Production of thin and elemental sulfur targets

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Target properties play a crucial role for data quality obtained in nuclear spectroscopy measurements using a magnetic spectrometer. A self-supporting target made of a pure element is the best one for the experiments because any signals contaminated from other nuclei do not appear in spectra. It has been, however, hard to prepare a ^{32}S target. An elemental sulfur sheet is very fragile and sublimes rapidly in vacuum by an irradiation of a beam because its melting point is relatively low (112.8°C) as well as its thermal conductively is low. Hence sulfur targets usually had been compounds or used with a metal base. A cooling system to prepare a frozen H_2O sheet for $^{16}O(p,p')$ experiments has been developed at RCNP [1]. The target ladder of the system is cooled by liquid nitrogen (LN_2) at temperatures of lower than 90K. A sulfur target on the ladder with cooling is expected to bear its sublimation by irradiations even though it is an elemental sulfur.

The process to make a sulfur target is illustrated in Fig. 1. At first, sulfur powder in a mortar and a pair of Teflon sheets are heated on a hot-plate tuned at temperatures of up to 200−230°C. When the powder melts and its color seems orange, melted sulfur is poured onto the heated Teflon sheet. An appropriate thickness of feeler gages (thickness gages) is selected to determine a thickness of the sulfur target. The gages with a thickness of 30−300 μm were put on the Teflon to make 6−60 mg/cm^2 thick targets of sulfur. Then, the dropped sulfur fluid is quickly sandwiched by another Teflon and is uniformity pressed on top of it by brass blocks as a weight. When the temperature has fallen down to that one can touch, the Teflon sheets are carefully opened. The stuck sulfur is peeled off by bending the Teflon sheet or by using a thin cutter knife with a skilled treatment. Finally, the sulfur sheet is mounted on the target frame. It is a key point to put a thin aluminum foil between them.

A target thickness was 5.9 ± 0.1 mg/cm^2 when feeler gages of 30 μm were used to make it. Here, the thickness was determined by dividing the mass by the area. The sheet was divided into several pieces to study its uniformity, so that a standard deviation of the thicknesses was within 2%, then it was taken as the error. Since a 30.0 μm^t sulfur is 5.88 mg/cm^2 in theory, the target thickness we produced was consistent with the ideal value. We note, however, that a thickness is not always consistent with an ideal value. A proper thickness of a sheet should be calibrated via not only a size of feeler gages.

A sulfur target with a thickness of 30.6 ± 0.3 mg/cm^2 was used in high resolution proton inelastic scatterings measurements, and an energy resolution of 30 keV in FWHM was achieved via a 295 MeV proton beam. A typical spectrum at 0° is shown in Ref. [2]. The target on a cooled ladder [1] worked stably during the experiment without sublimation.

Details of the production of sheets and discussion on uniformity are described in Ref. [3].

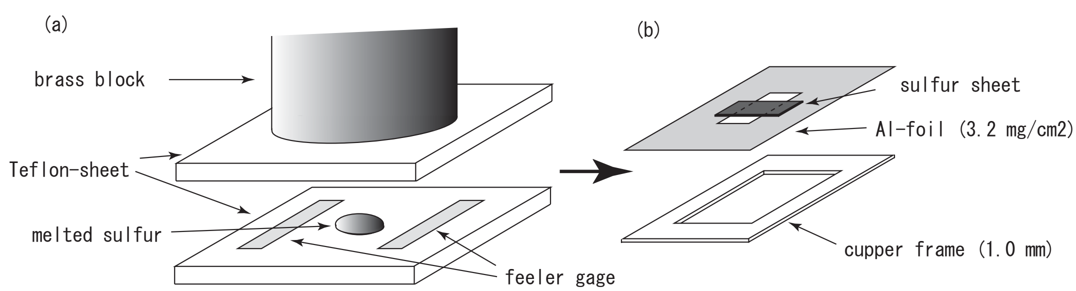

Figure 1: The process to make a sulfur sheet is shown. (a) Melted sulfur is sandwiched by the Teflon sheets, and pressed with a brass block. A thickness of feeler gages determines that of a sulfur target. (b) After peeled from the Teflon sheet, a sulfur sheet is mounted on the aluminum foil which is attached on the cupper frame.

References

[1] T. Kawabata *et al.*, Nucl. Instr. Meth. A 459 (2001) 171.

[2] H. Matsubara *et al.*, in this Annual Report.

[3] H. Matsubara *et al.*, Nucl. Instr Meth. A, to be submitted.