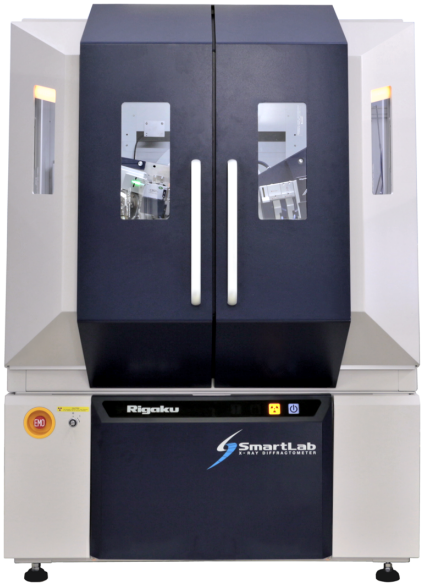
9 kW–60 kV type automated multipurpose X-ray diffractometer

SmartLab



1. Introduction

Copper is the most popular target material for an X-ray generator in general X-ray diffraction measurements, but sometimes other materials are chosen depending on the composition and shape of the sample and the measurement purpose. Rigaku's automated multipurpose X-ray diffractometer, SmartLab, can utilize X-ray source materials such as cobalt, chromium, molybdenum, silver, etc. in addition to copper, depending on the sample and the measurement purpose. The 9 kW–60 kV type SmartLab is an advanced model of the high-brightness X-ray diffractometer equipped with the PhotonMax rotating anode X-ray generator.

2. Features

In general, characteristic X-ray intensity can be obtained efficiently when a voltage about 3 times the excitation voltage of the target material is applied. Since the excitation voltage of the Mo K line is 20 kV and that of the Ag K line is 25.5 kV, it is possible to obtain characteristic X-rays more efficiently with the 9 kW–60 kV type SmartLab, in which a maximum voltage of 60 kV can be applied, than with a conventional SmartLab (maximum voltage 45 kV). With this device, it is possible to apply 60 kV–150 mA for a molybdenum target and 60 kV–100 mA for a silver target. It is possible to obtain a characteristic X-ray intensity of 1.5 to 2 times that of the conventional molybdenum and silver rotating anode X-ray generators, 3 to 5 times greater for sealed tubes.

Molybdenum and silver have shorter wavelengths of characteristic X-rays than copper and are known as high-energy X-ray sources. They are used for transmission measurement of thick samples and inorganic materials due to their strong penetrating powers. For both molybdenum and silver, high-intensity and high-resolution transmission measurement is possible using the ellipsoidal multilayer mirror (CBO-E)[1] as the incident optical element and the semiconductor detector D/teX Ultra250-HE. For measurement examples, please refer to the technical note in Rigaku Journal (English version), Vol. 36, No. 1, the article on evaluation of crystal structure and stage structure of positive and negative electrode materials during charge and discharge of laminated cell battery [2].

Measurement with SAXS or U-SAXS optical system using molybdenum wavelength can be performed by combining a parabolic multilayer mirror (CBO) with selection slit or double crystal monochromator and U-SAXS analyzer crystal. It is possible to analyze samples of thickness or material that copper characteristic X-ray cannot penetrate, or the particle/pore size of a sample using a solvent, or long-period structure.

The short wavelength means that a wide Q range ($Q=4\pi\sin\theta/\lambda$) can be obtained within the same measurement angle range. Using molybdenum and silver X-ray sources, sufficient measurement data can be obtained for pair distribution function (PDF) and radial distribution function (RDF) analyses, well-known evaluation methods for amorphous substances. The 9 kW–60 kV type SmartLab can perform transmission measurements up to $2\theta=155°$ using molybdenum and silver X-ray sources. Using the capillary rotation

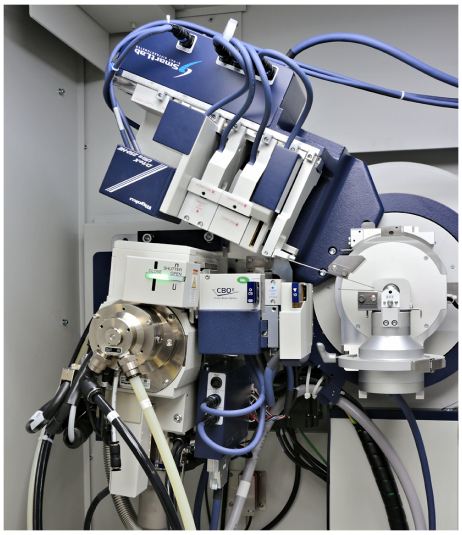


Fig. 1. Transmission mode configuration using a capillary attachment ($2\theta = 155°$).

attachment and the scattering protector together, low background measurement can be performed in a wider Q range. Please refer to the technical note in Rigaku Journal, Vol. 36, No. 1, the article on PDF analysis performed using measurement data obtained with the 9 kW–60 kV type SmartLab[3].

3. Summary

The 9 kW–60 kV type SmartLab can apply high voltage to the rotating anode X-ray generator so that high-intensity characteristic X-rays of short wavelengths can be obtained from molybdenum or silver targets. By combining various mirrors and a high-energy detector, it is possible to perform high-intensity and high-speed measurements by the reflection and transmission methods for samples whose shape and material composition are difficult with a conventional copper X-ray source.

References

(1) T. Osakabe: *Rigaku Journal (English version)*, **33** (2017), No. 1, 15–19.
(2) Y Shiramata and T. Konya: *Rigaku Journal (English version)*, **36** (2020), No. 1, 1–9.
(3) M. Yoshimoto and Y. Shiramata: *Rigaku Journal (English version)*, **36** (2020), No. 1, 10–18.