VIII-Y Study on Compact X-Ray Sources

Electron storage rings are useful devices as x-ray sources. However, these synchrotron radiation facilities usually occupy large area and cost much. So that there have been many works to investigate compact x-ray sources using small electron accelerators. It is also useful to use laser undulator radiation or backward Compton scattering caused by the interactions of electron beams with laser photons, if we provide enough electrons to produce practical intensity of x-rays. RF-photocathode would produce high peak intensity electron beam so that it is a useful candidate of a electron source. It is necessary to search good materials as the photocathode for construction of a practical compact x-ray source. Cesium telluride has reported to have a good quantum efficiency, so that we have studied about it.

In order to generate high brilliant x-rays using small electron accelerators, we propose metal multi-foils as the target irradiated by the electron beam. We have studied x-ray intensity generated from the multi-foil target using Monte Carlo simulation code.

VIII-Y-1 Feasibility Study of X-Ray Generation by Using Metal Multi-Foil Target Irradiated by High Energy Electron Beam

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We performed feasibility study of x-ray source using metal multi-foil target irradiated by high energy electrons. Figure1 shows the sketch of the setup. High energy electron beams extracted from small accelerators are incident on metal multi-foil targets with small angles. X-rays generated in the foils by bremsstrahlung are reflected on the surface of the next foils if the incident angle is small enough to satisfy the total reflection condition.

We calculate the spectrum and angular spread of the x-rays radiated from the multi-foil targets by using EGS4[1)] simulation code. Figure 2 shows the geometry used in the EGS4 calculation. We use stacks of copper foils as the target. The thickness, width and length of a foil are 0.1 μm, 100 mm and 500 mm, respectively. We stack 100 foils as the target for EGS4 calculation. Incident electron energy was 150 MeV and the incident angle of the electron on the surface of the target was 1 mrad.

Figure 3 shows the angular spread of 5keV x-rays using multi-foil and bulk targets. The total thickness of the multi-foil is 10 μm which is the same thickness of the bulk target. The yield of the x-rays from multi-foil target is larger than that from the bulk target because of the reflection of x-rays between the foils.

The energy spectra of x-rays from the multi-foil and bulk targets are shown in Figure 4. X-ray intensity radiated from multi-foil is larger than bulk target in the low energy region, because low energy x-rays have large total reflection angles so that it is not absorbed in the target material but extracted by reflection between foils.

We calculated the spectrum and angular distribution of x-rays generated from metal multi-foils irradiated by high energy electrons using EGS4 simulation code. For further study, we should include the effect of transition radiation in the calculation in order to estimate x-ray intensity more precisely.

Reference
1) W. R. Nelson, H. Hirayama and D. W. O. Rogers, SLAC-Report-256, (1985).

Figure 1. Sketch of experimental setup using multi-foil target.

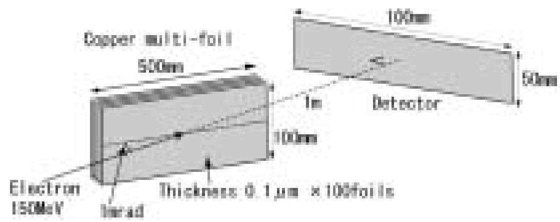

Figure 2. Geometry used in EGS4 simulation.

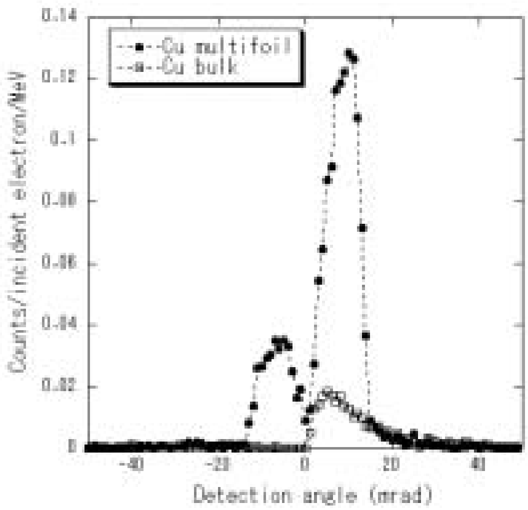

Figure 3. Angular distribution of x-rays generated from multi-foil and bulk targets.

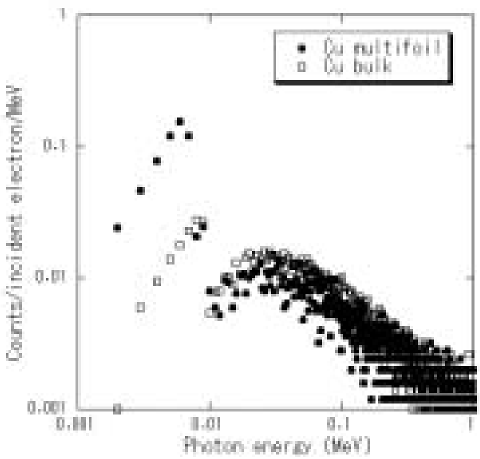

Figure 4. Energy spectrum of x-rays generated from multi-foil and bulk targets.