RD 51 December mini week 2015

Resistive protections
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outline

• Resistive protection in Micromegas
• Resistive protection with well detectors
• Resistive MSGC development status
• Conclusion
Surface or embedded resistor for low or High rate applications

- The thickness above the pad is similar in both structures
- Around 50 to 75um to minimize the signal loss
Surface protection

- Smaller signals by 10-20% related to insulator thickness
- Gives the possibility to ground the mesh or the drift
- Resistive lines are connected together

Resistive lines
(see Silvia Franchino &... study)
**Resistive strips production:**

*Photolithography*

Possibility to go down to 0.1mm pitch

*Screen printing*

![Screen printing process diagram]
Screen printing:

Semi automatic machine
20 boards/hour
Printing area 1.5m x 0.9m

Full automatic line also available. On going study. Many hundred foils/hour possible rate

Subcontracted to the company Charbonney near CERN
Maximum sizes

- Picture: 2m x 1m x 0.5 mm read-out board with pillars in 4 parts
- 10 mm thick Aluminum honeycomb
- Max size for 1 PCB: 2.2m x 0.6m
Resistive layer for mass production:

Bare STD read-out PCB

Screen printed or vacuum deposited resistors (KOBE style) on a Kapton foil

Thin solid cast Glue (12um)

High pressure, High temp gluing
Embedded resistor with LAPP
Production steps

Bare PCB
Production steps

Bare PCB

Coverlay gluing + via fill
Production steps

Bare PCB

Coverlay gluing + via fill

Inner resistor printing
Production steps

Bare PCB

Coverlay gluing + via fill

Inner resistor printing

Coverlay gluing + via fill + top resistive layer print
Shapes and values for embedded resistor
R1 Detectors for the LAPP

Real values:
40 to 60 KOhms with 10KΩ/Sq
400 to 750 KOhms With 100KΩ/Sq

Real values:
400 KOhms with 10KΩ/Sq
4 MOhms With 100KΩ/Sq

Real values:
4 MOhms with 10KΩ/Sq
40 MOhms With 100KΩ/Sq
Results with embedded resistors in Micromegas

• Results are corresponding to expectations

• Up to 11 mega events per cm2 with good linearity (rate VS current) have been measured

• For deeper details please contact Maxime Chefdeville at LAPP.
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Well detectors

- Introduced by Ronaldo Bellazini in 1997
- Simple and accurate structure
- Single stage amplification
- More robust than MSGC
- But suffering anyway from spark
Embedded resistors in well structure

Medium rate

High rate
Process medium rate

Bottom resistive DLC deposition on 50um Kapton
Process medium rate

Glue to read-out board
Process medium rate

Top layer patterning + kapton etching
Process high rate

Bottom resistive deposition
Process high rate

Bottom coverlay + via fill + second resistive layer print
Process high rate

Strip or pad flex gluing + via fill
Process high rate

Rigidizer gluing if needed
Process high rate

Top layer patterning + kapton etching
Problems in first high rate production

- due to the multiple gluing steps and the high value targeted (80Mohm/square) the first resistive layer value increased in a non controllable way.

- after many test we have discovered that the 1MOHMS/square paste is polluted by the glue.

- new samples are planned, we will use DLC resistor for the first layer. The second one will be screen printed with 100Kohms paste.

- For preliminary results please contact Giovanni Bencivenni.
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MSGC

No introduction needed

We are still investigating this device because it is still one of the simplest existing MPGD
MSGC production with PCB technologies

• We have produced many samples with PCB technologies and materials
• They work as expected:
  – Good gain
  – Good energy resolution
  – They suffer from spark damages
  – They charge up
  – They show polarization effects
First improvement

- We have changed the material of the cathode electrode. From metal we went to 100 Kohms/square paste.

- This modification solved the spark problem.

- But we were still suffering from charging up and polarization.

- Looking in literature we have found a lot of papers dealing with this problem and giving solutions, one of them was to deposit a thin resistive high value layer over the full structure.
After resistive deposition

- We have subcontracted resistive Vacuum deposition in 2 institutes.
- We have discovered that one of them already did in the past the deposition on Glass MSCG mentioned in literature.
- We have asked for 4 different resistive value depositions on 20 small pieces from $10^{12}$ to $10^{15}$ ohms/square.
- After this coating 2 situations appeared: high values do not improve the behavior; low values are showing the expected effect but totally degrading the device at the same time.
- None of the suppliers were ready to guaranty their resistive value.
- Due to the last statement this direction is abandoned (still ALD deposition could be investigated but completely out of our budget).
New direction: remove material between electrodes where charges are attaching

Type 1 etching the substrate
New direction: remove material between electrodes where charges are attaching

- Type 1: etching the substrate
- Type 2: etching the substrate
- Adding an electrode
- Removing top electrode

Graphs showing the results of each type.
New direction: remove material between electrodes where charges are attaching

Type 1 etching the substrate

Type 2 etching the substrate
Adding an electrode

Type 3 Removing top electrode
Micro gap

• Even more simple than MSGC
• We are now producing some micro-gap structures
• This time we will study first that the charging up and polarization effects are as expected negligible by construction.
• We will then introduce the resistive layer for spark protection
Micro gap pad prototype layout

1cm x 1cm pad structure

4 pads structure
Micro gap production

- We expect some samples in the coming weeks
- STD qualification test will be then performed
  - Gain
  - Energy resolution
  - Rate
  - Stability in time and rate
- If OK we will produce a resistive version
Conclusion

• We know 2 ways of resistor deposition
• We have applied them to Micro megas, R-Well and THGEM successfully
• We are trying to apply it to Micro Gap detectors
Thank you