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Neutron Scattering Effect from Bulk Carbon Matrix Samples

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1. Introduction

In prompt gamma activation analysis using a neutron capture, analytical sensitivity is affected by a geometric effect, a gamma-ray self-attenuation and a neutron self-shielding effect within a sample and so on [1]. Especially for elements with large scattering cross sections like hydrogen and carbon, thermal and fast neutrons incident on the sample are partially scattered in the direction of a detector and interact with a detector material. In this study, the neutron scattering effect in bulk carbon matrix samples is investigated by analyzing their characteristic spectra.

2. Experimental

Measurements were carried out at a PGAA facility of HANARO research reactor at KAERI. Samples were prepared by shaping Aldrich reagent (#49659-6) of a graphite powder of 99.999% purity into a disk-type with 13 mm in diameter. The samples were wrapped in a Teflon sheet and mounted on a mount made of pure aluminum. Masses of the samples were 215.4, 336.8, 761.8 and 1953.4 mg, respectively.

3. Result and discussion

Fig. 1 shows that the analytical sensitivity of the 4945 keV carbon peak is slightly lowered according to the amount of carbon. The large scattering cross section of carbon is partially considered for the reason.

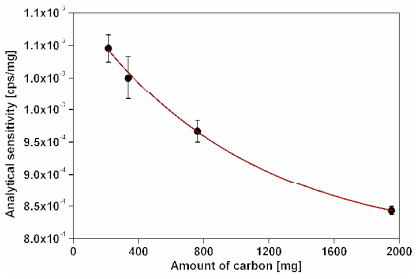

Figure 1. Analytical sensitivity according to amount of carbon.

As shown in Fig. 2, prompt gamma-ray spectrum shows a complex spectrum because there are additional peaks arising from radiative capture and inelastic scattering with germanium atoms which are a detector material. Intrinsic triangularly broadened peaks are due to the inelastic scattering of the fast neutrons. These additional germanium peaks were used for the quantification of the scattered neutrons from the carbon samples. Spectra

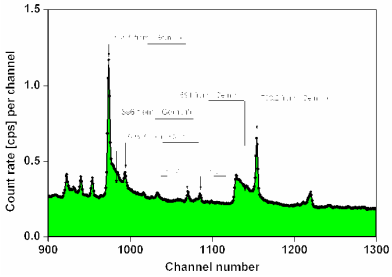

Figure 2. The partial spectrum of carbon sample.

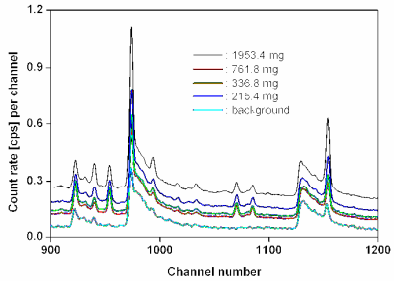

Figure 3. Spectra according to the amount of carbon.

are shown according to amount of carbon in Fig. 3. 708.2 keV thermal neutron capture peak grew as the carbon mass increased. When no sample is mounted, such peaks still exist at the energy region because some thermal neutrons are also scattered from the peripherals around the sample mount. The triangles are much less influenced by this. Their variations are shown in Fig. 4. Count rate under the 708.2 keV peak is increased by 3.9 cps/mg whereas that under the 691.1 keV peak was almost constant. Though the elastic scattering cross sections of carbon for thermal and fast neutrons are 4.94 b and 2.36 b, respectively, the lower portion of the fast neutrons (cadmium ratio for Au at sample position is above 250) caused the thermal neutron scattering from carbon samples to become dominant.

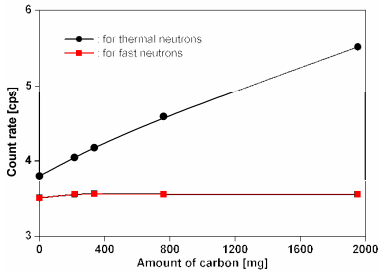

Figure 4. Variation of count rates of the germanium peaks.

REFERENCES

[1] J.R. Copley and C.A. Stone, Nucl. Instrum. Methods, A281 (1989) 593.