AN AUTOMATED IRRADIATION FACILITY FOR NEUTRON DOPING OF LARGE SILICON INGOTS

J. L. Bourdon and G. Restelli
Joint Research Center
Ispra, Italy

ABSTRACT

The tendency of the NTD silicon producers to increase their capacities and the extending range of devices in which NTD silicon is being used, calls for special reactor irradiation facilities. This is increasingly important at low resistivity values where the neutron dose requires a high neutron flux to keep within acceptable values the irradiation time. In addition an automated charging-discharging device for the silicon ingots is desirable to optimize the dead handling times with respect to the irradiation time.

The JRC heavy water moderated ESSOR reactor presents large irradiation volumes in large diameter experimental channels with neutron flux characteristics especially suited to the above requirements. The described facility has been conceived for installation in one of these channels; its main characteristics are indicated below.

The irradiation volume consists of a cylinder 50 cm long, 87 mm in diameter; the future extension of the diameter to 112 mm is feasible; the thermal neutron flux is equal to $2.7 \times 10^{14}$ n cm$^{-2}$s$^{-1}$ with a thermal to fast (> 100 keV) neutron flux ratio equal to about 400. The irradiation position in the channel is optimized by displacement during the reactor operation cycle so that the axial spread of the neutron flux is maintained within $\pm$ 4% over the total length.

The silicon ingots are irradiated in bored plastic material capsules immersed in a D$_2$O flux to ensure efficient cooling; a slow
rotation of the ingots is induced by a suitable shaping of the capsule. The D$_2$O flux from the moderator carries the capsules from a valving arrangement (SAS) to the irradiation position and keeps them for the required irradiation time determined from a calibrated three collectrons system with associated electronics where the integrated neutron dose can be achieved with a precision of 3%.

At the end of the irradiation time, the capsule is discharged by gravity into the SAS where the remaining D$_2$O is evaporated. The capsules are introduced into the SAS and extracted by a suitable system (TAU) which is manually loaded and unloaded with the capsules also during the reactor operation; the TAU system holds up to 100 capsules, and advances them automatically to the correct position for injection into the reactor.

Preliminary experimental production of NTD-Si in ESSOR has shown the outstanding advantages of this reactor for such work.

1. INTRODUCTION

The tendency of the NTD silicon producers to increase their capacity and the extending range of devices in which NTD silicon is being used, call for special reactor irradiation facilities. This is increasingly important at low resistivity values where the neutron dose requires a high neutron flux to keep within acceptable values the irradiation time. In addition an automated loading-unloading device for the silicon ingots is desirable to optimize the dead handling times with respect to the irradiation time.

The JRC heavy water moderated ESSOR reactor was built to test components such as fuel bundles for pressurized or boiling water reactors, or complete channels of heavy water reactors.

The large irradiation volume with a good neutron flux homogeneity in large diameter experimental channels, in conjunction with its neutron flux characteristics, make this reactor well suited to the requirements for silicon irradiation.

In this article, a silicon irradiation facility which has been conceived for installation in one channel of this reactor is briefly described.

Attention has been especially devoted to obtain an automated operation of the facility, and to optimize the characteristics of the irradiation volume.