

Superconducting Nano/Microstrip Single-Photon Detectors for Quantum Applications

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Abstract: Superconducting Nanostrip (Microstrip) Single-Photon Detectors (SN(M)SPDs) represent the current gold standard for photon-starved applications in near-infrared. We report on SNSPDs performance in high-demand applications, alongside the development of large-area NbRe and MoSi-based SMSPDs via UV photolithography.

Superconducting Nanostrip Single-Photon Detectors (SNSPDs) are the current gold standard for photon-starved applications at the 1.55 μm telecommunication wavelength. While conventional semiconductor-based detectors exhibit limited sensitivity in the near-infrared, commercial nitride-based SNSPDs (such as NbN or NbTiN) provide unmatched performance accessible by standard cryocooler, including near-unity detection efficiency, milli-hertz dark count rates, picosecond timing jitter, and nanosecond recovery times [1,2]. Nevertheless, significant challenges remain in optimizing these devices for specific applications, particularly regarding large-area coverage, as required for dark matter research [3], or light detection and ranging (LIDAR) [4]. Scaling traditional SNSPDs to these dimensions results in significant kinetic inductance, leading to prolonged dead times and severely limited maximum count rates [2]. To address this limitation, Superconducting Microstrip Single-Photon Detectors (SMSPDs) are emerging as a promising platform, benefitting from simplified fabrication via UV photolithography, which is less expensive and time-consuming when compared to electron beam techniques. Moreover, there is an increasing demand for devices capable of detecting low-energy photons. In free-space communications, for instance, operating in the MIR range significantly reduces solar background interference, a key requirement for space-to-ground integrated quantum networks [5].

We present an overview of our research activity regarding the impact of commercial SNSPDs in high-demand applications [6,7], alongside our recent progress in developing NbRe and MoSi-based SMSPDs, optimized for wide-area and sensitivity in the MIR range [8].

References

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