly sensitive and unambiguous fluorescence measurement which is suitable for the practical evaluation of the industry samples.

References

- [1] N. Awaji et al., Jpn. J. Appl. Phys. 43, 1644 (2004)
- [2] N. Awaji et al., Jpn. J. Appl. Phys. Lett.. 39, L1252 (2000)

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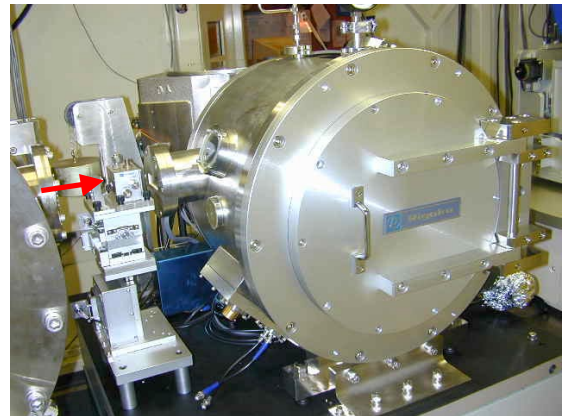


Fig.1 Sample chamber of the WD-TXRF equipment. Currently the equipment is covered with the clean booth to prevent the contamination from the environment.

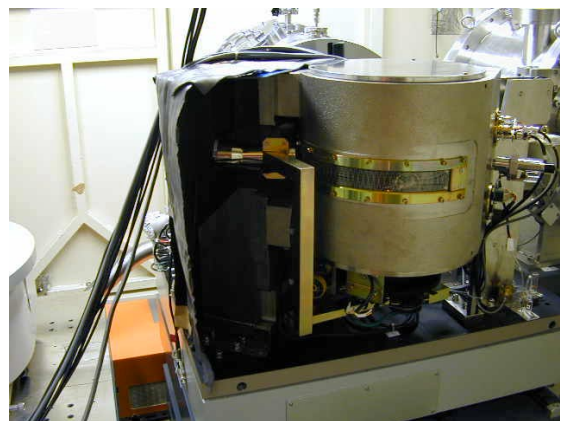


Fig.2 X-ray spectrometer from Rigaku Corp. A part of the spectrometer is covered by the lead sheet to suppress the background arise from a scattered x-ray.