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New Developments in Low Gain Avalanche Diode Fabrication Technology

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In the last few years, Low Gain Avalanche diodes (LGAD) obtained growing attention as radiation sensors due to some important advantages: larger internal signal, potentially higher signal-to-noise ratio, better time resolution, and higher radiation hardness with respect to standard p-i-n sensors. They are currently considered state-of-the-art silicon detectors for timing application in HEP experiments, and more recently they are also being investigated as low-energy x-ray segmented detectors (< 1 keV) for synchrotron applications.
An increasing number of foundries and R&D laboratories started to work on this technology by proposing novel designs, mainly focused on increasing the radiation hardness of LGAD and optimizing the segmentation technology for fine-pixel and high-fill-factor sensor production.
In this presentation, the major ongoing developments on LGAD will be reviewed and discussed, supported by experimental results, and with particular attention to the fabrication process and to the technological challenges.
Among the others, some novel segmentation strategies aimed at increasing the fill-factor of fine-pixelated sensors will be discussed: i) inverted-LGAD (i-LGAD); ii) Resistive AC-coupled Detectors (RSD) and Resistive DC-coupled Detectors (DC-RSD); iii) Trench-Isolated LGAD (TI-LGAD); iv) Deep-Junction LGAD (DJ-LGAD).
In addition, new strategies for the production of LGAD operating at extreme fluences above 5e15 neq/cm^2 will be presented. The ideas behind this radiation tolerance are: i) using ultra-thin substrates, ii) optimizing the doping profile by using doping compensation to make it less sensitive to the acceptor removal effect and iii) including some chemical impurities (like Carbon) to mitigate the effect of radiation-induced effects.

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