Abstract

At the onset of this study, the work presented in Chapter 3 of this thesis was the primary focus. The work was motivated by JF Prins where he observed the formation of diamond layers on copper followed by C^+ implantation into copper. This initial result suggested that it may be possible to generate single crystal diamond layers on single crystal copper. Subsequent efforts to reproduce this result failed. A unique end station was developed where a number of parameters could be altered during the implantation process. A series of carbon ion implantations were carried out on copper and copper-nickel (FCC) single crystals in this end station. The layers were characterised using initially Auger Electron Spectroscopy (AES), Low Energy Electron Diffraction (LEED) and later Raman Spectroscopy. During the early period of this study, the surface science equipment at the then Wits-Schonland Research Institute for Nuclear Sciences, was constantly giving problems. The time constraints on waiting for funds to be made available to repair the equipment, urged me to pursue alternative research endeavours and the results of this research is presented in chapter 4 and 5. The initial work will be investigated further in the future. Details of the end station are presented and the initial results of carbon layers generated in this end station are presented.

In chapter 4, a study of C^+ implantation into a type IIa (FCC single crystal) diamond using the cold implantation rapid annealing (CIRA) technique is reported. The Raman spectrum was recorded as a function of annealing temperature and C^+ ion dose. Defect peaks at 1450, 1498 and 1638 cm^{-1} appear in the Raman spectra, which have been previously considered to be unique to MeV implantation. The maximum energy of implantation used in this study was 170 keV. The peaks were monitored as a function of annealing temperature and ion dose. The annealing behaviour of the peaks were similar to those observed in the MeV implantation experiments. It is thus concluded that the defects that give rise to these peaks are related to the point-defect interactions that occur within the implantation regime and not to the implantation energy.

Understanding the nature of the defects that arise during the implantation annealing process, allows one to manipulate the implantation-annealing cycle, so as to generate defect structures that are useful in the fabrication of an active device in a diamond substrate. This is shown in chapter 5.

A p-type (type IIb, FCC crystal) diamond was implanted with either carbon or phosphorus ions using the cold implantation rapid annealing (CIRA) process. In each case, the energies and doses were chosen such that upon annealing, the implanted layer would act as an n-type electrode. The electroluminescence (EL) emitted from these carbon and phosphorus junctions, when biased in the forward direction, was compared as functions of annealing and diode temperatures. Typical luminescence bands such as those observed in cathodoluminescence (CL), in particular blue band A (2.90 eV) and green band (2.40 eV) were observed. Two bands centred around 2.06 and 4.0 eV were also observed for both the carbon and phosphorus junctions, while a band at 4.45 eV appeared only in the phosphorus implanted junction. This was the first time that the 4.45 eV band was observed in an electroluminescent junction.