Floater Removed Model of 6" NTD2 Irradiation Device in HANARO

Sungtaek Hong, H.S.Jung, S.J.Park
Korea Atomic Energy Research Institute, HANARO Management Division
989 Deadeok-daero, Yuseong-gu, Daejeon 305-353, KOREA
hong79@kaeri.re.kr

1. Introduction

HANARO has been providing commercial Neutron Transmutation Doping (NTD) services since 2002. Two vertical irradiation holes in the reflector region are used for NTD.

From safety point of view, this paper proposes a floater-removed design model for a 6-inch NTD2 **[1]** device. Also calculations were carried out for the nuclear design.

2. Methods and Results

Fig. 1 shows the lower part (Si ingot, Bi plate, Lower Graphite, Floater) of a 6-inch NTD2 Si ingot irradiation device. When the Si ingot was lifted up, the NTD device separated into two parts. The irradiation part (Upper graphite, Neutron screen, Si ingot, Bi plate) was lifted up to the outside of the reactor. And the floating part (Floater and Lower Graphite) remained in the NTD hole. However, a floater has buoyancy; this can be the reason of the floating incident in an NTD device.

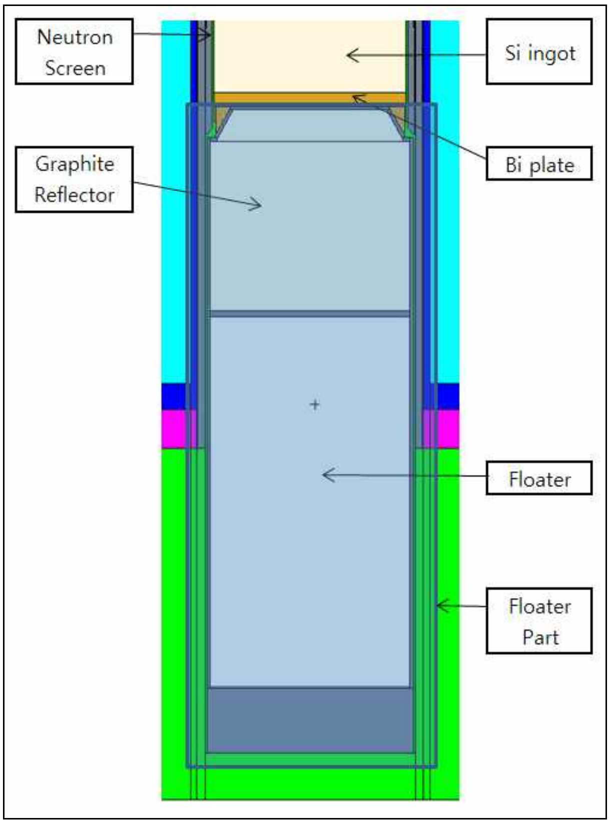

Fig. 1. Under part of 6-inch NTD2

2.1 Floater removed model

In order to complement the NTD device, this paper proposes new design model of an NTD device.

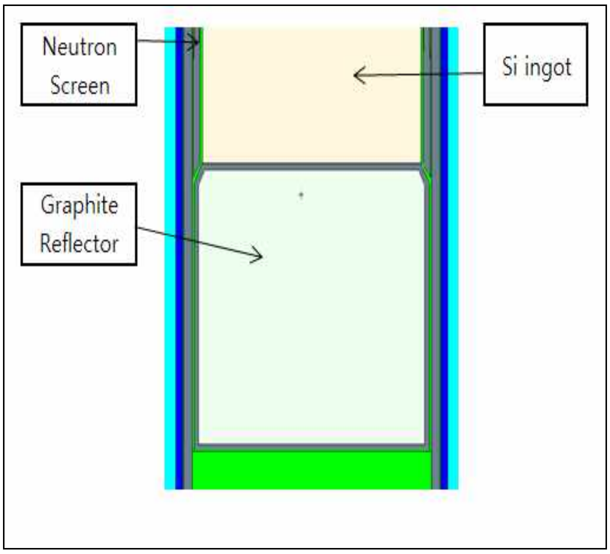

Fig. 2. New Design Model of 6-inch NTD2 device

Fig. 2 shows the geometry of the new design model. The floater and Bi plate were removed, which shows lower graphite and a neutron screen integration model.

Because this design model has no floater, a floating incident will not occur. In order to adjust the flatness of the distribution on the reaction rate, the size of the lower graphite and irradiation position were recalculated. **[2]**

The first step is finding the optimized irradiation position of the original NTD2, when CAR is 300mm.

We then use this irradiation position and CAR value to calculate the size of the lower graphite.

The last step is finding the optimized irradiation position of the new NTD2 model, when CAR is from 300mm to 600mm. The interval of the CAR position is 50mm.

Using the MCNP code, the $Si^{30}(n,\gamma)Si^{31}$ reaction rate was calculated and was checked the flatness of distribution on the reaction rate. To find the flatness of the distribution, axially, an Si ingot is divided into 30 plates. The simulation used 100 million histories, and the fractional standard deviation (fsd) was less than 0.5%.

2.3 Calculation Result

Fig. 3 shows the axial $Si^{30}(n,\gamma)Si^{31}$ reaction rate distributions of the irradiation positions (CAR position is 300mm.). When TR91 was 0.6, it shows a good flatness within 2.60%.

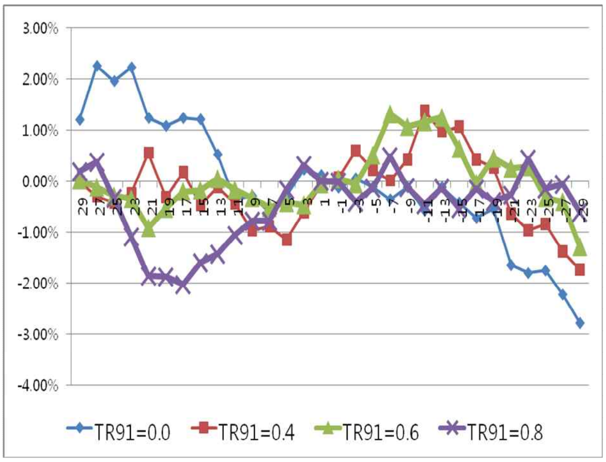

Fig. 3. Axial $Si^{30}(n,\gamma)Si^{31}$ reaction rate distributions of Irradiation Positions(CAR=300mm)

*When TR91=0, the center of Si-ingot is 5.7cm lower than center of fuel core.

Fig. 4 shows the axial $Si^{30}(n,\gamma)Si^{31}$ reaction rate distributions for lower graphite sizes (CAR=300mm, TR91=0.6). When the graphite size is 13cm, the gap of maximum and minimum value is 2.13%, and at 16.6cm, the gap is 2.19%. Therefore, 13cm was adopted for the size of the lower graphite.

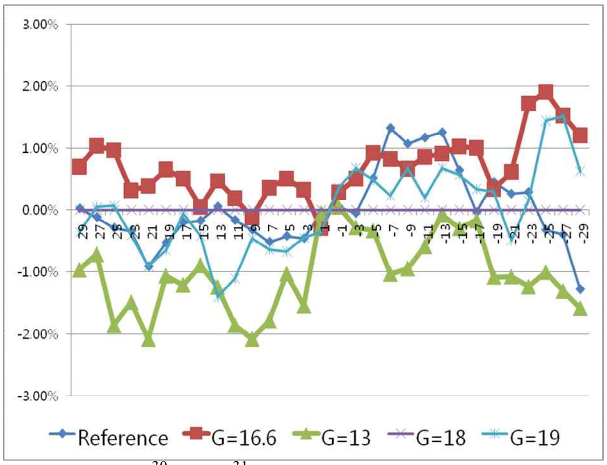

Fig. 4. Axial $Si^{30}(n,\gamma)Si^{31}$ reaction rate distributions for Lower Graphite sizes (CAR=300mm, TR91=0.6)

Table 1 and Fig. 5 show the optimized irradiation position of the new NTD2 model. The position of CAR is from 300 to 600mm, and the interval is 50mm. The flatness of each position is lower than 3%. So, it shows a good flatness in the axial direction.

Table 1. Optimized Irradiation Position of new NTD2 model.

Position of CAR	Position of NTD(TR91)	Flatness
300	0.6	2.13%
350	0.6	1.90%
400	1.2	1.64%
450	2.2	2.25%
500	2.8	1.87%
550	3.6	1.77%
600	4.4	1.56%

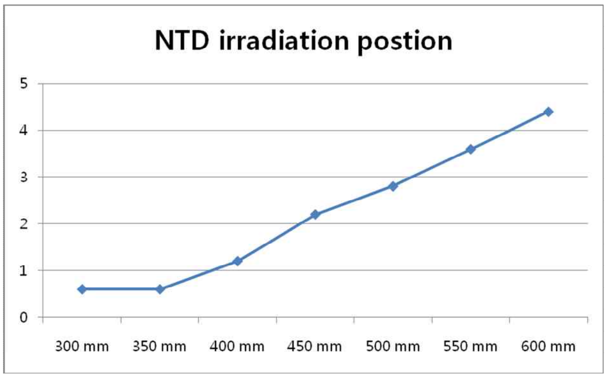

Fig. 5. Optimized Irradiation Position of new NTD2 model

3. Conclusions

Because a floater has buoyancy, it can be the reason for a floating incident in an NTD device. A silicon Neutron Transmutation Doping (NTD) service needs an improvement of the devices. To prevent an incident, this paper proposes a floater-removed design model for a 6-inch NTD2 device. Also, the optimized size of the lower graphite and irradiation positions were calculated.

In order to verify the validity of this design model, the $Si^{30}(n,\gamma)Si^{31}$ reaction rate was calculated by the MCNP code. When the graphite size is 13cm, the gap of maximum and minimum value has good flatness; therefore a 13cm size lower graphite was adopted. And when the CAR was 300 to 600mm, the flatness at each irradiation position was lower than 3%.

Consequently, if this design model were adopted, a floating incident will not occur in an NTD device. Also, the irradiation quality will be satisfied.

REFERENCES

[1] H.S. Kim, et al., “Design of Neutron Screen for 6″ NTD Irradiation in HANARO,” Proc. of 2005 KNS Spring Meeting, KNS (2005)

[2] S.T. Hong “Calculation of Lower Graphite size of 6” Integrated NTD2” KAERI Internal Report, HAN-SL-CR-11-03, KAERI (2011)