Development of RPC using glued bakelite sheets

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Introduction

Resistive Plate Chambers (RPC) of area 2 m × 2 m will be used in the proposed India-based Neutrino Observatory (INO) to determine precisely the oscillation parameters using atmospheric neutrinos in a 50 kton Iron Calorimeter (ICAL) [1, 2]. During the last few years R&D on the RPC with bakelite paper laminates commercially available in India is going on at SINP/VECC. Since the bakelite sheets of size 2 m × 2 m are unavailable in Indian market, therefore it becomes necessary to make a 2 m × 2 m bakelite sheet by joining four 1 m × 1 m bakelite plates. Hence a prototype single-gap bakelite RPC of size 20 cm × 20 cm has been fabricated with electrode plates made by gluing eight 10 cm × 10 cm bakelite plates together to examine the feasibility of the option of planar electrodes made of glued plates.

Fabrication of RPC

In this work, P-120 grade bakelite has been used because of its better electrical properties like surface resistivity, bulk resistivity etc. in comparison to other available bakelites grades [3, 4]. Eight pieces of 3.2 mm thick bakelite sheet having dimension 10 cm × 10 cm have been taken to make two plates of size 20 cm × 20 cm, used as electrodes. After proper cleaning, four 10 cm × 10 cm bakelite plates have been glued together by applying a resin hardener at their sides in order to make a 20 cm × 20 cm bakelite plate. A thin layer of viscous silicone fluid is applied on the inner surfaces of the bakelite sheets as explained in Ref. 3 and 4. A gap of 2 mm between these 20 cm × 20 cm plates has been created in order to make the chamber, by using four button spacers having diameter 1 cm, four edge spacers, eight spacers of size 3 cm × 1.2 cm and one 2 cm × 1.2 cm spacer made of polycarbonate. Since the electrode plates used in this RPC have been made of small pieces, a few extra supporting spacers at the joining lines were used for reinforcement. These spacers at the joining lines also conceal the sharp edges at the joints, which cease the chances of sparking at the sharp edges. The arrangement of the button spacers and the spacers at the joint are shown in FIG. 1. After preparing the gas gap, leak test has been performed by using argon sniffer probe.

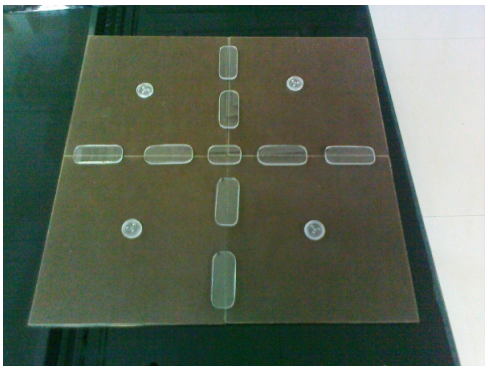

FIG. 1: Arrangement of spacers.

After cleaning the graphite coating has been done on the outer surfaces of the chamber to apply uniform electric field. Graphite coat-

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ing was avoided over the gas passages at the joints to prevent sparking. A gap of 1 cm is maintained from the sides of the chamber to the graphite layer to prevent any external discharge at the edges. Two pieces of copper tape having size 2 cm × 1.5 cm × 0.002 cm have been pasted on both the graphite coated outer surfaces to make electrical connections. High voltage connectors have been soldered to these small copper strips. Equal high voltages of opposite polarities are applied to the graphite surfaces by means of these electrical connections. A complete 20 cm × 20 cm chamber with gas tubing and high voltage connections is shown in FIG. 2.

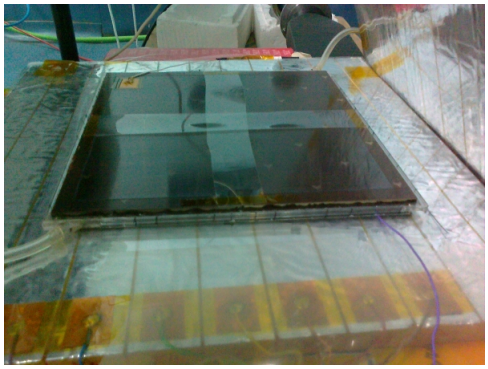

FIG. 2: Complete 20 cm × 20 cm RPC with gas tubing and high voltage connections.

Results

The I-V characteristic of the prototype RPC has been studied in the avalanche mode of operation with a gas mixture of R-134a and isobutane in 95/5 volume mixing ratio and shown in FIG. 3.

It can be seen that the current through the RPC increases gradually with the applied voltage up to ∼12 kV and after 12 kV, there occur a sudden jump in the current with a small increase in the voltage i.e. the current-voltage curve has two distinctly different slopes. The slope at the lower voltages characterises the resistivity of the spacers and that at the higher voltages characterises the resistivity of the bakelite plate. It can be inferred that the detector reaches the limited proportional region at the voltage > 12 kV. A RPC is operated in this region to attain high gain such that a detectable signal can be obtained. Thus the satisfactory working of this RPC is anticipated.

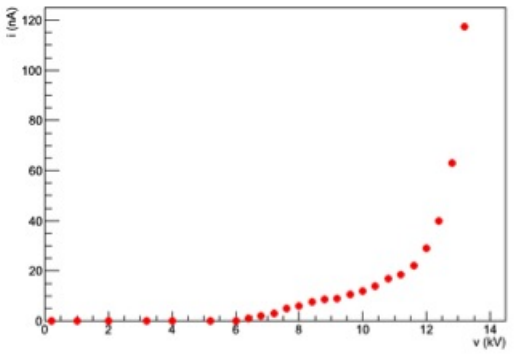

FIG. 3: I-V characteristic of 20 cm × 20 cm single-gap bakelite RPC having electrode plates made of glued pieces of the bakelite sheet.

Summary and outlook

In conclusion, a prototype single-gap bakelite RPC of size 20 cm × 20 cm has been fabricated with electrode plates made by gluing four 10 cm × 10 cm plates together and has been tested to examine the viability of the option of planar electrodes made of glued plates. The I-V characteristic studied in the initial testing is found to be satisfactory. Two distinct slopes in the I-V plot have been obtained. Thus this RPC is expected to work adequately and further testing is therefore needed to examine its performance such as efficiency, area coverage or dead area determination, etc.

References

[1] R. Santonico, R. Cardarelli, Nucl. Inst. and Meth. 187, (1981) 377.
[2] INO Project Report, INO/2006/01, June 2006, ⟨http://www.imsc.res.in/∼ino/⟩.
[3] Saikat Biswas, Ph.D. Thesis, University of Calcutta, 2010. (http://www.ino.tifr.res.in/ino/theses/Saikat.Biswas-thesis.pdf).
[4] S. Biswas, et al., Nucl. Instr. and Meth. A 602 (2009) 749.