CHAPTER 5

CONCLUSION

A transient hollow cathode device has been studied experimentally in several aspects. These include the variation of the pressure, voltage, the volume of the hollow cathode and measurements of the electron beam energy in the pre-breakdown phase. Various diagnostic tools are used such as Rogowski coil, charge collector and PIN diodes.

The geometry of the hollow cathode used here is different from conventional transient hollow cathode device. In the pre-breakdown phase, the electric potential contour and field lines distribution for this geometry have been computed by using the relaxation method in two dimensions to solve the Laplace's equation in cylindrical coordinates. The distribution of the electric field lines shows that along the axis of the symmetry of the system there is a high concentration of the electric field lines similar to those in the conventional transient hollow cathode device. This indicates that such a geometry is indeed suitable to be used as hollow cathode. This is confirmed by the detection of the electron beam experimentally.

The effect of the pressure on the electron beam generation in the transient hollow cathode discharge has been investigated. When the pressure is low, the intensity of electron beam is low. It is observed that there is an optimum pressure of 1.5 x 10^{-2} mbar, where the intensity of the electron beam output reaches its maximum. No electron beam signal is observed at a pressure of 4.0 x 10^{-2} mbar for the carbon disc but the copper disc still shows the existence of low level electron beam. At pressures higher than 4 x 10^{-2} mbar, no electron beam is observed.

To investigate the influence of the volume of the hollow cathode on the electron beam, two different diameters of the hollow cathode are used, which are 1.5 mm and 5 mm and both with the length of 12.5 mm. The experiment shows that the 5 mm diameter of the hollow cathode produces higher intensity of electron beam.

It is believed that due to the joule heating of the air inside the discharge chamber during the discharge, the rise time of the dI/dt signals is slow, particularly at low pressures. As the pressure increases to 4.0 x 10^{-2} mbar, the rise time of the dI/dt is reduced. The use of charge collector to detect the electron beam was not successful since it is also sensitive to UV light.

The study of the temporal evolution of the electron beam energy shows that the electron beam energy has a value almost as high as the charging voltage during the pre-breakdown phase. The electron beam energy drops during the breakdown.

5.1 Suggestion For Future Work

1) The size of the hollow cathode in this project are not optimized. Only two diameters of the hollow cathode have been tested, that is 1.5 mm and 5 mm, both with depth of 12.5 mm. To determine the optimum size of the hollow cathode for the production of maximum electron beam intensity, a systematic variation of the diameter and the depth of the hollow cathode must be investigated.

2) In this project, air is the only gas is used. According to Gastel *[M. Gastel, et al., 1995]*, different gases will produce different intensity of the electron beam. For this system, hydrogen, helium and argon may be used to observe the variation of the intensity of the electron beam in different gases.

3) The application of the electron beam for interaction with materials such as silicon can be considered.