Fabrication of 1m × 1m readout strips panel and quality verification of new set of SFS dielectric material

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1. Introduction

India based **N**eutrino **O**bservatory (INO) is going to use ~30,000 **R**esistive **P**late **C**hamber (RPC) as an active detector. Resistive Plate chambers are parallel plate fast gaseous detector made up of high resistivity (10^{12} ohm-$\square$) of glass or bakelite. Glass plates work as electrodes of positive and negative potential. When a charged particle passes through chamber it ionizes the gas and charge move towards opposite electrodes. The Pick-up panels pick these signals. Signals are sent to front end electronics. The characteristic impedance of the strips of the panels should be matched with front end electronics which helps in minimizing the reflected signal. Since INO is an underground laboratory, all material used in it must be fireproof. Since ~60,000 pick-up panels are going to be used in INO hence it should be cheaper also. We recently received a new set of Silicon Fiber Sheets – a dielectric material, of 25 pieces of 1m × 0.5m having thickness 05 mm. We fabricated a set of readout strips panel of dimension 1m × 1m. We will present this work in detail.

2. Quality verification of new set of SFS dielectric material

The major requirement for the readout strips panel in INO is its characteristic impedance which must be 50 ohm. The thickness must be less than 5mm so that it enters the space provided between two stacks in INO- ICAL properly. Along with this the material must be fire proof, cheaper and easily available in local market. We received a new set of SFS material from the company. We measured its characteristic impedance using circuit diagram as shown in Figure 1. We observed that the characteristic impedance of this batch is better than the earlier batch and it come out to be 50Ω.

Results of this measurement are shown in Figures 2. Figure 2 (top left) shows the input and output pulses in the open circuit. We see the original pulse, frontend and backend reflections of signal. The top right and both bottom pictures are the signal pulses when the circuit is terminated by the 49, 50, and 51Ω impedance. It is observed that there is minimum backend reflection under 50 ohm impedance. Hence Silicon Fiber Sheet of thickness 5mm are used as dielectric for the fabrication of readout strips panel. Earlier batch Silicon Fiber Sheet has impedance close to 48.5Ω.
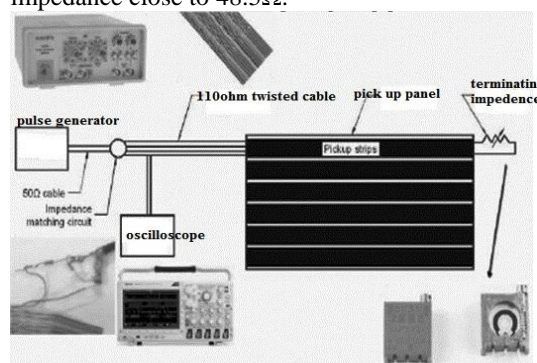

**Fig. 1:** Diagram of characteristic impedance matching circuit.

3. Fabrication of 1m × 1m size readout strips panel

A new batch of 25 Silicon Fiber Sheet has recently arrived which is of size 1m x 0.5m from the market. It is not possible to get more than 0.5m wider sheet due to mechanical property problem of the material. Therefore, the two sheets of readout strips panels are glued electrically with aluminium foil of thickness 0.01 mm which is generally used for the wrapping purpose. For the strips, a copper sheet of thickness 0.09 mm is cut into 1m long and 28 mm width pieces with the help of needle and scale arrangement. An adhesive called Bluecoat

adhesive provided by Bluecoat Pvt. Ltd. is used for the gluing purpose. These strips are arranged and pasted with the uniform gap of 2mm. Thirty three strips of copper are used in the preparation of 1m × 1m readout strips panels. After pasting these strips and ground sheet, a wooden sheet of 1m × 1m are placed on it with heavy load – few lead bricks. This wooden sheet provides the uniform distribution of pressure on the pick-up panel. This uniform pressure is kept for at least 24 hours which helps in proper attachment of copper strips to Silicon Fiber Sheet.
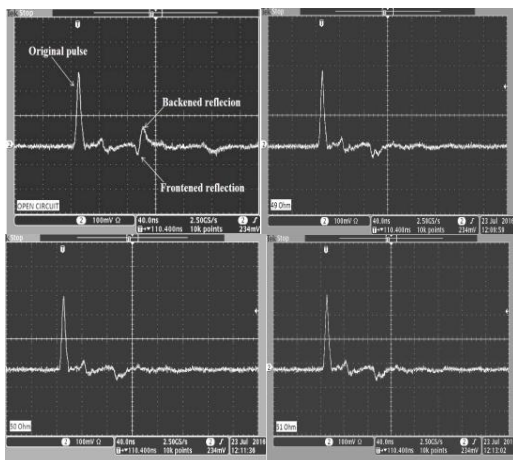

Fig. 2: Display of pulse on oscilloscope: from top left to bottom right (i) Open Circuit (ii) 49 ohm (iii) 50 ohm (iv) 51 ohm.
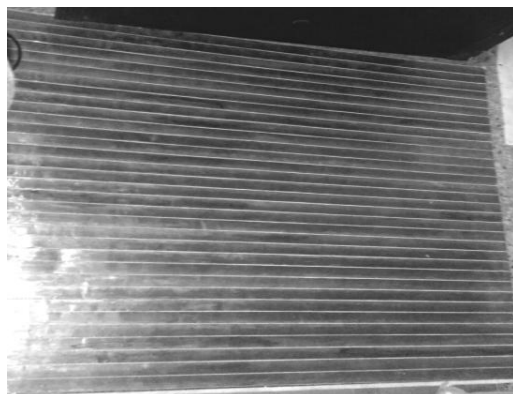
Fig. 3: Readout strips panel of SFS material having 1m x1m dimension.

This process of pressurizing the readout strips panel has been done after both gluing. The final finished product of SFS based readout strips panel is shown in Figure 3. We have already presented other physical and chemical properties of this material [1, 2, 4] and this batch has also fulfilled the same. Now the pick-up panels are ready for work. After preparation of readout strips panel, characteristic impedance of each strips is measured. The results are shown in Figure 4. It may be seen from the Figure 4 that all strips have characteristic impedance value close to 50 ohm which is the most important requirement of such panel.
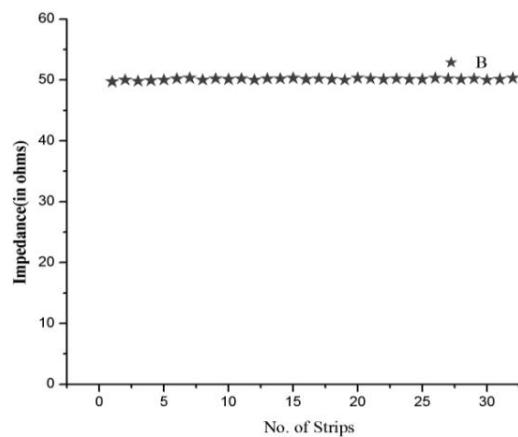
Fig. 4: Variation of impedance with readout strip number is shown for 1m × 1m panel.

4. Remarks and conclusions

It is found that the readout strips panels made up of Silicon Fiber Sheet as a dielectric material is better than the other available dielectric readout strips panel. It is best suitable for RPC detector which will be used in INO-ICAL. The fabricated readout strips panel is operational.

References
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