CO11-1 Progress of Terahertz-wave Spectrophotometry by Compton Backscattering of Coherent Synchrotron Radiations at KURRI-LINAC

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INTRODUCTION: Terahertz-wave spectrophotometry by Compton backscattering (THz-SCB) has been developed with an L-band electron linear accelerator at the Kyoto University Research Reactor Institute (KURRI-LINAC) [1, 2]. We have already demonstrated the THz-SCB with using coherent transition radiation (CTR) as a THz wave source [1]. However, optical transition radiation generated with the CTR at wavelengths of the Compton backscattered photons (CBPs) in the THz-SCB. Because the intensity of the optical transition radiation was much stronger than that of the CBP, an error caused in a spectrum measurement of the CBPs was considerable. Then, we started to develop THz-SCB experiments with using coherent synchrotron radiation (CSR) as the THz-wave source. Because a critical wavelength of synchrotron radiation for the low-energy electron beam at the KURRI-LINAC is in a far-infrared region, visible photons which become backgrounds in the THz-SCB experiments are not generated from the synchrotron radiation.

EXPERIMENTS: To generate CSR for THz-SCB experiments, two permanent bending magnets with a length of 50 mm was installed in a vacuum chamber dislocated from the accelerator by titanium windows. The bending magnet had a gap of 40 mm, and its magnetic field was 0.155 T. A distance between the two bending magnets was 216 mm. The CSR beam emitted from the bending magnets was reflected by two flat mirrors and was converted into the parallel beam with a concave lens of focus distance 1.5 m. It was necessary to return the CSR beam to the electron beam so that the CSR beam performed Compton backscattering. Then, a hole-coupled flat mirror was inserted in the parallel beam to separate a CBP beam from the CSR beam. The hole-coupled flat mirror was deposited aluminum onto a quartz window except a center circle with a diameter of 20 mm.

We observed the CBP with using the CSR at a charge of 0.32nC per micropulse. To shift a peak of a CBP spectrum to the visible region, the electron beam energy was set to be 18.9 MeV. The relativistic energy spread of the electron beam was measured 10.8% in full width at half maximum. To isolate the effect of the CBPs, a millimeter-wave absorber with the same cross section as the hole-coupled flat mirror was installed in front of the mirror. The intensity of the CBPs could be calculated as the difference with and without the millimeter-wave absorber. The measured CBP spectrum had maxima at wavelengths of around 400 and 500 nm, and it was in agreement with the calculated one. A ratio of the CBPs to the background photons was approximately 1/4 with using the CSR, and it was improved than that with using the CTR in the previous experiment, which was 1/13.

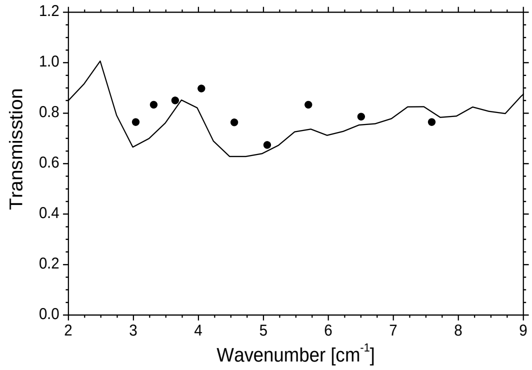

Fig.1. Transmission spectra measured by the THz-SCB (circle) and interferometer (line).

Because the CBP spectrum could be measured in spite of high background level, we performed the THz-SCB experiment with using CSR. A hole-coupled polystyrene film with a thickness of 0.3 mm was inserted instead of the millimeter-wave absorber. The effective thickness of the polystyrene film was 0.6 mm because the CSR beam passed through the polystyrene film twice. The transmission spectrum measured by the THz-SCB was roughly in agreement with that measured by the Martin-Puplett-type interferometer in the whole of the observing wavelength region as shown in Fig. 1.

CONCLUSIONS: We achieved the observation of the CBP spectrum with using the CSR in KURRI-LINAC. It was similar to the spectrum calculated using the CSR spectrum. The transmission spectrum of the polystyrene film was measured by THz-SCB, and it roughly agreed with that measured by the interferometer. Using the CSR as a THz-wave source, we could reduce the background photons in the visible region where the CBPs were emitted. However, the CSR reflected in the vacuum chamber generated intense background photons between the bending magnets by Compton backscattering. We will study a technique to eliminate the background photons by controlling the reflected CSR.

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