Highlights

Activity E - Advanced materials and techniques for organic electronics, biomedical and sensing applications - 2021

Investigation of random telegraph signal in two junction layouts of proton irradiated CMOS SPADs

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This paper focuses on the understanding of the Random Telegraph Signal (RTS) in Single-Photon Avalanche Diodes (SPAD). We studied the RTS of two different SPAD layouts, designed and implemented in a 150-nm CMOS process, after proton irradiation. The two structures are characterized by different junction types: the first structure is constituted by a P+/Nwell junction, while the second is formed by a Pwell/Niso junction, see Fig. 1. RTS occurrence has been measured in about one thousand SPAD pixels and the differences addressed in two layouts are motivated and discussed. Hypotheses on the RTS origin are drawn by analyzing the RTS time constants and the RTS occurrence evolution as a function of the annealing temperature.

In order to investigate the RTS behaviour, we measured the RTS characteristics in a sub-set of two-level RTS pixels for each of two SPAD layouts. In a two-level RTS, the time distribution of the DCR levels spent in the high (low) state follows an exponential distribution, see Fig. 2. The distribution time constants represent the inverse of the DCR switching probability. In Fig. 3, the RTS probabilities as a function of sensitive area for two different proton doses are reported.

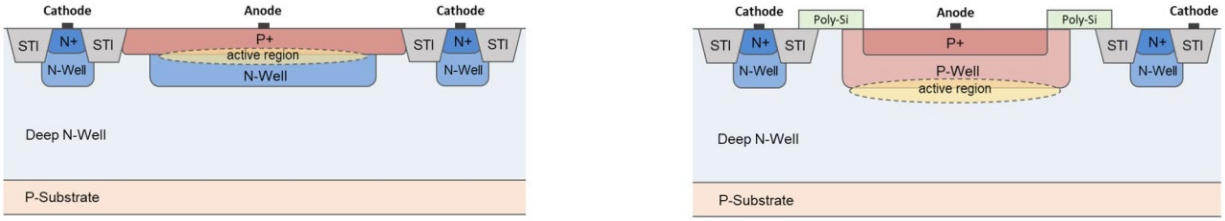

Fig. 1: Layout of SPAD structures: P+/Nwell (left) and Pwell/Niso (right)

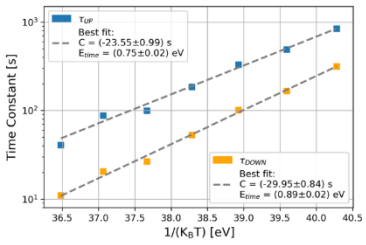

Fig. 2: RTS time constants (for up and down levels) as a function of1/KBT and the extracted values for the activation energy E_{time}.

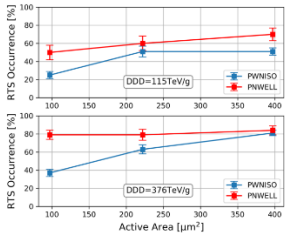

Fig. 3: RTS occurrence as a function of sensitive area for the 115 TeV/g sample (top) and for the 376 TeV/g sample (bottom).