Development of Auto Focusing System of Soft X-Ray Microscope at BL-12

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Abstract

Soft X-ray microscopy beam line at BL-12 was newly rebuilt. Both CZP and OZP positions were accurately regulated by high performance stepping motors, which is the first step of automatically controlled station. Cryogenic sample chamber was also designed.

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1. Introduction

Soft X-ray microscope at BL-12 has been opened to researchers of universities, government research centers and companies since 1996 when it began to operate [1].

Fig. 1 shows optical configuration of this X-ray microscope. The achieved resolution upto now is 45 nm, judged from the edge analysis [2, 3]. We observed various samples: diatom [3], latex sphere [3], humic acid, blood cells of ascidians [4], malignant melanoma [5, 6], macrophage, human chromosome [7], CH_3-SiO_2 organo-silica micro-particle [8, 9], dictyostelium discoideum, metallic multiplayer and so on.

In order to improve this X-ray microscope to a full automatic observation system, a new project started at 2002. Last year, as the first step in this project, an automatic accurate positioning system has been introduced. Now, it is used for daily observation and shows good performance. As the next step, we designed a new OZP chamber with an automatic positioning system of OZP [10]. In addition, a sample stage was also designed more suitable for an observation of biological samples. In this report, details of the improved system are described.

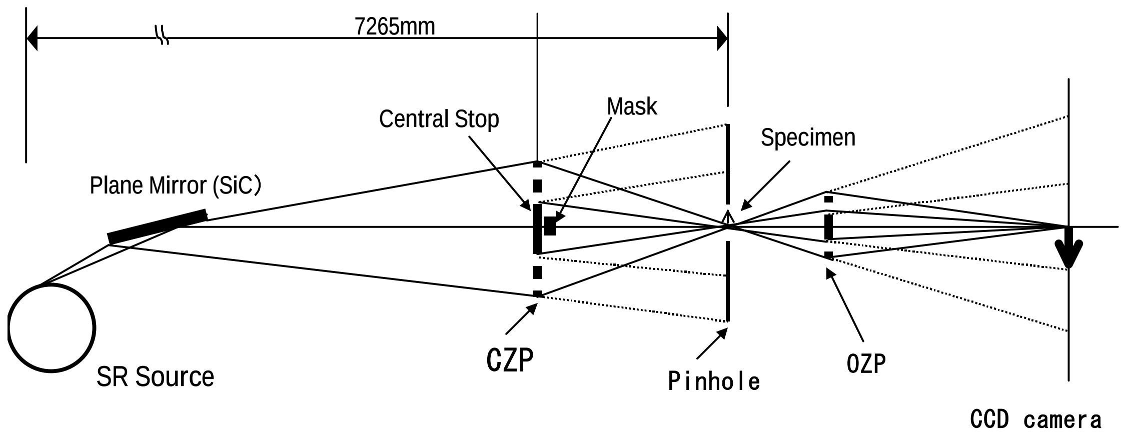

Fig. 1. Optical configuration of the X-ray microscope at BL-12.

2. Improvement

2-1. Auto-focusing system

Fig. 2 shows a new OZP system. In case of a previous OZP chamber, OZP has been brought into focus position. In order to automate the accurate positioning of OZP, a stepping motor is adopted. As the motor axis and the screw axis are connected straightly, no-backrush control system is realized. The motor resolution is 0.002 or 0.001mm. Manufacture of this system is scheduled for 2005.

In order to construct a full auto-focusing system to BL-12, a new control system which combines the new CZP chamber with the new OZP chamber is required. As the next development step, we have to design this system.

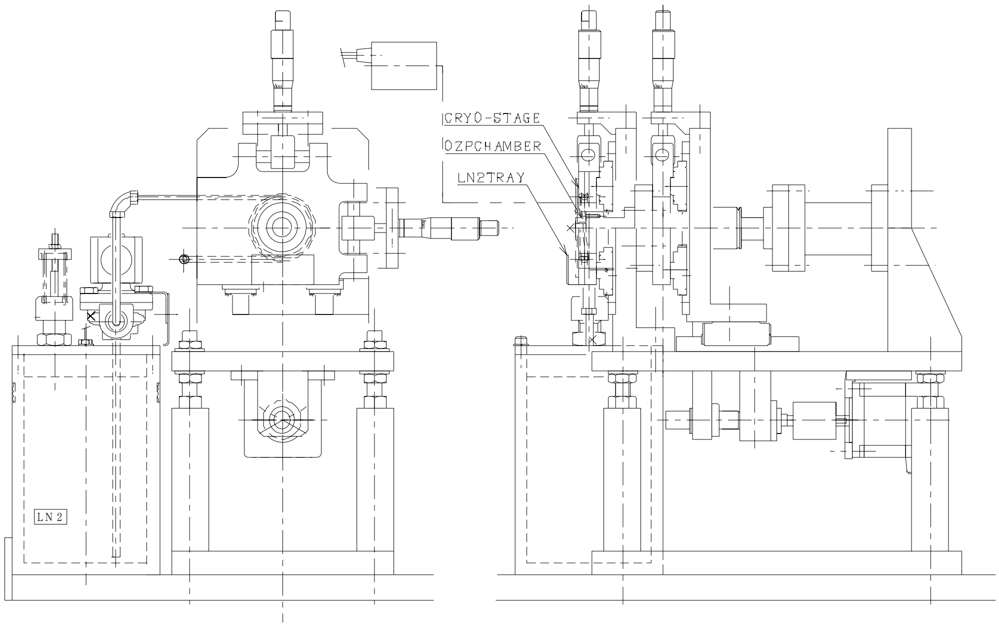

Fig. ２. New OZP chamber.

2-2. Cryogenic sample chamber

Fig. 3 shows a scheme of the cryogenic sample chamber. Liquid nitrogen (LN2) is used as a coolant. This cryogenic chamber consists of a LN2 dewar with LN2 pumping system and a sample stage. The function of the pump system is to circulate LN2 throughout the object stage and samples are indirectly cooled by the stage. The bottom of the tray is filled with LN2 and samples are directly cooled by LN2 gas. LN2 flux is controlled by a temperature sensor set on the object stage. When LN2 is required by it, a small overpressure is generated by a micro processor controlled heater element in the LN2. Therefore LN2 flows out of the system like water from a tap. Manufacture of this system is also scheduled for 2005.

Front view **Side view**

Cryogenic sample stage

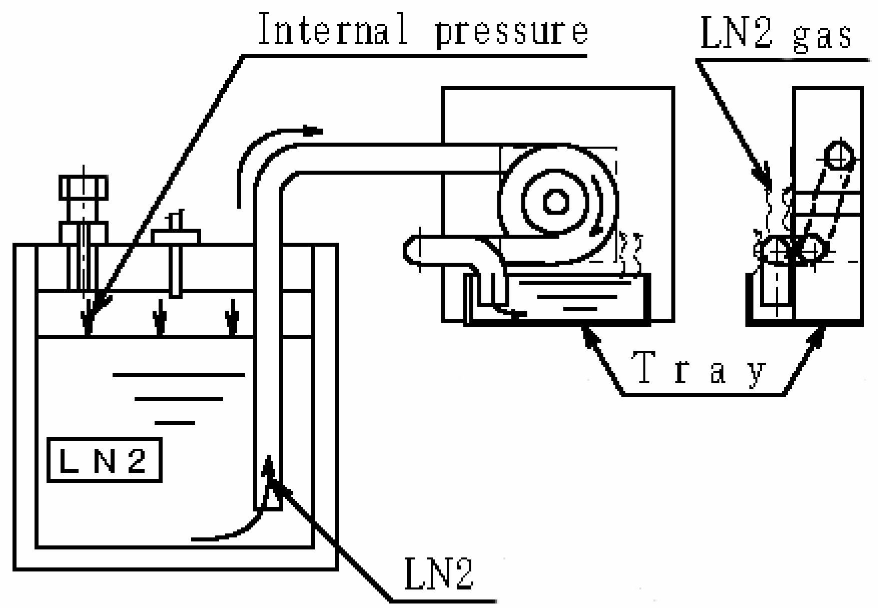

Fig. 3. Schematic diagram of the cryogenic sample chamber.

3. Summary

As the new project which constructs a full automatic observation system to BL-12, the new OZP chamber was designed. The new OZP chamber performs the automatic positioning system of OZP. In order to construct a full auto-focusing system to BL-12, a new control system which combines the new CZP chamber with the OZP chamber is required. As the next development step, we have to design this system. In addition, the cryogenic sample stage was also designed more suitable for an observation of biological samples.

5. Acknowledgement

We are grateful to Ritsumeikan SR center staff for their support. Dr. D. Rudolph *et al* at Göttingen group and Dr. D. Attwood *et al.* at Lawrence National Berkeley Laboratory are appreciated for the use of CZPs and OZPs, respectively.

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