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Determination of the p-spray profile for n^+ p silicon sensors using a MOSFET

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The standard technique to electrically isolate the n^+ implants of segmented silicon sensors fabricated on high-ohmic p-type silicon are p^+-implants.
Although the knowledge of the p^+-implant dose and of the doping profile is highly relevant for the understanding and optimisation of sensors,this information is usually not available from the vendors, and methods to obtain it are highly welcome.The paper presents methods to obtain this information from circular MOSFETs fabricated as test structures on the same wafer as the sensors. Two circular MOSFETs, one with and one without a p^+-implant under the gate, are used for this study. They were produced on Magnetic Czochralski silicon doped with $\approx 3.5 \times 10^{12}\text{cm}^{-2}$ of boron and $\langle 100 \rangle$ crystal orientation. The drain-source current as function of gate voltage for different back-side voltages is measured at a drain-source voltage of 50\,mV in the linear MOSFET region, and the values of threshold voltage and mobility extracted using the standard MOSFET formulae. To determine the bulk doping, the implantation dose and profile from the data, two methods are used, which give compatible results. The doping profile, which varies between $3.5 \times 10^{12}\text{cm}^{-3}$ and $2 \times 10^{15}\text{cm}^{-3}$ for the MOSFET with p^+-implant, is determined down to a distance of a fraction of a μm from the Si-SiO_2 interface. The method of extracting the doping profiles is verified using data from a TCAD simulation of the two MOSFETs. The details of the methods and of the problems encountered are discussed.

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