CHAPTER 5

CONCLUSION

5.1 CONCLUSION

In this study, a computer model for simulation of a nitrogen gas discharge under the non-uniform electrical field had been completely developed. This new model had includes the powerful Phoenical SHASTA FCT algorithm that can simulate the fluid behavior of the plasma with higher accuracy and stability. This present model has also take care of the motion of the charge particles while calculating the internal current of the discharge channel under a non-uniform electrical field. Finally, the simulation of the electrical field variation in the discharge gap enabled the study on space charge effect and the cathode sheath formation.

Several testing methods had been carried out in this study. The power of the FCT algorithm was tested and its accuracy was demonstrated while solving the continuity equation and the fluid equation, using an auxiliary step. The new model was also tested under the uniform electrical field and its results were shown to be numerically identical with the Fitzsimmons's model. This new model was then used to simulate the time-dependent electron density distribution. The space charge effect and the formation of the cathode sheath had been studied. The important role of the ion bombardment process for creating the secondary electron emission had been investigated. The effect of some external

parameters such as the electrical discharge properties and gas pressures had been tested on its influences on the space charge effect, and further on the electrical discharge behaviors.

The relationship between the formation and collapse of the cathode sheath with the electrical breakdown process had been identified. From this model, the electrical discharge voltage of the gap could indicate when the cathode sheath had completely collapsed. This result is comparable to the simulation under the uniform electrical field.

The results also showed that the space charge effect could be distinctly seen before the complete breakdown process and its formation could be seen over a very short period, in terms of a few nanoseconds. However, the role played by these natural phenomena could not be ignored and are important while creating the secondary properties at the surface of the cathode. The breakdown process could be clearly understood from the microscopic point of view with this new model.

However, the program has difficulty in modeling the great distortion of cathode region between a few millimeters with the finite mesh size. If finer mesh sizes were selected, more computing time was needed. This will increase in the propagation of numerical errors. In the future investigation, this computational source code can be upgraded to employ a non-uniform mesh FCT algorithm. Some important secondary emission properties such as the photon-bombardment process and the photoemission process can then be included for the purpose of higher accuracy. This one-dimensional model is also not suitable to be applied for the case of pin to plate electrode discharge configuration. The two-dimensional model is needed for that purpose.

As a conclusion, a simulation of the space charge effect in the electrical discharge for the nitrogen gas laser had been successfully implemented and various effects had been investigated.