On the optimization of dark current in silicon detectors monolithically integrated with CMOS readout circuitry.

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Silicon detectors of ionizing particles and electromagnetic radiation play an important role in high energy physics. The paper describes an effective methodology of minimizing dark currents and early breakdowns in fully depleted ionizing radiation (and particle) detectors in terms of their monolithic integration with readout systems. In such a case both readout circuitry and radiation sensor are integrated within the same wafer. A family of SOI detectors might serve as an example . The read out requires usually complicated technology involving several processes including implantations, high temperature annealing and plasma etchings. These processes are detrimental to the high-resistivity, fully depleted sensor layer), causing the creation of defects resulting in an increase of the dark current and in early breakdowns.

Classic methods of struggling with defects, useful in the production of integrated circuits, cannot be used. They bring good results in the vicinity of the device surface only, while the sensor area extends down to the bottom contact. Also solutions related to photodetector technology are not promising because these detectors are most often produced with use of epitaxial layers with their strong gettering properties.

In this work, an external polysilicon getter was used. Carefully selected technological parameters, along with additional protection of the bottom of the substrate against mechanical damages and technological impurities allowed for a significant reduction of dark currents and for a complete elimination of early breakdowns.