Oblong InGaAs/InP SPADs for evanescent waveguide coupling

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InGaAs/InP Single-Photon Avalanche Diodes (SPADs) are the most widespread compact solution for detecting single photons in the short-wavelength infrared (SWIR) range. In the context of applications like quantum communications and quantum computing, a growing interest in the integration of these detectors with photonic integrated circuits (PIC) has emerged in recent years. One of the most promising solutions consists in the heterogeneous integration via evanescent wave coupling [1], where light is coupled to the absorption region of the SPAD by exploiting the length of the InGaAs layer, instead of its thickness. A long and narrow oblong shape represents the perfect choice to maximize the waveguide to SPAD coupling.

In this work, we present the experimental characterization of an oblong SPAD test structure (Fig. 1(a)) fabricated in the same production run of previously reported InGaAs/InP SPADs with round active areas [2]. Fig. 1(b) shows the Dark Count Rate (DCR) of the oblong SPAD at 235 K as a function of the gate period. At longer gate periods the DCR is in the order of few tens of kHz (depending on the excess voltage), while the afterpulsing contribution becomes dominant for shorter periods. The Photon Detection Efficiency (PDE) map of the oblong SPAD at 5 V of excess voltage is reported in Fig. 1(c). The SPAD oblong active area can be appreciated, with efficiency values above 20%. However, the PDE map also highlights increased photon counts outside of the shallow zinc diffusion (continuous black line in Fig. 1(c)) due to charge persistence [3]. The counts increase is exacerbated at the device tips by edge breakdown, which is caused by high electric field produced by the SPAD tips curvature. Further investigations are required for quantifying the different contributions in the efficency map at the edges of the oblong SPAD.

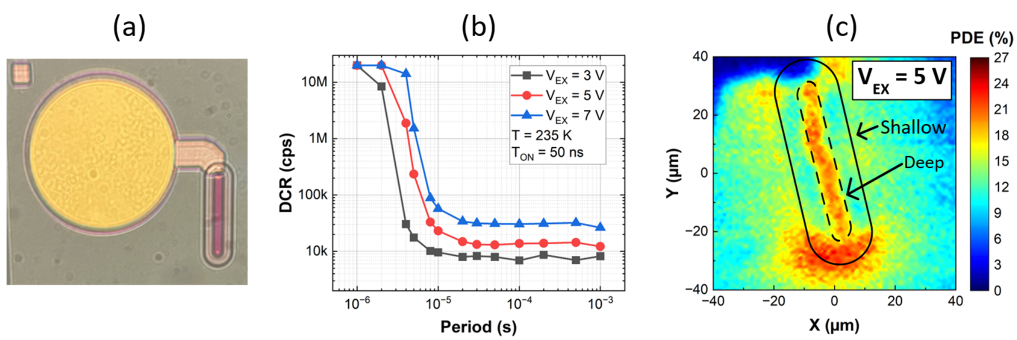

Fig. 1. (a) Oblong SPAD structure. The SPAD has a length of 55 µm and a width of 5 µm (b) Dark Count Rate (DCR) at 235 K for excess voltages of 3 V, 5 V and 7 V. (c) Photon Detection Efficiency (PDE) at 235 K for excess voltage of 5 V. The deep (dotted line) and shallow (continuous line) zinc diffusion regions are highlighted.

References

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