BL12XU
Asia and Pacific Council for Science and Technology (APCST ID)

1. Introduction

As part of a five-year construction program of the Taiwanese x-ray facility at SPring-8 started in 1998, the construction of the APCST Inelastic X-ray Scattering (IXS) Beamline (BL12XU) has made good progress this year. The beamline is designed primarily for IXS experiments to explore frontier research in strongly correlated systems. A secondary purpose is for high Q-resolution scattering and x-ray physics and optics. The scientific program, the conceptual design of the beamline, and some initial considerations of the IXS spectrometer were reported in last year's Annual Report.[1] During this fiscal year, the detailed engineering design of the beamline was completed, and full-scale beamline construction activities were started. The conceptual design of the IXS spectrometer was also completed, along with some R&D efforts in developing spherical analyzers with matching energy resolutions and good efficiency for the spectrometer. All these activities will be reported in some details in the following sections.

2. Beamline Construction

The engineering design of the beamline has been the result of a close collaboration with SPring-8 staff, particularly Dr. Shunji Goto who gave a lot of advices, and Dr. Yoshihiro Asano who made sure that the beamline complied with SPring-8's radiation safety standards. The engineering design was submitted to STA for approval in November 2000, and the approval was expected to be due in April 2001.

The construction will be carried out in several phases. The Phase I construction includes mainly the main beamline. [1] By the end of year 2000, all major beamline components and construction work had been contracted out. Specifically, the white-beam transport pipe in the side hutch will be lead-shielded and the down-stream shutter for the diamond monochromator will be installed to allow access to the side hutch during the operation of the main beamline. The Double crystal monochromatar (DCM) uses a modified SPring-8 standard design from Kohzu Seiki. Both crystals are cryogenically cooled with a close-cycled LN_2 cooling system made by Suzuki Shokan. The high-resolution monochromator uses the so-called Ishikawa system, [2] which consists of several high-precision coaxial goniometers on an optics table. This provides the basis and the flexibility for all conceivable mountings of channel-cut crystals in 2- or 4-bouce configurations. The rest of the beamline components, including the collimating and focussing mirror chambers will be manufactured and installed by Toyama. The collimating and focusing mirrors, to be ordered from Seso, are made from Si crystals. The collimating mirror takes a tangential cylindrical shape with a radius of 41.47 km. The reflecting surface has two stripes, one with bare Si and the other coated with Pt, for effective higher harmonic rejection. The focusing mirror has a toroidal shape, with the radius being 6.4 km along the meridional and 35.6 mm along the sagittal direction. Beamline interlock and control system will be provided and installed by Hitachi Zosen. Shimatzu will supply all pumping units for the entire beamline.

The standard SPring-8 in-vacuum undulator was installed into the storage ring in January 2000. The front end was installed in August 2000 during the summer shutdown. Installation of the beamline optics and components will begin from April 2001, and will be completed by October 2001. The First light through the beamline is expected in November 2001.

3. IXS Spectrometer

The conceptual design of the IXS end station was initiated around April, and was largely completed by December. In concept, the IXS spectrometer is a kind of triple-axis spectrometer with both a horizontal and a vertical arm of 3m long. Spherically bend crystal analysers are used to analyse the inelastically scattered photons. To accommodate different resolution requirements of the experiment, the radius of the analysers can be chosen from 1, 2 or 3 m. The motion mechanism will be designed to maintain both the sample and a detector on the Rowland circle of the analyser, and to allow the arm cover almost 180 degree of the scattering angle. The horizontal arm length will be extended to 12 m in the future together with a backscattering monochromator at the end of the beamline for 1-meV resolution experiments.

The construction of the IXS spectrometer will be carried out in several phases as dictated by the scientific program of the IXS beamline, and the complexity of the spectrometer. Phase I of the spectrometer, to be constructed next year, will be capable of performing resonant and non-resonant inelastic x-ray scattering experiments with 10 - 100 meV resolution. The scientific focus will be on the electronic excitations in a variety of materials of current interest.

The present design of the Phase I spectrometer is shown in Figure 1. It consists of a heavy-duty sample goniometer tower with a flexible sample environment and the capacity of supporting the weight of a cryo magnet. A detachable cryostat carrier provides the support for a cryostat with up to 1.5W cooling power at 4.2K. The 3-m horizontal arm provides support for the sample slit, the analyser stage, detector stage and flight tubes. The analyser stage can be translated continuously along the arm to accommodate the three radii of the analyser. In addition, the low profile of the 3-m arm allows the mounting of multiple analysers in the vertical plane in future to increase the

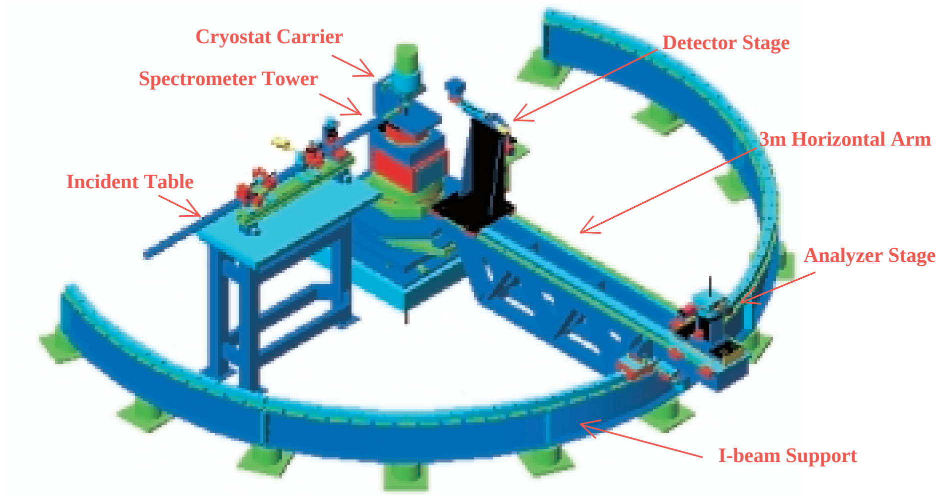

Fig. 1 Overview of the Phase I inelastic x-ray spectrometer, designed in collaboration with the Advanced Design Consulting, Inc., NY, USA.

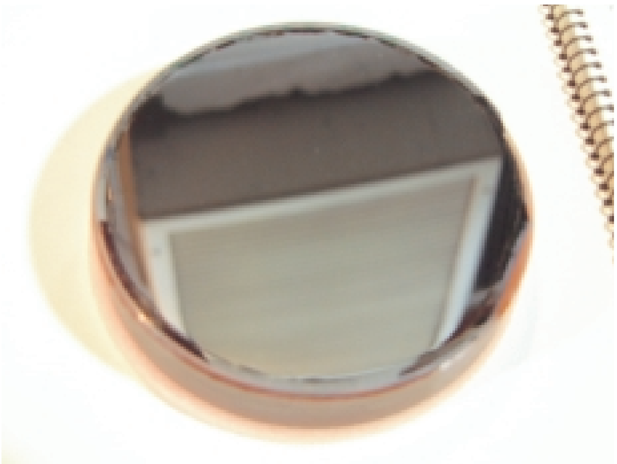

Fig. 2 Spherically bent Si(hhh) analyzer with 2m bending radius on a glass blank. The 4-inch, 0.5-mm thick wafer was diced with the RIE technique with a groove size of about 20 μm, and a block size of about 480 μm. The diced depth was about 450 μm.

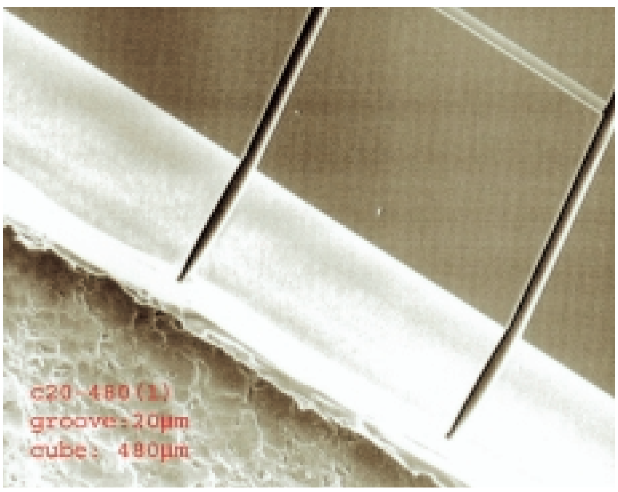

Fig. 3 A SEM image on a Si(111) test wafer diced with the RIE technique using parameters similar to those used for the wafer shown in Figure 2.

acceptance. The detector stage allows the detector to be positioned anywhere within a hemisphere of a 300-mm radius from the sample, and scanned to follow the trajectory of the Rowland circle of the analyser for resonant inelastic scattering experiments. The incident table conditions and monitors the incident beam for the experiment.

As an indispensable part of the spectrometer, we have been investigating ways to build crystal analysers with energy resolutions in the range of 10 - 100 meV. In order to release the strain induced by the spherical bending which broadens the energy bandwidth, the crystal can be diced into many small blocks either using a diamond saw or by the technique of reactive ion etching (RIE). One such analyser with RIE-diced Si(111) wafer has been fabricated and is shown in Figure 2. Compared to dicing with a diamond saw, the RIE dicing is a non-strain process. It is possible to produce much smaller feature sizes, and therefore maximize the reflecting area for the x-rays. Preliminary tests on the analyser with an incident beam of 240 meV width at 7.9 keV showed that the energy resolution was about 105 meV with 8.9% efficiency.

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Reference

[1] Y.Q. Cai, T. E. Dann, C. C. Chen, K. L. Tsang, P. Chow, C. C. Kao, C.T. Chen : SPring-8 Annual Report 1999.
[2] T.Ishikawa, et al. : Rev. Sci. Instrumen. **63** (1992) 1015.