SILICON IRRADIATION FACILITIES AT THE NBS REACTOR

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ABSTRACT

A program of silicon irradiation is being carried out at the National Bureau of Standards 10 MW, heavy water moderated reactor. The facility, which operates on a 40 day round-the-clock cycle, can provide a wide range of neutron fluxes with an equally wide range of cadmium ratios.

1. DESCRIPTION OF FACILITIES

A plan view of the NBS reactor core showing several of the irradiation locations is shown in Fig. 1. A set of five pneumatic rabbit tubes, useful for irradiating silicon chips to analyze for impurities or to study irradiation damage, provide a range of thermal fluxes from $2 \times 10^{11}$ n cm$^{-2}$ sec$^{-1}$ (copper-cadmium ratio of 3400) to $6 \times 10^{13}$ (copper-cadmium ratio of 46).\(^1\) Irradiation times of up to 24 hours and sample sizes up to 20 grams can be accommodated.

Those researchers interested in long term silicon doping irradiations can currently use two vertical facilities designed G2 and G4. Both facilities are D$_2$O filled and are completely isolated from the reactor coolant. Since they are isolated, encapsulation of the silicon is unnecessary and only an aluminum harness is needed to hold the sample. The G2 tube will accept samples up to 1.6 inches in diameter and has a neutron flux at the core midplane of $1.1 \times 10^{14}$ (copper-cadmium ratio of 55).\(^1\) A vertical flux profile of this facility is shown in Fig. 2. Irradiation of
samples in G2 for periods of one day to six weeks has been done for Oak Ridge National Laboratory (ORNL). The predicted phosphorus doping rate of $7.5 \times 10^{13}$ atoms cm$^{-3}$ hr$^{-1}$ yielded a concentration in excellent agreement with that measured by ORNL.

The G4 tube is located at the center of the reactor core and will accept samples up to 3 inches in diameter. Its neutron flux has roughly the same shape as that in G2 but is about 28% greater. A one kilogram silicon sample has been irradiated in G4 to a measured phosphorus concentration of $1.4 \times 10^{17}$ atoms cm$^{-3}$.

Several additional vertical tube facilities are available for development. In addition to 3.5 inch diameter incore positions with fluxes similar to G2, several 4 inch reflector positions are available with somewhat lower fluxes but higher cadmium ratios.

Fig. 1. Plan view of NBS reactor core and irradiation facilities.