ABSTRACT

The objective of this project is to study the structural, optical and electrical properties of crystalline and amorphous semiconductors. The crystalline semiconductors studied in this work are Germanium and Silicon while thin film hydrogenated amorphous Silicon (a-Si:H) is the amorphous semiconductor studied. The crystalline Germanium and Silicon are grown commercially while the hydrogenated amorphous Silicon was prepared using a home-built horizontal d.c. plasma glow discharge system from a pure silane discharge. For the a-Si:H samples, two sets of samples prepared using different silane flow-rates are studied. These sample are also annealed at temperatures of 300^0C and 500^0C to study the effects of annealing on these properties.

The x-ray diffraction technique is used to confirm the crystallinity and amorphous nature of these samples. Fourier Transform Infra-Red Spectroscopy technique is used as a tool to determine the bonding configurations present in the a-Si:H film. The hydrogen content in the film is also determined from the infra-red spectrum of the a-Si:H film. The optical transmission spectrum in the ultra-violet to near infra-red wavelength region is used to determine the energy gap of the crystalline silicon while for the a-Si:H film, this spectrum is used to determine various parameters namely refractive index, film thickness, hydrogen content, optical energy gap and the Urbach tail band width. Alternating and direct-current conductivity measurements are carried out on both the crystalline and amorphous semiconductors studied. For the d.c. conductivity measurement the Four Point Probe technique is used on the crystalline Germanium while the normal current-voltage measurement technique is used on the crystalline Silicon and the a-Si:H samples. Variation

of capacitance and conductance with frequency measurement is used in the a.c. conductivity studies of these materials. The conductivity and the activation energy of the crystalline Silicon and a-Si:H are obtained from the d.c. conductivity measurements. The density of states of the a-Si:H film at the Fermi Level is determined from the a.c. conductivity measurement. The resistivity, the carrier density, the energy gap, the hole mobility and the activation energy of the crystalline Silicon and Germanium are determined from the d.c. conductivity and the Hall effect measurements.

The results of the characterisations done on the crystalline semiconductors show that the magnitudes of the above parameters determined are close to the standard values for these materials as reported in the literature. As for the a-Si:H samples studied, the results show that hydrogen plays an important role in the structural, optical and electrical properties of the film. However, it is not the hydrogen content in the film that determines these properties but the manner in which the hydrogen atoms are incorporated is the more dominant factor.