Implantation of Radioactive 119Sb

V. 23 Implantation of Radioactive ^{119}Sb

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Implantation of radioisotopes combined with internal-conversion spectroscopy is giving a unique method in solid-state physics and in chemistry in that the contact density of valence electron can be separated from the core contributions.[1,2] Such a project is in progress and up to now implantation of ^{119}Sb ($T_{1/2}$ = 38 h) has been conducted; the decay of this nucleus leads to the Mössbauer transition of 23.8 keV in ^{119}Sn.

A natural Sn metal target was irradiated for several hours by an α beam from the cyclotron at E_α = 45 MeV and I_α ~ 15 μA. The target was welded onto a copper plate in vacuum; the copper plate was cooled during bombardment. After cooling short-lived activities for 1 day the target surface corresponding to the thickness of α-particle penetration (~0.5 mm) was scraped off using a "target scraper" as shown in Fig. 1. From the sample of irradiated Sn (~ 1 g) ^{119m}Te ($T_{1/2}$ = 4.6 d) produced mainly by $^{118}Sn(\alpha, 3n)^{119m}Te$ was chemically separated as explaned in Fig. 2. After waiting 4 days for the daughter nuclide ^{119}Sb to grow from ^{119m}Te, ^{119}Sb was separated from the Te fraction (milking); see Fig. 2. From the Sb fraction, ^{119}Sb together with stable Sb carrier was electroplated onto a Pt foil of 20 μm thickness or a Pt wire of 25 μm diameter, and the latter was put into the oven of a Nielsen-type ion source of the electromagnetic isotope separator of this center. The ^{119}Sb was separated and implanted at 60 kV in the collector chamber of the separator onto a Sn foil. The total implantation efficiency of ^{119}Sb was measured using a pure-germanium low-energy photon spectrometer; the maximum efficiency was 0.5 % but it was not stable and changed from time to time. The efficiency was found to depend strongly on the mass-separated current for A = 119, the main part of which is probably due to ^{119}Sn from the target. A typical implantation process monitored by the $^{121}Sb^+$ current is shown in Fig. 3. The intensity of implanted ^{119}Sb was ~10 μCi.

The Mössbauer spectrum of the implanted sample was measured for the 23.8 keV gamma rays in ^{119}Sn at a liquid-nitrogen temperature. After a thermal annealing of the implanted sample for 40 sec at 150° C in an Ar atmosphere, a Mössbauer absorption dip was obtained against a standard absorber of $CaSnO_3$, indicating a substitutional site of the implanted ^{119}Sb in Sn metal. The study of Mössbauer measurement is still in progress in order to define a good condition of annealing.

In view of the possible mixing in implantation from stable ^{119}Sn of the target, we are also trying to produce ^{119}Sb by the $Sb(p, 3n)^{119m}Te$ reaction[3], in which the stable isotopes of Sb have A = 121 and 123 and such a possibility of mixing can be excluded.

References

1) Spijkervet W. J. J. and Pleiter F., Hyperfine Interactions 7 (1979) 285.
2) Spijkervet W. J. J., Pleiter F. and de Waard H., to be published (Calibration of the Isomer Shift of ^{83}Kr).
3) De Waard H., private communication (Sept., 1980).

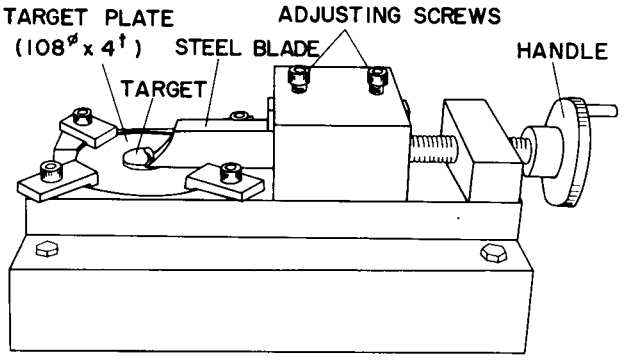

Fig. 1. Target Scraper. The top of the target is scraped off before irradiation, and a spacer of appropriate thickness is placed below the target plate to define the thickness of scraping after irradiation.

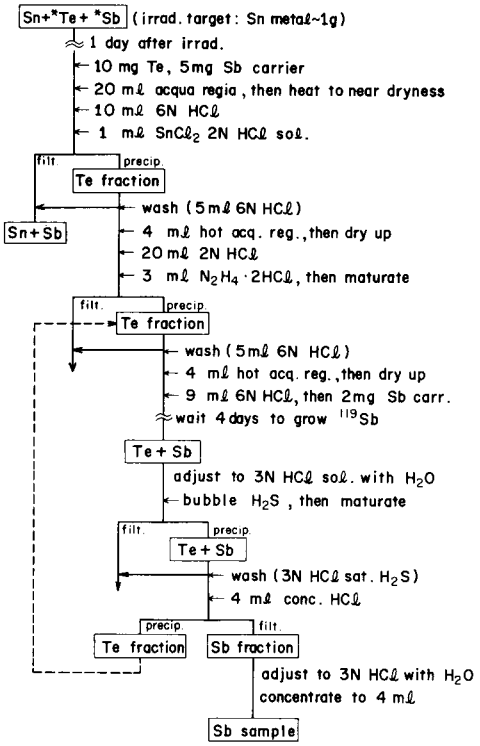

Fig. 2. Block diagram of chemical separation of ^{119m}Te from the Sn target and that of ^{119}Sb from the Te fraction.

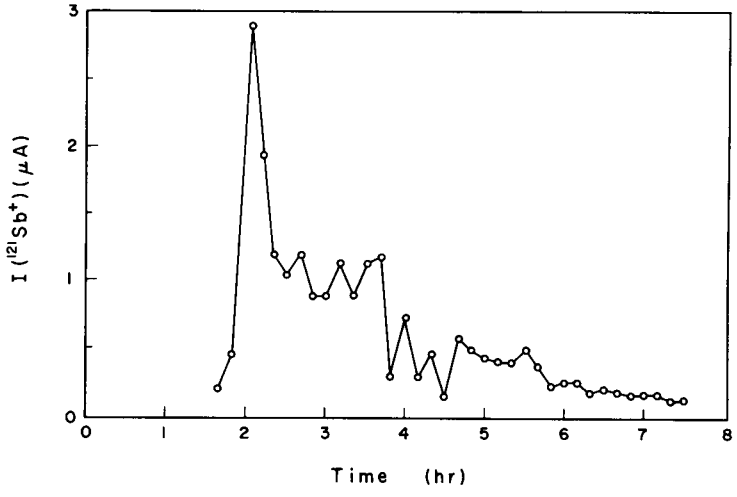

Fig. 3. Monitoring of the implantation with the current of stable $^{121}Sb^{+}$. In this example the total implantation efficiency of ^{121}Sb was 0.9 % whereas that of ^{119}Sb was 0.3 %.