Chapter 5

Conclusions and Suggestions for Future Work

5.1 Conclusions

A small RF planar coil inductively coupled plasma system has been designed and constructed. The general behaviour of the characteristic E to H mode transition present in the inductively coupled plasma has been studied by using three types of gases, namely argon, hydrogen and methane. Application of the system for plasma enhanced chemical vapour deposition of diamondlike carbon thin film on silicon substrate has been carried out.

The system is powered by a 600W, 13.56MHz RF generator and is coupled to the load via a matching network consisting of a transformer and variable vacuum capacitor. The variable capacitor is calibrated and used to tune the circuit in order to transfer maximum power to the plasma. A capacitive voltage probe is constructed and calibrated to give a calibration factor of 13.9. While the coil current is measured by a pearson probe with a factor of 2 A/V.

An E to H mode transition in argon plasma, hydrogen plasma, and methane-hydrogen admixture plasma have been studied at different pressure and different power. The changes in the emission intensity of plasma, coil current and coil voltage have been observed during the E to H mode transition. All of these changes exhibit hyteresis behaviour. The concentration of plasma with a glass funnel is formed to be able to reduce the RF power required for achieving the H mode discharge. Besides that, the induction heating effect of silicon substrate has been studied and it is sufficient to heat up the sample to 800 to 900°C. It is found that the RF power available in the present system is not sufficient to achieve H mode discharge when induction heating of the silicon substrate occurs since a portion of the RF power is used to induced the eddy current on the silicon substrate.

The different conditions for PECVD of diamondlike carbon films on silicon substrates have been studied. The different percentage of methane mixed with hydrogen have been shown to have significant effect on the texture of the surface morphology of the diamondlike carbon thin film. The percentage of the methane gas mixed with hydrogen gas should be less than 1 % in order to deposit a better quality diamondlike carbon film. Besides, the pretreatment of the diamond paste on the silicon substrate seems to improve the nucleation of the diamondlike carbon film. The study also shows that induction heating which can heat up the sample to 800-900°C is important for the nucleation and growth of diamondlike carbon film. However, the induction heating process is not able to spread the temperature uniformly and consequently the diamondlike carbon film coated on the surface is not uniform.

5.2 Suggestions for future work

One of the weaknesses of the current ICPs is that the heating of the sample is not uniform and the substrate temperature achieved is dependent on the type of substrate. Different type of substrate may have different value of eddy current induced inside the substrate and hence will give different heating effect of the sample. Besides, the heating is dependent on the RF power. For a better control of the substrate temperature, a controllable heater should be used to heat the substrate. For this purpose, a properly designed substrate table is required.

Reports by various workers show that the use of mixtures of $H_2/CO_2/CH_4$, $H_2/CO/CH_4$, $H_2/O_2/CH_4$ or H_2/CO_2 will enhance diamond or diamondlike carbon films growth and improve the quality of the diamond film deposited (the percentage of the sp^3 bonds is higher) [5,6]. The mixtures of carbon monoxide or carbon dioxide with hydrogen and methane can be used for future experiments to be carried out with the present system.