Contribution ID: **9** Type: **not specified**

Investigation of the insulator layers for segmented silicon sensors before and after X-ray irradiation

Friday 21 November 2014 10:50 (20 minutes)

For the proper simulation and understanding of segmented silicon sensors the surface boundary conditions and the charge density distribution in the SiO2 layer (and other insulator layers if present), as well as at the Si-SiO2 interface have to be known. It has been observed previously, that the boundary conditions on the sensor surface change with relative humidity, RH. A simulation example of time dependent surface potential of an AC coupled n+-p sensor with p-spray will be presented.

We therefore have measured the surface conductivity of SiO2 at room temperature for RH values between 30 and 46 using a Gate Controlled Diode fabricated on n-type high-ohmic Si, and for RH = 50% using a MOSFET. For determining the effective oxide-charge density, Neff_ox, which is required
for sensor simulations, as function of ionizing dose and biasing conditions, capacitance-voltage-frequency (C-V-f) measurements on MOS
capacitors (MOS-C) irradiated up to SiO2 doses of 1GGy by 10 keV X-rays were performed previously. Large hysteresis effects were observed when the voltage was ramped from accumulation to deep inversion and back. We interpreted these shifts
as evidence for field-enhanced injection of charges from the Si into the SiO2. Here we present C-V-f measurements on MOS-Cs fabricated on <100> and <111> high-ohmic Si, without irradiation and after X-ray irradiation to 1 GGy. In order
to determine the time- and field-dependence of the injection of positive charges from the Si into SiO2, the MOS-Cs have been biased at different voltages in inversion for different time intervals.

Summary

The performance of segmented Si-sensors is influenced by the conditions at the sensor surface and at the Si-SiO2 interface.

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Session Classification: TCAD and Surface Damage