Siemens Sensor Developments: Material Design and Characterisation

Common effort of the Institut für Experimentelle Physik, Universität Hamburg, and the Institut für Experimentelle Kernphysik, KIT

Introduction

The work package combines the infrastructure and expertise needed to develop silicon sensors for future high energy experiments at the LHC. Especially, the upgrade of the LHC (LHCb) requires to increase the radiation tolerance of the silicon detectors to be used in the experiments. With the help of the Helmholtz Alliance AFA (Alliance for Future Accelerators) the two institutes could improve their experimental setup. They are prepared to measure all relevant microscopic and macroscopic parameters of silicon sensors as they are needed for further developments. The concept is in accordance with all Alliance members and comprises:

- Proton irradiation facility (20MeV)
- Heavy ion facility (HIC)
- Manual and semi-automatic probe stations
- Thermally Stimulated Current (TSC) Setup
- Deep Level Transient Spectroscopy (DLTS) Setup
- Transmission Current (TC) Setup
- Multi-channeled TCT
- Random system for strip sensors
- Cosmic Telescope

Proton Irradiation Facility

The 20 MeV proton beam is available to study the effects of the higher energy regime. The first batch of sensors will be irradiated and the results will be published in the near future. The location of the facility is in Hamburg.

X-Ray Irradiation Facilities

Synchrotron source at Hamburg

The synchrotron source in Hamburg is a very sensitive tool for the characterization of irradiated sensors. Experiments and studies were performed in Hamburg [2].

Probe stations for sensor characterisation

A first version of a short strip mini sensor has been designed and integrated in the wafer fabrication process at Karlsruhe. The setup has been used by the universities Bonn, Dortmund, Freiburg, Karlsruhe and HHL München, which results in a total of 100 hours of beam time.

Thermally Stimulated Current

The concept

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Deep Level Transient Spectroscopy

The General

Deep Level Transient Spectroscopy (DLTS) is a technique for measuring the interband transition (DLTS) caused by the emission of the charge carriers. The signal contains information about the type of active defects, their concentration and the energy position of the energy levels.

Impact of microscopic defects on the effective doping concentration

The results from the TSC-defect investigations were used to predict the annealing effects of P, which are then compared with the measured annealing effects of P in MCz and a high-resistivity p-type silicon wafer. The results show a good agreement between predictions and results for the annealing effects in the high-resistivity p-type silicon wafer and the MCz wafer. The effects of P annealing on the effective doping concentration can be extracted from the effective doping concentration.

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Deep Level Transient Spectroscopy

A correlation between the generation of the dark current and the radiative hole (due to a defect) can be observed. This is achieved by using a high temperature and a low bias voltage. The results show a good agreement between predictions and results for the annealing effects in the high-resistivity p-type silicon wafer and the MCz wafer. The effects of P annealing on the effective doping concentration can be extracted from the results of the DLTS experiments.

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