Abstract

Perfect plasma environments rarely occur in the natural world; instead, plasmas are often mixed with neutral particles and other trace elements, giving rise to the name dusty plasma. Dusty plasma physics is a subject that is being researched extensively in the fields of plasma science, astrophysics, semiconductors, nuclear fusion, nanotechnology, and crystal physics.

From research conducted, dusty plasma chambers are possible. A dusty plasma chamber that can be used for research is the Naval Research Laboratory’s DUPLIX chamber. This chamber creates a dusty plasma within a clear chamber, in which all experiments can be easily observed. A dusty plasma chamber will serve as an asset to Embry-Riddle Aeronautical University for conducting research in plasma physics which has applications to a myriad of fields, as listed above. The purpose of this project is to construct the chamber to certain requirements to accommodate for a more functional chamber and to fit within a small budget, in which the new design is seen overall structure for the chamber, as seen in Figure 2. However, several design changes have been made to accomplish a more functional chamber and to fit within a small budget, in which the new design is seen in Figure 3.

Introduction

A plasma is an electrified gas of charged particles, with equal amounts of positively charged and negatively charged particles, such that it is neutral. Some familiar examples of plasmas include a lightning bolt, neon lights, and the Aurora Borealis. Much of the universe consists of plasmas, including the Van Allen Radiation belts, the solar wind, and interstellar nebulae.

Dusty Plasma consists of background plasma (electrons, ions, and neutral atoms) and charged microparticles (i.e., “dust”). A dusty plasma is an ionized gas containing dust particles, with sizes ranging from tens of nanometers to hundreds of microns. The interaction of the dust particles with the plasma and ambient environment results in a charging of the dust grains. The dust particles can be in the shape of spheres of rods or irregularly shaped particles. They are typically much more massive than the electrons and ions. The dust particles acquire an electric charge in the plasma (a very interesting feature), usually a negative one.

Results

The DPC is currently being prepared to start testing for a voltage drop and creation of a plasma. The major work and modifications completed thus far include:

- “Duster” designs were added to the chamber to safely release dust into the chamber along with other additions and changes.
- Removing the acrylic flanges and adding a boss to the flanges.

Testing of the roughing pump and vacuum pump with the chamber in small increments and applying modifications to compromise leaks.

Placement of the anode/cathode and prepping for a test with the power source.

Once every component is in place and the vacuum is at our goal vacuum (10^-6 torr), the power source will be turned on to very low current and a low voltage. The voltage will be increased in very small increments and the current will be increased only a small amount. Once the chamber has proven reliable with a combined vacuum feedthrough, and an electrical feedthrough.

Conclusion

This project has provided experience with mechanical engineering, electrical engineering, manufacturing, plasma physics, and vacuum technologies as part of an individual senior design project for the Bachelor of Science degree in Engineering Physics. It will provide an outlet for future students and professors to learn more about space plasmas and to conduct experiments. The design and concepts for the objectives and requirements have been completed and the DPC has been built. The chamber vacuum has also been tested and is ready for voltage testing. Once the voltage drop has been tested, plasma creation will be the primary short term goal.