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TCT characterization and scanning of fine pitch of n+-in-p pixel detectors

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Previously, fabrication of n+-in-p AC-coupled pixel detectors on p-type magnetic Czochralski silicon substrates at Micronova Nanofab facilities in Espoo, Finland has been reported. In our pixel detectors, we employ a layer of aluminum oxide (Al2O3) grown by atomic layer deposition (ALD) as dielectric and field insulator, instead of the commonly used SiO2. The high dielectric constant and dielectric strength of Al2O3 facilitates the implementation capacitive coupling, which separates the signal from the significantly increased leakage currents caused by radiation damage in the silicon detector. In addition, Al2O3 exhibits high negative oxide charges and thus serves as a substitute for p-stop/p-spray insulation implants between pixels. The charge and interface properties of the Al2O3 film can be by the ALD process, most importantly by the choice of oxygen precursor.

Our detectors have two geometries. First, 80 × 52 pixels in 26 double columns, compatible for flip-chip bonding with the currently used CMS PSI46dig readout chip (ROC). The size of the pixel in this layout is 120µm × 70µm. The size of the detector chip is 1 cm2 and the pixel are capacitively coupled (AC). The second geometry we have implemented on 150mm wafers is a larger 2cm × 1cm size detector. This follows the design of RD53 ROC to be foreseen in the future. The size of the pixel is 40µm × 40µm and layout forms a symmetric 400 × 192 matrix with 50µm pitch. The "RD53"sensor is DC coupled. In both designs the pixels are resistively connected by integrated metal nitride thin film bias resistors.

Here, we report Transient Current Technique (TCT) characterization of above-mentioned detectors. TCT measurements have been carried out by 660nm (RED) and 1064nm (IR) lasers for different bias voltages. Our TCT setup provided by Particulars d.o.o, allows scanning measurements in xyz –directions and the data is read out by a 4GHz Oscilloscope. With focused laser beam, TCT area scans reveal microstructure of those detectors. A emphasize has been put on analyzing the data to determent the homogeneity over the active pixel area. Analytic methods like the Discrete Fourier Transform (DFT) were performed to disentangle mechanical and stage controller issues.

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