*Transactions of the Korean Nuclear Society Autumn Meeting*
*Gyeongju, Korea, October 27-28, 2011*

# Fabrication of Multi Layer Insulation DC Break for Microwave Ion Source

Yong-Sub Cho [a*], Han-Sung Kim [a], Hyeok-Jung Kwon [a], Kyeong-Tae Seol [a]
[a] *Proton Engineering Frontier Project, Korea Atomic Energy Research Institute,*
*Daedeok-Daero 989-111, Yusong-Gu, Daejeon, Korea 305-353*
[*] *Corresponding author: choys@kaeri.re.kr*

## 1. Introduction

To make a compact microwave ion source of 100keV for industrial applications, we are developing the three key components. The first one is a magnetic solenoid with permanent magnets instead of an electromagnet solenoid which requires a high voltage insulation between the ion source and the solenoid or a high voltage floated DC current supply. The second one is a high voltage semiconductor switch that connects or disconnects high voltage power supply for beam extractions to the ion source. With this switch we can control the beam duty to control the average beam current without any tetrode beam extraction geometry or any beam optics component to keep the same beam shape. The last one is DC break in the wave guide between a microwave source such as a magnetron and an ion source. The conventional method for DC break is a choke flange, but that is useful for high voltage less than 50kV. We are developing a multi layer insulation method to obtain the high voltage holding capability higher than 100kV.

## 2. Design

A multi-layer insulation has the arrangement of conductors and insulators as shown in Fig. 1. In the design, we should consider two properties. One is the microwave property that it should transfer microwave from generator to ion source with minimum reflection and minimum radiation, and the other is the high voltage insulation property that it should hold high voltage between ion source and generator without break down. The frequency of the microwave is 2.45GHz, and the waveguide is a WR340 (86.4 mm width and 43.2 mm height).

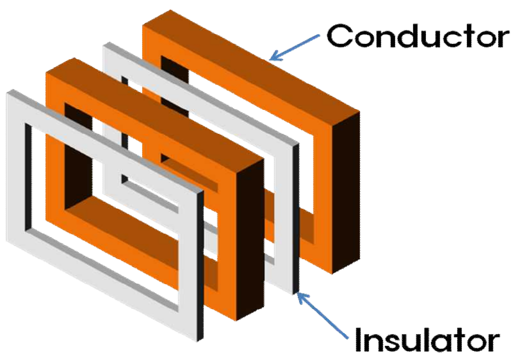


Fig. 1. Multi layer insulation DC break.

### *2.1 Microwave Design*

The thickness of the insulator is 2mm for fabrication and mechanical strength. As an insulation material, BN (boron nitride) and AlN (alumina) have been compared. AlN shows better performances than BN in reflection and radiation. Fig. 2 shows the typical radiation loss simulated with MWS (Micro Wave Studio).

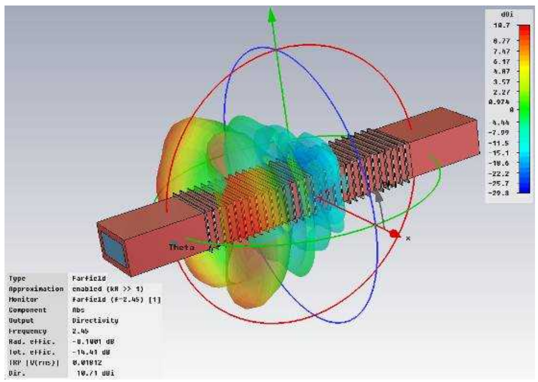

Fig. 2. Radiation loss from multi layer insulation dc break.

The longer conductor section is, the less radiation loss is expected. The longer one is better to reduce the radiation loss, but the total length of DC break is also longer, not compact.

2.1% radiation loss, 0.94% reflection, and 0.94% dielectric loss are expected by the code simulation.

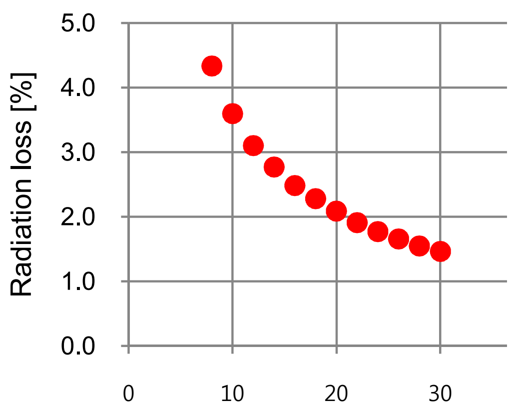


Fig. 3. Radiation loss by conductor section length.

### *2.2 High Voltage Insulation Design*

The geometry of the triple junction between conductor, insulator and air is important for the high voltage insulation property of the multi layer insulation.

Using POISSON code, the maximum electric field strengths have been calculated. Fig. 4 shows a case of the calculations, and Fig. 5 shows the maximum electric field strength by changing the relative position of insulator from the inner conductor surface. If the insulators are located inward more than 0.5mm from the inner conductor surface, the maximum electric field strength has stable minimum value.

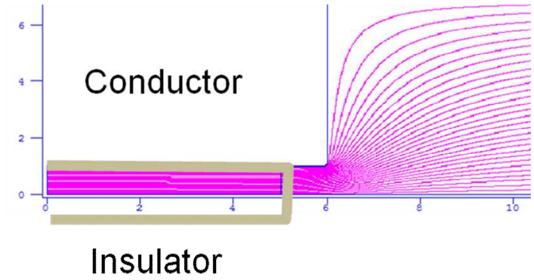

Fig. 4. Fabricated conductor parts for DC break.

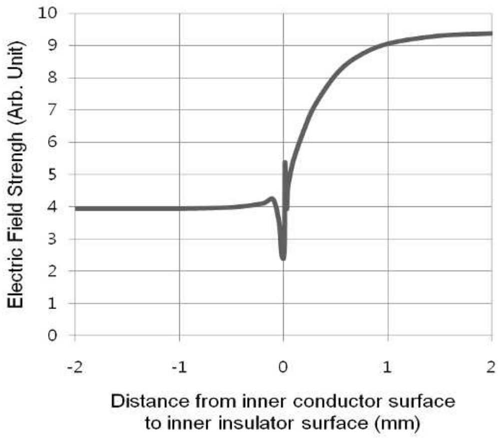

Fig. 5. Maximum electric field strength.

### 3. Fabrication

The insulator parts of 2mm thickness are made with 95% alumina as shown in Fig. 6 and the conductor parts of 20mm thickness are made with aluminum as shown in Fig. 7. The insulator and the conductors have been assembled on a granite surface plate to avoid the change in the microwave property due to the misalignment. Fig. 8 shows the assembled multi layer insulation DC break using four insulator rods within the accuracy of 0.5mm

Fig. 6. Fabricated alumina insulator parts for DC break.

Fig. 7. Fabricated conductor parts for DC break.

Fig. 8. Fabricated multi layer insulation DC break.

### 4. Conclusions

The multi layer insulation DC break for a microwave ion source has been designed and fabricated. Its high voltage and microwave properties will be checked by the measurements, and it will be installed between the microwave generator and the ion source for beam test.

### ACKNOWLEDGMENT

This wok was supported through the Proton Engineering Frontier Project by the Ministry of Education, Science and Technology of Korea.

### REFERENCES

[1] F. Maimone, L. Celona, G. Ciavola, F. Consoli, S. Gammino, S. Barbarino, and L. Tumino, Electromagnetic Study and Optimization of the PMTRIPS Ion Source and the Related Microwave Line, INFN/TC-07/04, April 3, 2007.