

PDE and Jitter simulation in 3D SPAD Devices.

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Abstract

In this paper we present a full 3D simulation methodology to extract Photon Detection Probability (PDP) and Jitter of Single-Photon Avalanche Diode (SPAD) Devices. The simulation results are compared with measurements on devices and show good agreement with the experiments.

Keywords— single-photon avalanche diode (SPAD), photon detection probability (PDP), jitter, avalanche breakdown probability, breakdown voltage

1 Introduction

Single-photon avalanche diodes (SPADs) are key opto-electronics devices.

2 Device structure and TCAD simulation

3 Avalanche breakdown probability

4 Jitter modelisation

5 Results and comparisons with experiments

6 Discussion

References

[Ascher et al., 1987] Ascher, U. M., Mattheij, R. M. M., and Russell, R. D. (1987). *Numerical Solution of Boundary Value Problems for Ordinary Differential Equations*. Society for Industrial and Applied Mathematics, Philadelphia, 1st edition edition.

[Gulinatti et al., 2009] Gulinatti, A., Rech, I., Assanelli, M., Ghioni, M., and Cova, S. D. (2009). Design-oriented simulation of the Photon Detection Efficiency and temporal response of Single Photon Avalanche Diodes. In *2009 IEEE LEOS Annual Meeting Conference Proceedings*, pages 297–298, Belek-Antalya, Turkey. IEEE.

[Oldham et al., 1972] Oldham, W., Samuelson, R., and Antognetti, P. (1972). Triggering phenomena in avalanche diodes. *IEEE Transactions on Electron Devices*, 19(9):1056–1060.

[Sun et al., 2019] Sun, F., Xu, Y., Wu, Z., and Zhang, J. (2019). A Simple Analytic Modeling Method for

SPAD Timing Jitter Prediction. *IEEE Journal of the Electron Devices Society*, 7:261–267.

[Van Overstraeten and De Man, 1970] Van Overstraeten, R. and De Man, H. (1970). Measurement of the ionization rates in diffused silicon p-n junctions. *Solid-State Electronics*, 13(5):583–608.