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Low Gain avalanche Diodes Technology: state of the art and future developments

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In the last few years, Low Gain Avalanche diodes (LGAD) have been considered one of the most promising solutions for timing application in HEP experiments, as well as for 4-dimensional tracking, due to some important advantages: larger internal signal, better time resolution and higher radiation hardness with respect to standard p-i-n based sensors.
Although the LGAD technology recently reached a good technology readiness level, an increasing number of foundries and R&D laboratories are proposing novel design schemes and microfabrication technologies mainly focused on improving two key aspects of the technology: i) increasing the radiation hardness at fluence higher than 3e15 neq/cm^2 and ii) improve the spatial resolution moving through fine-pixellated and high-fill-factor sensor designs.
In this contribution, the major technology developments in these directions done at Fondazione Bruno Kessler together with INFN Torino will be presented and discussed, supported by experimental results and simulation studies.
To improve the spatial resolution, a novel segmentation scheme named Trench-Isolated LGAD (TI-LGAD) has been developed. In this technology, the pixel segmentation is obtained by means of trenches, physically etched in the silicon, and filled with silicon oxide. The electrical and functional characterization of the first prototypes before and after irradiation will be presented, prooving the possibility to produce LGAD sensors with a pixel pitch of 50 μm and not-sensitive inter-pixel width less than 5 μm.
Moreover, to improve the radiation hardness at high fluences, novel junction schemes based on dopant co-implantation with electrical inactive elements (like carbon) and compensated doping profiles are under investigations. The outcome from a simulation campaign and the first experimental results will be presented, showing the potentiality of these techniques to mitigate the effect of the radiation damage on some important figure-of-merit of the sensor, like gain and breakdown voltage.

Collaboration

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