CO11-1 Demonstration of Terahertz-Wave Spectrophotometry by Compton Backscattering of Coherent Transition Radiation Using KURRI-LINAC

N. Sei and T. Takahashi[1],

Research Institute of Instrumentation Frontier, National Institute of Advanced Industrial Science and Technology
[1]Research Reactor Institute, Kyoto University

INTRODUCTION: Terahertz-wave spectroscopy is useful for material identification and imaging tool. Powerful terahertz-wave sources based on electron accelerators have been developed before 1990. However, terahertz-wave sources based on short-pulse lasers and parametric oscillators have been developed recently, and it has been possible to develop terahertz-wave spectroscopy by using compact devices based on short-pulse laser and parametric oscillator technology. To exploit the feature that a terahertz-wave source based on an electron accelerator is high power, the terahertz-wave spectrophotometry by Compton backscattering (THz-SCB) was proposed [1]. We performed to observe the continuous-spectrum light beam resulting from Compton backscattering using an L-band electron linear accelerator at the Kyoto University Research Reactor Institute (KURRI-LINAC).

EXPERIMENTS: The KURRI-LINAC uses coherent transition radiation (CTR) as the light source to produce the beamline for millimeter-wave and terahertz-wave spectroscopy [2]. CTR is generated at a titanium window and an aluminum foil, and it is transported in vacuum to the experimental room by a parallel beam of 150 mm diameter. CTR is penetrated through a Mylar window, which is at a distance of approximately 9 m from the aluminum foil, and then it is injected into a Martin-Puplett-type interferometer. To perform Compton backscattering at the KURRI-LINAC, it is necessary to retune the CTR beam to the electron beam. A hole-coupled flat mirror was inserted in the parallel beam to separate the light beam caused by Compton backscattering from the CTR beam. The diameter of the hole-coupled flat mirror was 130 mm, and the diameter of the hole was 30 mm. The distance between the hole-coupled flat mirror and the aluminum foil was 2.2 m. Macropulse time of 100 ns was selected for the THz-SCB experiments. Optical transition radiations (OTR) generated by the aluminum foil also reached the light sensor module with the same transportation system. The intensity of the OTR was much stronger than the intensity of the Compton backscattered photons. To isolate the effect of the Compton backscattered photons, a millimeter-wave absorber with the same cross section as the hole-coupled flat mirror was inserted in front of the hole-coupled flat mirror as shown in Fig. 1.

We inserted a hole-coupled Mylar film with a thickness of 0.3 mm instead of the millimeter-wave absorber, and then we performed the THz-SCB experiment. The effective thickness of the Mylar film was 0.6 mm because the CTR pulse passed through the Mylar film twice. Figure 2 shows the transmissions of the Mylar film measured using THz-SCB (solid circle) and the Martin-Puplett-type interferometer (solid line). It can be noted that the transmissions measured using the two methods were in good agreement. This experimental result validates the practical applicability and effectiveness of the THz-SCB spectroscopy measurements in the terahertz and millimeter-wave regions.

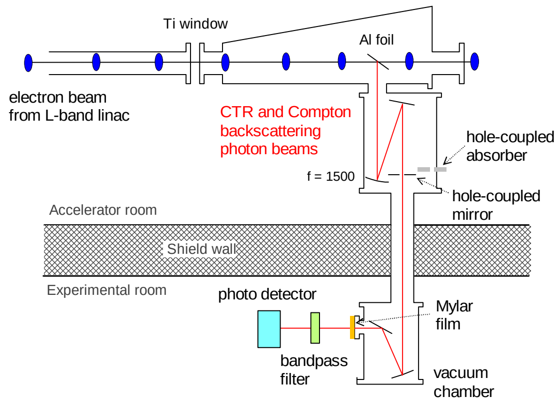

Fig. 1. Layout of the THz-wave spectroscopy experiments.

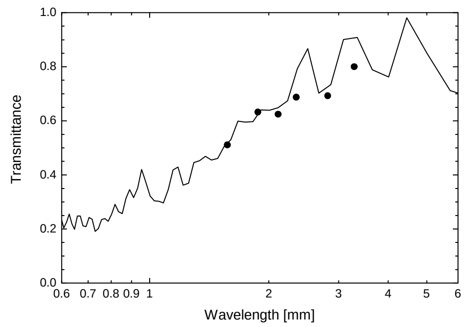

Fig. 2. Transmittance of the Mylar film.

CONCLUSIONS: We have measured the spectrum of the Compton backscattered photons using the KURRI-LINAC. The measured spectrum was similar to the spectrum calculated using the CTR spectrum. The transmission spectrum of the Mylar film was measured by THz-SCB, and it was in good agreement with that measured by the Martin-Puplett-type interferometer.

ACKNOWLEDGMENT: This study was financially supported by the Sumitomo foundation.

REFERENCES:

[1] N. Sei *et al.*, Appl. Phys. Exp., **1** (2008) 087003/1-3.
[2] T. Takahashi and K. Takami, Infrared Phys. Technol., **51** (2008) 363-366.