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Commissioning of a Collimated Plane-Grating Monochromator with Ultra-High Resolution and Evaluation by Resonant Auger Spectra

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Modern soft x-ray spectroscopies such as resonant inelastic x-ray scattering require stable x-rays with high energy resolution. To realize such a grating monochromator, the state-of-the-art optics have to be installed without any distortion on precise scanning stages in ultra-high vacuum. Their attitude must be precisely aligned by the beam. Instability of photon energy due to vibration and thermal drift can result in reduced energy resolution, so the optical elements must be cooled quietly and efficiently. We have upgraded a soft x-ray monochromator with moderate resolution at SPring-8 into a collimated plane grating monochromator with ultra-high energy resolution of over 30,000 based on the fundamental technologies, including vibration measurement, optical metrology, and beam evaluation.

As shown in Figure 1, a plane grating monochromator with variable line spacing [1] was reconstructed as a plane grating monochromator operating with parallel beams [2]. The advantage of this monochromator is that it always satisfies the focusing condition. Thus, photon energy can be scanned by simply rotating the grating without any reduction in resolution. The optical elements were replaced with state-of-the-art optical components. To reduce the effects of vibration, environmental vibration was minimized and the coolant flow path was optimized using low-vibration flexible tubes.

Collimation and focusing of M0 and M3 respectively are necessary to maintain resolution over a wide energy range. The collimation and focusing conditions of these two mirrors were confirmed by Foucault tests using total ion yield spectra. Misalignment of the mirrors was corrected using the results of ray tracing. The energy resolution was estimated from resonant Auger electron spectra of noble gases. Since the energy width of the excited photon is smaller than the natural width of the core-excited state, the Auger line is not affected by the lifetime width. Therefore, the energy resolution can be estimated with high accuracy in a relatively short time. The energy resolution was estimated to be 39,000 at 867 eV from the Ne resonant Auger spectrum, which is almost the same as the design value.

Details of the upgrade, how the monochromator was adjusted, and the evaluation of the energy resolution will be presented.

[1] Y. Senba et.al, Nucl. Instr. And Meth. A 649, 58 (2011).

[2] R. Follath and F. Senf, Nucl. Instr. Methods A 390, 388 (1997).

Figure 1. Optical layout of a collimated plane-grating monochromator.

I plan to submit also conference proceedings

Yes

Primary author: SENBA, Yasunori (Japan Synchrotron Radiation Research Institute, RIKEN SPring-8 Center)

Co-authors: Mr SHIMIZU, Satsuki (Japan Synchrotron Radiation Research Institute); Mr KISHIMOTO, Hikaru (Japan Synchrotron Radiation Research Institute); Mr TSUBOTA, Koji (Japan Synchrotron Radiation Research In-

stitute); Dr OHASHI, Haruhiko (Japan Synchrotron Radiation Research Institute, RIKEN SPring-8 Center)

Presenter: SENBA, Yasunori (Japan Synchrotron Radiation Research Institute, RIKEN SPring-8 Center)

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