Preparation of Conductive Coating for RPC

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Introduction

Conductive coating is essential for the operation and performance of Resistive Plate Chambers (RPCs), commonly used as tracking detectors in high-energy physics experiments. In these detectors, the conductive coating acts as an electrode, applying high voltage across its surface for accurate particle tracking and detection. The signal is induced on the resistive coating, which confines the electron avalanche signal within the gas gap of the detector, enhancing spatial resolution and enabling precise localization of particle interactions. Additionally, the resistive coating reduces cross-talk between adjacent pickup strips, minimizing noise and improving the overall performance of the detector.

Choosing the right conductive coating material is crucial for RPCs, which operate under varying temperature and humidity conditions. Graphite is an ideal option due to its low cost, electrical conductivity, and thermal resistivity, ensuring a uniform electric field and durability against environmental changes. Additionally, the coating must adhere well to various substrates like glass, bakelite, and acrylic.

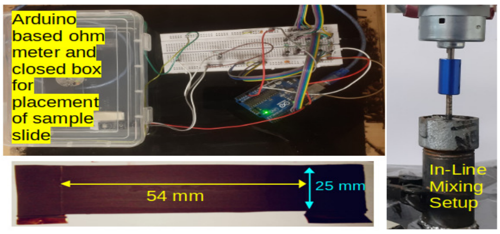

FIG. 1: Setup used for sample preparation and resistance measurement.

In this work, our goal is to develop an affordable, indigenous resistive coating that enhances the efficiency and positional resolution of RPCs. Achieving a consistent and replicable conductive coating is vital for improving the performance of RPC detectors, significantly impacting their functionality in high-energy physics experiments. Additionally, this innovative coating has the potential for further applications in EMI/RFI shielding, broadening its utility and importance in various technological fields.

Methodology

We employed nitrocellulose paint as the binder adhesive due to its availability and versatility, making it suitable for application on various substrates such as glass and acrylic. In this formulation, graphite was incorporated as the pigment, serving as an effective charge-inducing agent. To achieve a uniform dispersion of the graphite pigments, we utilized NC thinner as a dispersing agent, along with an indigenously developed inline mixing unit for thorough blending. This methodology ensures that the prepared mixture possesses the desired properties for effective application in RPCs.

The conductive coat was then applied manually by brush onto slides measuring 5.4 cm × 2.5 cm. To measure surface resistivity, copper strips were attached to each end of the slides. Initial measurements were conducted using a multimeter capable of reading up to $60 M\Omega$ during the first two minutes. To monitor resistivity over time until saturation was reached, we employed an auto-ranging Arduino ohm-

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meter, which provides reliable measurements up to $2M\Omega$. This comprehensive approach not only verifies the conductive coating's performance but also emphasizes its potential impact on enhancing the functionality of RPCs in high-energy physics applications. In order to check the if we can extrapolate the results, we have qudraple the Sample area, and result does not changes.

Results

Our analysis of the conductive coating application highlighted two key factors essential for achieving stable resistance values. First, we observed an initial stabilization period during which resistance fluctuates significantly. Following the application, the dispersing agent evaporates, and the graphite settles, leading to variable resistance until the coating dries. Once dried, the resistance stabilizes, maintaining a consistent value over time. Figure 2 illustrates the resistance versus time for different amounts of graphite pigment, showing an initial dip in resistance due to moisture content, followed by a more stable pattern as the coating dries. For lower graphite concentrations, higher resistivity was noted, with fluctuations likely arising from the systematic variability of the Arduino-based ohmmeter at high impedance. External factors such as temperature, humidity, and dust exposure also contributed to these fluctuations, especially since earlier measurements were taken in an open system. Second, the proportion of graphite in the coating significantly impacts resistance. As illustrated in Figure 3, increasing the graphite content leads to decreased resistivity. However, we noted instability at higher concentrations, particularly a marked increase in resistivity at 1350 mg. This trend was consistently confirmed through repeated sample preparations in closed systems.

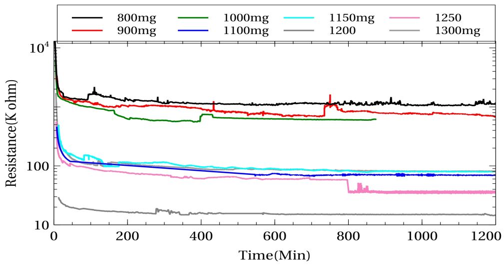

FIG. 2: Variation of the resistance as a function of time for different amounts of graphite mixing. The initial value of the resistance is very high and drops rapidly for an initial few seconds. Over a sufficient period of time the sample achieves its saturation value.

To enhance the uniformity and reliability of our conductive coatings, we are currently exploring alternative application methods, such as spin coating and dip coating, which could ensure a consistent layer thickness. Additionally, we are considering the use of a homogenizer for mixing to improve consistency in the paint formulation. These strategies are anticipated to yield more reliable and reproducible results, ultimately enhancing the performance of RPCs in high-energy physics applications.

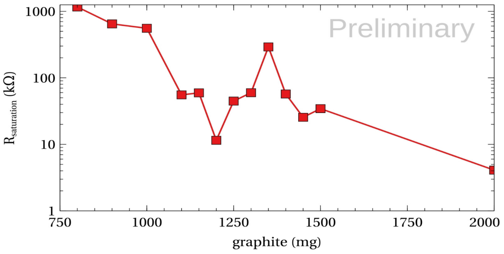

FIG. 3: Variation in saturated surface resistivity of the slide with the increasing amount of the graphite pigment.

Acknowledgments

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