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SDC
SOLENOIDAL DETECTOR NOTES

NOTE ON THE SURFACE RESISTIVITY OF ALUMINIZED PLASTIC FILM

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NOTE ON THE SURFACE RESISTIVITY OF ALUMINIZED PLASTIC FILM

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I have made measurements of the surface resistivity of the new material that we have recently received from the G. T. Sheldahl company in Northfield MN. The resistivity is surprisingly low. It is approximately 1/4 ohm per square. The thickness of the coating is supposed to be about 10^{-5} cm and they tell me that they can't put more on reliably. The resistivity depends not only on the type of metal but on the way it is applied for if it falls in the form of a net of aluminum instead of a uniform thin coating, the resistivity could be much larger. It is true also that if one calculates the expected surface resistivity of a uniform coat of aluminum 10^{-5} cm thick one obtains 0.262 ohms per square in good agreement with the measured value. Our previous experience, however, was that the tubes made using the old material seem to have a resistivity of about 1 ohm per square and the special kapton material that we ordered with 2.5×10^{-5} cm of aluminum measures about 1/4 ohm per square. Both examples indicate an effective volume resistivity considerably higher than 2.62 micro-ohms cm. (the resistivity of pure aluminum).

In order to clarify this situation I measured the thickness of the aluminum coating in the following way. I took a sample out of the center of the roll of polycarbonate material near the samples that I took to measure the resistivity. The sample was 12 1/8 inch wide by 7 3/4 inch long referring to the width and length of the roll. I cut it up into 8 approximately equal parts and measured the total weight of the sample on a Mettler electronic balance in the chemistry building. This balance is accurate to 0.1 mg. I then etched off the aluminum with a dilute NaOH solution and reweighed the sample. The difference was 28.2 mg. Using the density of aluminum 2700 mg/cc and the area of 606 cm^2 I obtained an effective thickness of 1.72×10^{-5} cm. This explains partly why the resistivity is so low. I also measured the thickness of the coating on the kapton. This time I used the whole width of the roll (5 inches) and a section 11 3/4 inch long. The weight of aluminum was 17.3 mg over an area of 379 cm^2 giving 1.69×10^{-5} cm for the thickness. I also took another sample

of the polycarbonate with an area of 379 cm^2 and obtained a weight of aluminum, of 16.8 mg determining a thickness of $1.64X10^{-5}$ cm. The two measurements of the polycarbonate agree well. It looks like the kapton material and the polycarbonate material have the same surface resistance because they have essentially the same thickness of aluminum. The man at Sheldahl warned me, however, that kapton takes up water quite easily and more adsorbed water on the sample after etching would cause the result to be too small. The polycarbonate adsorbs less water but the same effect would imply a thickness in excess of what was measured.

At Sheldahl they monitor the thickness for most materials including the kapton. But they don't measure the thickness of the polycarbonate material probably because it is opaque. Instead they monitor the feed of aluminum being evaporated and the feed of the material as it goes through the metalizing chamber. They calibrate against the rate of deposition known to occur for other film materials under the same conditions. The man at Sheldahl assured me that the material can be reproduced by referring to the lot number, and the records that Sheldahl keeps about the production will allow them to duplicate the process exactly. The tolerance should be to 20%. That doesn't answer the question why is this new material diferent from the old but we should be able to get 1/4 ohm per square in the future.

I measured the variation of the surface resistivity over the width of a sheet. The narrow, 5 inch wide, kapton roll only varied by 20% over the width with the resistivity being higher at the edge. The 23 1/2 inch polycarbonate roll comes with a warning that the metalization is not complete all the way to the edge; specifically it says that 1/2 inch on each side should be considered as waste. I find that we should throw away 2 inches off each side to obtain a 20% variation of the surface resistivity. As far as measuring along the length I have only sampled at three places successively 2 feet apart on the end of the roll and find no significant difference at the level of 10%. The kapton roll may have been trimmed from a wider sheet and that is why it has a small variation. Or it may have been run through a metalizing machine meant for a larger width. It may be that the wider stuff could also be run through a different machine which would reduce the variation near the edges. There would naturally be a difference in cost. Fig. 1 show the variation of the surface resistivity over the width for the two samples we have.

The method for measuring the variation of surface resistivity was to cut strips parallel to the length of the sheet at different distances from the edge. Each strip was 6 1/8 inches long and 1/2 inch wide. Then I placed each strip on a moderately soft surface and

pressed the edges of the multimeter probes against the strip 1/16 inch from either end. The surface resistivity is then the measured resistance divided by 12.

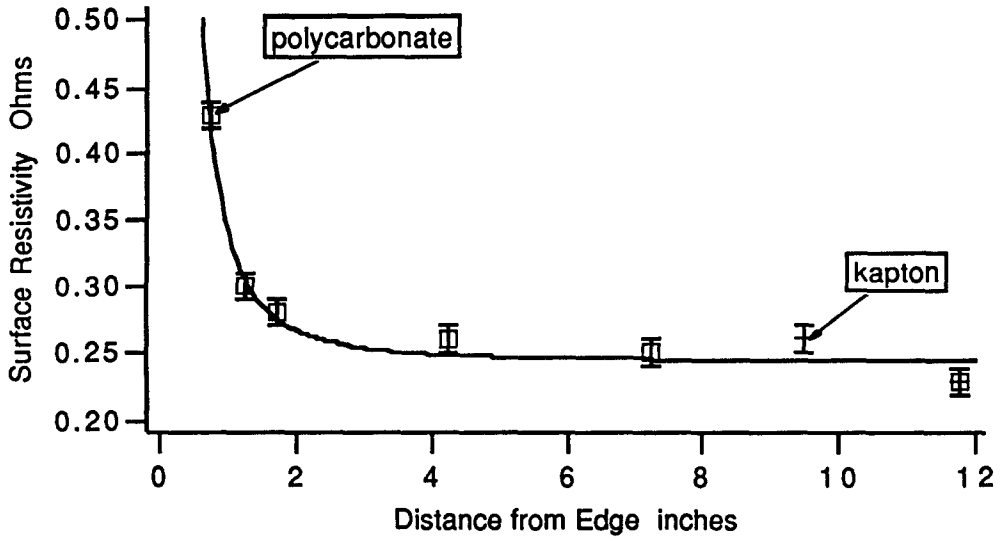

Fig.1