Useful Information for High Voltage Power Supply
(Related with Arcing and Breakdown)

Hiroshi Horibe*
Masami Ohnishi**, Hodaka Osawa**
*KURITA Manufacturing Corporation
(Ujitawara Town Kyoto Japan)
**Kansai University
Introduction(1)

- Have you ever experienced measuring meter or PC got into freeze when big arcing occurred?
- Have you ever heard arcing sound outside of Vacuum chamber?
- Arcing sometimes destroy the equipment. We have tried to protect this kind of trouble.
Introduction(2)

• Everyone admits High Voltage Power Supply is a must to IEC research.
• We are very enthusiastic in increasing NPR and watching vacuum level. But I am afraid we may not pay much attention to characteristic of HV power supply.
• Why don’t you think of these inevitable problems in IEC research. Arcing and Breakdown.
• My objectives are to show you 4 examples which I have experienced in my work and how those have been solved.
Before talking 1st example I have to specify two words in this presentation. "Arcing" “Breakdown”

• “Arcing”
  Arcing in the air
• Imagine you are doing IEC experiment increasing voltage set.
  • -50kV,60,70,80,,
  • “Pa---n!!” (outside the chamber)
    “Arcing”

• “Breakdown”
  Arcing in the Vacuum Chamber
• Imagine you are doing IEC experiment increasing voltage set.
  • -50kV,60,70,80,,
  • “Gru—n!” (dull sound from inside the chamber)
    “Breakdown”
4 examples

1st ex. Ground wiring
(Must be short and wide)

2nd ex. PVD System
Arcing sound inside the PS cabinet.
(Bypass diode have solved this problem)

3rd ex. Mock Up of NBI
Rush current detects OC every pulse rise.
(0.4mH Inductance have solved this problem)

4th ex. Cluster Ion Beam System
Break down influence from inside the chamber.
(Isolation relay have solved this problem)
1st Ground Wiring
(Must be short and wide)

• Ground wiring is most important. Especially Chamber frame to HVPS low potential side.
• Nevertheless ground is earth potential, HVPS current flows in this wiring. (50mA, 20A ,, and so on.)
• When break down occurred inside the chamber over 100, over 1000 ampere current flows simultaneously in much shorter than 1us. (500ns, 100n, <100ns)
• This current sometimes makes arcing in the air. Destroy the equipment, makes display freeze and so on.
Ground wiring must be short and wide

Everything depends on how good this wiring is or not.
Poor ground wiring for IEC is out of the question

Except small control unit case ground, those three are out of the question.

I recommend those Copper plate.
Nothing bad would be happened against big breakdown if it would be ideal ground wiring.
2nd Arcing have made Controller freeze
(Bypass diode have solved the problem)

- 25 years ago.
PVD system with +40kV ACC, -2kV DEC, 150V ARC, 20V FIL power supplies.
- A kind of ion implantation. Ion are implanted to the surface of Si wafer. There is precisely moved automatic wafer carrying and changing system controlled by motor.
- Problem: Big breakdown inside the chamber made arcing in the air and freeze the motor controller.
- Bypass diode have solved this problem.
PVD Ion Implantation System

POWER SUPPLY ENCLOURE

FIL +15V
ARC +150V
+40kV
ACC +40kV
DEC +2kV
-2kV

HV Terminal

On the +40kV

Fil
Arc
Ceramic
Vacuum Chamber

ION Beam
Si Wafe
Wafe Carrying system

0V

"A" earth
PVD Ion Implantation System

On the +40kV
PVD Ion Implantation System

On the +40kV

POWER SUPPLY ENCLOURE

FIL+15V
ARC-150V
ACC+40KV
DEC-2KV

HV Terminal

Arc
Fil

+40KV

-2KV DEC

Ceramic
Vacuum Chamber

Si Wafe

Wafe Carrying system

"A" earth

0V
Diode

Those are not the same as that day: similar shape
DC 2500V
25A
3rd Rush current flows and detects over current every pulse rise

- 25 years ago at JAERI. Mock Up of NBI.
- This was happen just after moving all equipments from old site to new site.
- Pulse output -80kV 50A, every pulse rise, system detects OC. No way – We could not run any inch.
- We forgot an important main circuit connection.
- 0.4mH Inductance connection have solved this issue.
0.4mH Inductance have solved the problem

Mock Up For NBI -80KV 50A PULSE

Very Big site (50m*50m)
0.4mH Inductance have solved the problem

Mock Up For NBI -80KV 50A PULSE

Very Big site (50m*50m)
0.4mH 25 years ago. I forgot. I have tried to realize similar one.

0.4mH = 400 uH

Many many winding

0.4mH inductance did work well to limit the current when pulse rising.
4th Breakdown noise influence from inside the chamber

- 20 years ago. Inside the Cluster Ion Beam system.
- Just after breakdown inside the chamber. Sequencer which controls everything got into freeze.
- Motor controller which sensing cable are set into the chamber.
- Small relay contact inside the motor controller connect to sequencer directly. – That’s it.
Isolation relay have solved the problem.
Isolation relay have solved the problem
Small auxiliary relay: Not enough isolation ability in IG, PG.

I strongly recommend adding one more relay when using this relay contact to the application.
Summary

• Would you please pay more attention to HV power supply?
• Key to success to control HVPS is depend on ground circuit which is good or not.
• Arcing is not always occurred HV electrode to ground. Look carefully ground wiring to ground chassis also.
• With ground knowledge, we are not afraid of arcing, breakdown anymore.

Why don’t you make a good relationship with them?
Mock UP of NBI taught us other valuable information.

Arcing atmosphere lasts in 5ms in VC After OC.

Changing BL time gave us Certain consequence as below.

Arcing atmosphere have been cleared up perfectly in 7ms in this application.

3.5ms: 100% OC detect at next pulse rise
5ms: 50% 50% chance OC detect at next pulse rise
7ms: 0% No OC detect at next pulse rise

Mock UP of NBI taught us other valuable information.