Performance Test of the Microwave Ion Source with the Multi-layer DC Break

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1. Introduction

A microwave proton source has been developed as a proton injector for the 100-MeV proton linac of the PEFP (Proton Engineering Frontier Project). On microwave ion source, the high voltage for the beam extraction is applied to the plasma chamber, also to the microwave components such as a 2.45GHz magnetron, a 3-stub tuner, waveguides. If microwave components can be installed on ground side, the microwave ion source can be operated and maintained easily. For the purpose, the multi-layer DC break has been developed. A multi-layer insulation has the arrangement of conductors and insulators as shown in the Fig. 1 [1] [2].

For the purpose of stable operation as the multi-layer DC break, we checked the radiation of the insulator depending on materials and high voltage test of a fabricated multi-layer insulation. In this report, the details of performance test of the multi-layer DC break will be presented.

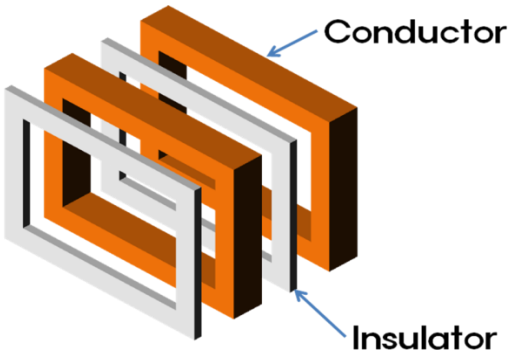

Fig. 1. Multi-layer insulation

2. Microwave Radiation Test

To check the propriety as insulator of the multi-layer DC break, the radiation measurements about two cases of insulator fabricated with Teflon and G-10 were carried out. According to calculation, the radiation depending on material was shown in Table. 1.

Table. 1. Radiation depending on the material

	BN	Alumina	Teflon	G-10	Air
Radiation [%]	5.3	2.0	47.1	4.3	71.7

Fabricated two multi-layer DC break were installed on microwave ion source and checked about the radiation loss. The Fig. 2 shows the installation of multi-layer DC break on microwave ion source for radiation test. The radiation depending on the magnetron power was measured at1.5m distance from multi-layer DC break. The results are shown in the Table. 2. The measured radiation ratio of Teflon and G-10 was about 10 times similar with calculation.

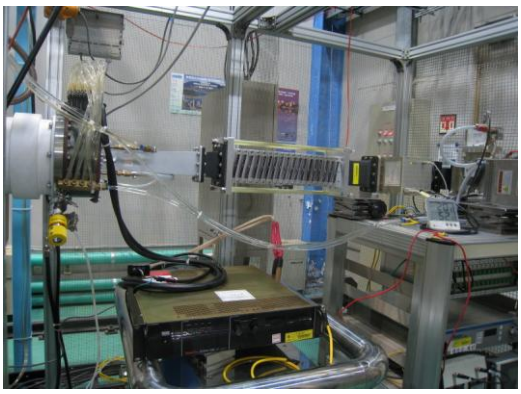

Fig. 2. Multi-layer DC break installation on the microwave ion source

Table. 2. Microwave radiation measurements [mW/cm^2]

Magnetron Power	350 W	400W	450W	500W	1000W
Teflon	1~3	4~6	13~15	20	-
G-10	0.2	0.8	0.7	0.7	1.1

3. High Voltage Test

During high voltage test of the multi-layer DC break, we observed the corona discharges on the insulator rods near to the waveguide adaptor flange. To avoid this problem, its structure was optimized and tested.

3.1. Optimization

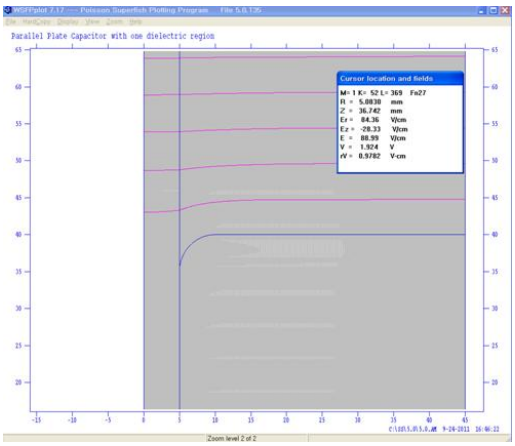

Fig. 3. Optimization using by POISSON code

First of all, the optimization of the multi-layer structure was used by POISSON code as shown in the Fig. 3. To calculate the electric field strength, it was simplified for the structure consists of the insulator rod and two waveguide adapter flanges. After that, it was calculated by changing the a hole structure of one of waveguide adapter flanges. The Fig. 4 shows results of the electric field strengths on the border where the corona discharge broke out. In Fig. 4, the electric field strength was minimized in the radius 5 mm.

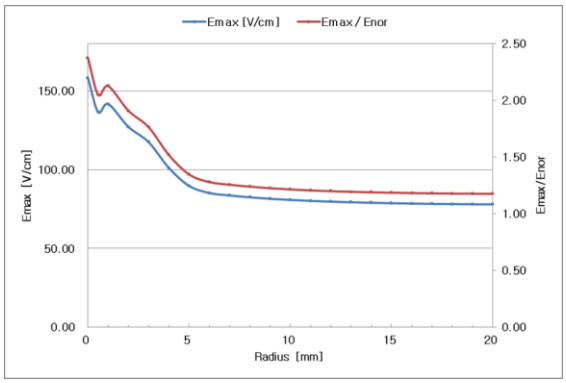

Fig. 4. Electric field strength

3.2. High voltage test

After modification by optimization of the multi-layer structure, the multi-layer DC break using the Cockroft-Walton power supply was tested up to 60 kV without any problem. The Fig. 5 shows the high voltage test of a multi-layer DC break.

Fig. 5. High voltage test of a multi-layer DC break

4. Conclusions

The multi-layer DC break has been carried out tests of microwave radiation and high voltage. In microwave radiation test, the radiation of the insulator fabricated with G-10 was measured less than Teflon in accordance with the calculated results. And the performance of a multi-layer DC break was confirmed by the high voltage test for the stable operation.

ACKNOWLEDGMENT

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REFERENCES

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[2] Yong-Sub Cho, et al., " Fabrication of Multi-layer Insulation DC Break for Microwave Ion Source" Transactions of the Korean Nuclear society Autumn Meeting, Gyeongju, Korea, 2011