Characterisation of Short-Wave Infrared InGaAs/AlGaAsSb Single Photon Avalanche Diode Detectors at Room Temperature

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Single-photon avalanche diodes (SPADs) offer significant advantages, including compact size, operation without cryogenic cooling, and lower manufacturing costs for mass-market applications [1]. Currently, the most widely used SPADs at 1550 nm wavelength utilise an InGaAs absorption layer lattice-matched to an InP multiplication region. However, the InP avalanche material has relatively poor impact ionisation characteristics and a significant temperature dependence of the breakdown voltage. The development of antimony-containing avalanche material lattice-matched to the InP platform enabled a new generation of avalanche photodiodes with low excess noise and high temperature stability. This, in turn, enabled room-temperature mesa-geometry InGaAs/AlGaAsSb SPADs operating at 1550 nm wavelength with a dark count rate (DCR) of 30 Mcps and a maximum single-photon detection efficiency (SPDE) of 14% [2]. Here, we present an InGaAs/AlGaAsSb SPAD operating at 1550 nm wavelength and room temperature. Compared to previous work [2], the device's electric field and processing have been further optimised to improve the performance. Fig. 1a shows the dark (dashed line) and photocurrents illuminated with different laser powers at 1550 nm (solid lines). The SPAD achieves a SPDE of 21% and a DCR of 10 Mcps at an excess bias of 3.6%, as shown in Fig. 1b, leading to ~4× improvement in noise-equivalent-power (NEP) compared to previous work. The NEP is also similar to the Ge-on-Si SPAD reported by Artilux Inc. at λ = 1310 nm and room temperature [3]. Although the SPDE is comparable to planar InGaAs/InP SPADs [4], high dark noise remains a major challenge. A potential future direction would be focused on the proof-of-concept of a planar InGaAs/AlGaAsSb SPAD.

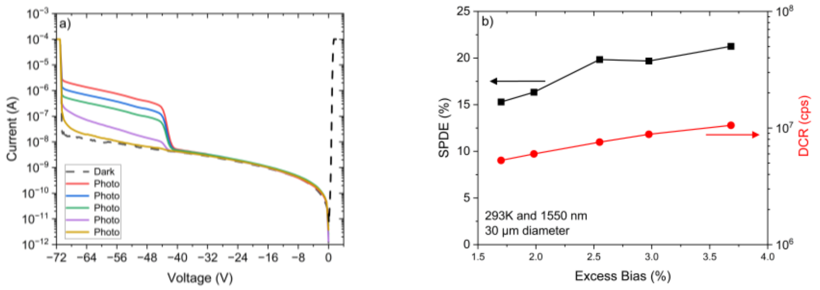

Fig. 1a: *Current-voltage characteristic of a 30 μm diameter device.* ***1b***: *DCR and SPDE at λ = 1550nm for a 30 μm diameter device operating at room temperature.*

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References

[1] L. Saalbach et al, Adv. Phys. X **1** 2611978 (2026).

[2] J, Taylor-Mew et al, IEEE Photonics J. **17** 2000106 (2025).

[3] N. Na et al, Nature **627** 295 (2024).

[4] S. Baek et al, J. Korean Phys. Soc. 78, 634 (2021).