Contribution ID : **475** Type : **not specified**

Development of SPAD detectors with improved sensitivity in NIR region

Tuesday, 22 March 2022 10:00 (20)

Abstract

Near-infrared (NIR) light is used in several non-invasive biomedical techniques to measure blood flow in deep tissues. Light from a NIR laser is injected into the sample and the scattered photons are detected using Single Photon Avalanche Diodes (SPADs), which are Avalanche Photo-Diodes (APD) operated in Geiger mode. From the SPAD signals the local blood flow can be inferred. In this work, we target the development and characterisation of SPADs with high Photon Detection Efficiency (PDE) in the NIR range, low Dark Count Rate (DCR) and fast timing. In the first stage of the project, SPADs with multiplication layers buried at different depths have been designed at IFAE and produced in 150nm CMOS technology. CMOS has the advantage of being a cost-effective commercial technology for production of large matrices and, in addition, allows to build very compact devices thanks to the capability of integrating the quenching mechanism and readout electronics on chip. In this study, we present results of the characterization of SPAD devices with an active area of 50×50 µm2 operated with an external passive quenching circuit. We compared properties, such as DCR and PDE, of the different SPAD designs, and their dependence on temperature. The PDE for 780 nm light of SPADs with a buried multiplication layer was observed to be in the range of 15-20% with a DCR of the order of 2 kHz. The results of these first prototypes are promising and are being followed up by the development of a new generation of SPADs in the CMOS technology at IFAE.

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Session Classification : Investigación orientada, tecnología e innovación

Track Classification : Investigación orientada, tecnología e innovación