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Particle induced x-ray emission (PIXE) is a novel method of trace element analysis, and it is widely applied at CYRIC, to studies of medicine, biology, petrology, geology and environmental science. In PIXE, the detection limit is mainly determined by a background of continuous x-rays produced by the sample itself and also the backing foil. Therefore, the quantity of sample should be minimum and the backing foil is desired to be as thin as possible. Recently, Iwata and his coworkers developed an excellent technique to make very thin foils of polyvinyl formal (PVF)[1].

Figure 1 shows a PIXE spectrum of the polyvinyl formal film (~10 $\mu g/cm^2$) for the bombardment of 3 MeV protons. X-rays were measured by a Si (Li) detector through a 100 μm mylar foil which protects the detector from the Rutherford scattered protons, but absorbs low energy x-rays from light elements. Total integrated beam current was 200 μC. Elements of Fe, and Cu are seen in this spectrum. These trace elements were mixed with the PVF film during a manufacturing process. The continuous background of the x-ray energy region of $\hbar\omega \leq 8$ keV can be explained in terms of the secondary electron bremsstsrahlung[2]. A constant background spreads over the region of high energy x-ray. This constant background was also observed in the case without targets. We interpret this background as follows. When γ-rays enter the detector , they recoil electrons by the Compton scattering and signals of recoiled electrons form the constant background[2] on the x-ray spectrum. The γ-rays may be produced from nuclear reactions, cosmic rays and natural radioisotopes. We consider a graphite collimator as the source of γ-rays ,which was placed just in front of the target to define a beam spot size. PIXE requires the beam collimator, which dose not produce characteristic x-rays of $\hbar\omega \geq 1$ keV and nuclear reaction γ-rays, too. In PIXE, graphite is popularly used as material of beam collimators or slits, since the energies of the first excited state for ^{12}C and ^{13}C are 4.4391 MeV and 3.0884 MeV, respectively. Proton capture process, however, remains as the γ-ray source. For the reduction of these γ-rays, shielding the collimator with lead blocks or ati-coincidence measurement with γ-rays[3] are useful.

Figure 2 shows the x-ray spectrum of the PVF film without the beam collimator. As seen in this figure, the constant background disappears from the PIXE spectrum. The detection limit is improved by one order of magnitude or more. However, in the experiment without beam collimator, we must take care that a beam hallow hits a target flame and produces its characteristic x-rays. For this problem, it is suggested to use target flames made with mylar.

In the case of insulating material, the electron bremsstrahlung is produced bu a charge-up effect of the beam spot[2]. This bremsstrahlung forms a huge background over the x-ray energy range of 0 ~ 40 keV and its intensity decreases slowly by a function of $1/\hbar\omega$. This makes the detection limit of PIXE extremely worse. The present results shows that the PVF film is an excellent backing foil which dose not produce such continuous background.

References

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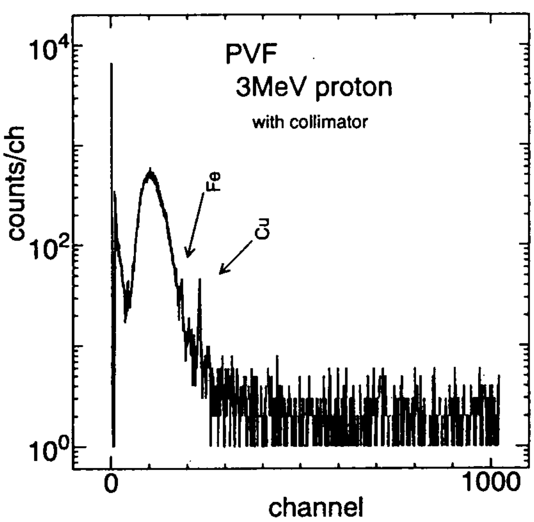

Fig. 1. X-ray spectrum of a polyvinyl formal backing foil for the bombardment of 3 MeV protons through a graphite beam collimator.

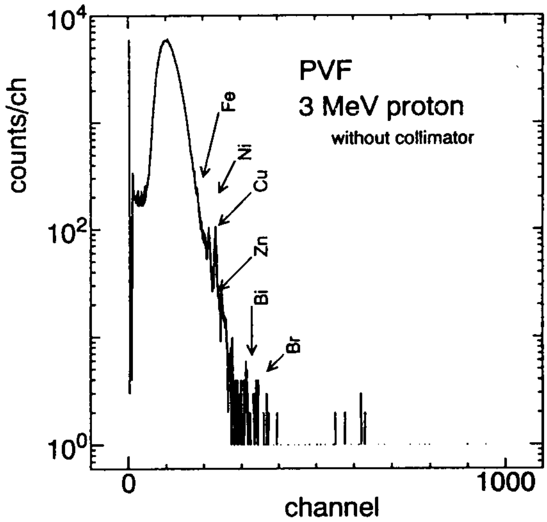

Fig. 2. Same as Fig. 1 except for without a graphite beam collimator.