

Search of Suitable Adhesive for attachment of metallic foils in making the readout strips panel of RPC Detector

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ABSTRACT: The India Based Neutrino Observatory needs 57,600 readout strips panels for 28,800 Resistive Plate Chamber detectors. Making of these readout strips panel will require suitable adhesive such that it can attach metallic strips with low cost. We studied several adhesives available in the local market. After considering all factors we reached at the conclusion that Bluecoat 9000 (Synthetic wood adhesive) is suitable adhesive for our purpose. We performed various tests associated with the strength measurement of the connection. In the present paper we will describe the experiments and their finding in detail.

KEYWORDS: RPC detector, Adhesive, Readout strips panel, Metallic foils, Characteristic impedance, Fevicol SR 998, Araldite.

I. INTRODUCTION

The India Based Neutrino Observatory is going to establish into the underground laboratory to reduce the cosmic ray background with all around rock cover of 1 km approximately [1]. This requires almost 28,800 Resistive Plate Chamber detectors placed in between the Iron plates. Each RPC will require two readout strips panel. In making these readout strips panel we need metallic foils such as Copper or Aluminium or both, suitable dielectric material and adhesives for attaching the metallic foils on dielectric material. We have observed that the Silicon Fiber Sheet is a suitable dielectric material for making the readout strips panel [2]. But for attaching these metallic foils we need a proper adhesive, such that it can attach the readout strips and ground metallic foil of readout panel strongly and quickly. One of the major criteria is that adhesive should be low cost. In our case we are using Copper foil (of thickness 0.09 mm) for making readout strips and Aluminium foil (of thickness 0.01 mm). A pickup strips panel having dimension 1 m × 1 m is made in our lab as shown in Fig. 1. In making of it we have used these materials, but for attaching these metallic foils, we faced problem for the use of a proper and cost effective adhesive. Also, since the INO experiment requires large number of pickup strips panels of size 2 m × 2 m, therefore search for suitable adhesive became very important, because it will seriously affect the working of readout strips and the budget of the experiment. Therefore, we have searched for such a suitable adhesive in our local market. To solve this problem we have bought ten numbers of suitable adhesives available in local market having properties very close to our requirements. We have performed the experiment of strength measurement, time taken to strengthen, their fireproof property and measurement of characteristic impedance after making the readout strips panel using each adhesives. But for making the ground plane using Aluminium foil we have used Araldite adhesive as a common factor for all others.

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Fig. 1 Image of 1 m × 1 m Silicon Fiber Sheet based readout strips panel.

Since, we have tested that Araldite is a very strong adhesive although its cost is very high. In this paper we have described the experiments by which we have chosen the appropriate adhesive for our purpose of making the readout strips panel at a large scale. This work will be basically useful not only for INO-ICAL (Iron Calorimeter) experiment but also for other experiments in which they need to attach the metallic foils. If attachment work is very small then use of the Araldite adhesive may be preferred because it is very well known and well tested adhesive for attaching very hard materials such as Iron sheet, Glass sheet and Stones etc [3].

II. EFFECT ON CHARACTERISTIC IMPEDANCE

We have searched for various adhesives available in our local market (so that it can be available very easily). We found that Band Aid Col (wood fixer, PVA emulsion), Bluecoat 9000 (Synthetic wood adhesive), Fevicol SH, Fevicol SR 998 (Synthetic rubber adhesive), Fevi Kwik, Fevibond, GRL Tyre and tube repair, Bondtite, Flex Kwik and Araldite are possible locally available adhesives. The photographs of these adhesives have been shown in Fig. 2. Brief information about these adhesives has been listed in Table 2.



Fig. 2 Photographs of few adhesives used in making the readout strips panel.

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Using these adhesives we have made up a test readout strips panel for further experiments, as shown in Fig. 3. In its making we have attached Copper strips using the above mentioned different adhesives. But for making its ground plane (by attaching the Aluminium foil) we have used the Araldite as a common adhesive, because it has good attaching property. After attaching them we have pressed the panel's strip with some weights using lead bricks for 24 hours.



Fig. 3 Test readout pickup strips panel made up by using different adhesives.

As we know that the characteristic impedance depends upon the property of material and geometry [4], therefore, a test has been performed to check the effect of these adhesives we used, on the characteristic impedance. In this respect, we have measured the characteristic impedance of each strip using the principle of termination [5]. The observed results have been shown below in Fig. 4. Here we would like to mention that the composition of the used Silicon Fiber Sheet is different with the previously used Silicon Fiber Sheet which has characteristic impedance similar to the front end electronics [2]. Because, we are in search for suitable adhesive and for that we can use any of the dielectric material either Silicon Fiber Sheet or any other.

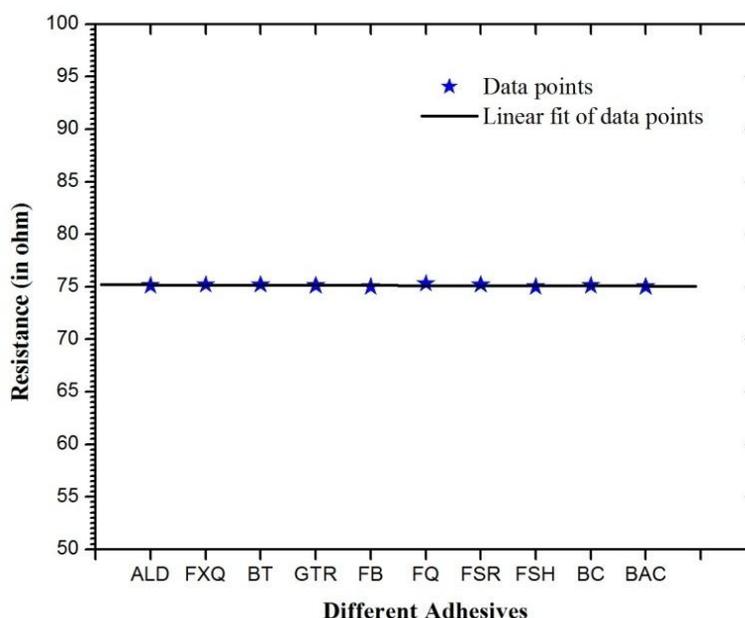


Fig. 4 Variation of characteristic impedance with the use of different adhesives for the same dielectric material

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From the plot as shown in Fig. 4, we may see that there is no any major variation in the value of characteristic impedance of every strips of the panel. Hence, as the characteristic impedance depends on the composition of the dielectric materials [4], but application of a very thin layer of adhesive in making the readout strips panel does not affect the desired test parameter.

III. MEASUREMENT OF STRENGTH OF ATTACHMENT

Other experimental requirement is that these strips remain attached for a very long time and also we should know about strength of the connections. Connections made should not be affected by any kind of jerks and should last longer. For getting the answer of above mentioned curiosities, we have performed tests to check the strength of the attachment. For this purpose, we have arranged an experimental setup as shown in Fig. 5. In which we have hung some weights through the wires being soldered on the under test readout strips. We adopted gluing procedure as mentioned in sec. II. Here we soldered the wire to the strip made using a known adhesive as listed in Table 1 at three places over the strip and hung the weights in increasing order as shown in Fig. 5. The above mentioned procedure has been applied for each strip. The maximum weight is continuously hung for maximum time of 3 hours. The results of the above test are tabulated in Table 1.



Fig. 5 Experimental arrangement for strength measurement of glued readout strip of the pickup strips panel.

Table 1: Results of strength measurement (of strips attachment on Silicon Fiber Sheet)

S. No.	Adhesive	Time of hanging	Results
1.	Band Aid Col (wood fixer, PVA emulsion) Manufactured by Narang Chemical Industries.	3 hours	Good and remain attached
2.	Bluecoat 9000 (Synthetic wood adhesive) Manufactured by Bluecoat Private Limited.	3 hours	Good and remain attached
3.	Fevicol SH Manufactured by Pidilite Industries Limited.	15 minutes	Gets detached
4.	Fevicol SR 998 (Synthetic rubber adhesive) Manufactured by Pidilite Industries Limited.	3 hours	Good and remain attached, but it is highly inflammable.
5.	Fevi Kwik Manufactured by Pidilite Industries Limited and makers of Fevicol.	3 hours	Attachment was good but dangerous to deal with it, heating takes place, dries fast.
6.	Fevibond Manufactured by Pidilite Industries Limited.	3 hours	Good and remain attached and it is inflammable.

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7.	GRL Tyre and tube repair Manufactured by Diamond Cycle Private Limited.	5 minutes	Not suitable for this purpose, it gets easily detached, and also it is inflammable.
8.	Bondtite Manufactured by Resinova Chemie Limited.	3 hours	Good and remain attached
9.	Flex Kwik Manufactured by Pidilite Industries Limited.	3 hours	Similar behaviour as the Fevi Kwik, not suitable for this purpose but attachment was good.
10.	Araldite Manufactured and Marketed by Huntsman International (India) Private Limited.	3 hours	Good and remain attached

With this strength measurement we have observed that, though Araldite is very good adhesive; but for our purpose we can also use other adhesives such as Band Aid Col (wood fixer, PVA emulsion), Bluecoat 9000 (Synthetic wood adhesive), Fevicol SR 998 (Synthetic rubber adhesive), Fevibond and Bondtite which are as useful as Araldite. But after attaching the strips using these adhesives, when the final readout panel is prepared, we did the soldering on them for attaching the wires. We found that due to the heat of soldering rod at the place of soldering, the strips started detaching from the dielectric material due to heat. This happens in case of Fevicol SR 998 (Synthetic rubber adhesive), and Fevibond. But very less effect occurred on Band Aid Col (wood fixer, PVA emulsion), Araldite, Bluecoat 9000 (Synthetic wood adhesive) and Bondtite adhesives attached readout strips. Also Fevicol SR 998 (Synthetic rubber adhesive) is highly inflammable; therefore we can't proceed with it for making readout strips panel.

IV. COST COMPARISON

From the above test, around 60% of the listed adhesives have been rejected. Since making of readout strips panel will require a very large amount of adhesives, therefore search for a cost effective adhesive is very important for us. Without any compromise with the adhesive's quality of attachment, which adhesive will provide long time stability in terms of strong attachment of metallic foil? To find out the answer of the important query, we did the comparative study about the cost with their amount as shown in Table 2.

Table 2: Cost comparison of the selected adhesives.

S. No.	Adhesive	Amount	Price (INR)	Cost per gram (INR)
1.	Band Aid Col (wood fixer, PVA emulsion)	125.0 gram	20.0	0.160
2.	Bluecoat 9000 (Synthetic wood adhesive)	125.0 gram	37.0	0.296
3.	Bondtite	04.0 gram	10.0	2.500
4.	Araldite	36.0 gram	90.0	2.500

From the Table 2, we may observed that, Band Aid Col (wood fixer, PVA emulsion) and Bluecoat 9000 (Synthetic wood adhesive) with good quality of attachment, less price (cost effective) and non flammable properties can fulfil our requirement very easily. Others are very costly in comparison to these. From Table 2 we have already erased the other adhesives which were not suitable for our experiment. Therefore, we are in favour of making readout strips panel using any of these two. But we are in favour of using Bluecoat 9000 (Synthetic wood adhesive) and not Band Aid Col (wood fixer, PVA emulsion). The reason behind is that Bluecoat 9000 (Synthetic wood adhesive) is less affected by the heat of soldering rod in comparison to the Band Aid Col (wood fixer, PVA emulsion). This may lead

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to the weakening of attachment at the soldering point. Therefore we prefer to make use of Bluecoat 9000 (Synthetic wood adhesive) in making readout strips panel. Though its cost is 0.296 INR per gram, which is very less but greater than the Band Aid Col (wood fixer, PVA emulsion) (0.160 INR per gram).

V. RESULTS AND CONCLUSION

From the above experimental results we finally reached to the conclusion that, we should make use of Bluecoat 9000 (Synthetic wood adhesive) for making the readout strips panel. It is non-flammable, very cheap in price, very well in handling and provides us a very good quality of attachment as the Araldite, which is very costly. Therefore, we strongly recommend the use of Bluecoat 9000 for making readout strips panel for any underground laboratory which requires fireproof materials such as India Based Neutrino Observatory.

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REFERENCES

- [1] Shiba P. Behera, Manmohan S. Bhatia, Vivek M. Datar, Ajit K. Mohanty, "Simulation Studies for Electromagnetic Design of INO ICAL Magnet and Its Response to Muons", IEEE Transactions on magnetics, Vol. 51, issue 2, 7300409, February 2015.
- [2] M. K. Singh, A. Kumar, N. Marimuthu, V. Singh, V. S. Subrahmanyam, "Characterization of Silicon Fiber Sheet for making the readout strips panel", IJRSET, Vol. 4, issue 10, pp. 10035-10042, 2015.
- [3] Seymour, Raymond B., "History of the Development and Growth of Thermosetting Polymers", Journal of Macromolecular Science, Part A Vol. 15, issue 6, pp. 1165-1171, April 1981.
- [4] David R. Voltmer, Mark A. Yoder, "Electrical Engineering Applications with the TI-89", Explorations, Chapter 12- Transmission lines, Texas Instruments Incorporated, pp. 117-126, 1999.
- [5] Oluwaseun Amoda, "Design of Readout System for a Resistive Plate Chamber", Project in SIST (Summer Internship in Science and Technology) FNAL (Fermi National Accelerator Laboratory), pp. 1-17, 2002, [sist.fnal.gov/archive/2002/papers/Amoda.pdf].

BIOGRAPHY



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