CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

J0904

Project Title

Zappity Zap Zap: The Breakdown Voltage for Two Different Types of Electrodes

Abstract

Objectives/Goals

Gases normally do not conduct electricity. When a large voltage is applied, current will flow through the gas. This is called the breakdown voltage. At atmospheric pressure, the breakdown voltage is thousands of volts. As the pressure decreases, the breakdown voltage also decreases. At a specific pressure, the breakdown voltage begins to increase. This is called Paschen#s Law.

In my project, I wanted to measure the breakdown voltages for two different electrodes: spherical electrodes and parallel plate electrodes. My hypothesis was that parallel plate electrodes will more accurately match the theoretical Paschen curve than spherical electrodes.

Methods/Materials

To test my hypothesis, I built two electrodes, one set of parallel plate electrodes and one set of spherical electrodes, assembled from stainless steel. The breakdown voltages were measured in nitrogen gas using a vacuum chamber located at Surface Optics Corporation. The voltage and pressure were varied and the breakdown of the gas was observed by looking for an arc between the electrodes and by measuring the current flowing through the electrodes.

Results

The discharge appeared as a bright line between the electrodes. When I observed the discharge between the spherical electrodes, the bright line was stationary. It was difficult to observe the discharge in the parallel plate electrodes because it was not stationary. The spherical electrode measurements appeared to match the Paschen curve and were repeatable. However, the parallel plate measurements did not match the Paschen curve and were not repeatable.

I also measured the current flowing through the gas between the electrodes. The spherical and parallel plate electrodes both matched the Paschen curve. However, there was an anomaly in the data that appeared for both electrodes.

Conclusions/Discussion

When I analyzed the data based upon current measurements, the parallel plates match the Paschen curve more closely than the spherical electrodes. Visually observing the discharge was not as good a measurement because it was subjective and it was very likely that the data was unreliable.

There was an anomaly in the Paschen curve. It turns out that the anomaly was two Paschen curves overlaid. One of the Paschen curves represented current flowing from the cathode to the anode. The other Paschen curve represented current flowing from the cathode to the chamber walls.

Summary Statement

I measured the current flowing through a rarified gas as a function of voltage, pressure, and electrode design.

Help Received

Father helped edit report; Used the lab equipment at Surface Optics Corporation under Mr. Dummer, Ms. Zimmerman, and Mr. Colsen's supervision