Superconducting strip photon detectors with widths ranging from several tens to over 100 μm

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Superconducting nano-strip photon detector (SNSPD) is one of the most powerful photon detectors [1]. SNSPDs using superconducting strips with around 100 nm width have achieved dramatical improvements in detection performance over the past two decades. High detection efficiency of more than 90% at near-infrared wavelengths, a few picoseconds timing resolution, Gigahertz counting rate, and extremely low dark count rate have each been demonstrated, and these continue to improve. The SNSPDs are indispensable tool in quantum information technology and are also play active roles in wide range scientific and technological fields, such as lidar remote sensing, bioimaging, space communications, and space exploration.

Here, we introduce our progress in the development of superconducting wide-strip photon detectors (SWSPDs) using much wider superconducting strips. In recent years, superconducting strip photon detectors with micrometer-scale strip width have been actively developed. Superconducting micro-strip detectors (SMSPDs) with widths of around 1 μm were first demonstrated in 2018 [2], and detection efficiencies exceeding 90% have been reported today. These detectors have made the large-area detectors and large-scale imaging sensors more feasible. Within this new trend in development, we have been challenging to detect a single photon using much wider superconducting strips and have succeeded to develop a SWSPD with a strip width of 20 μm. By adopting a new strip structure, which we call a high critical current bank (HCCB) structure, to reduce dark counts and improve detection efficiency, we have demonstrated highly efficient single-photon detection at 1550 and 2000 nm wavelengths [3]-[4]. More recently, we have also succeeded to expand the strip width to over 100 μm. Such extremely wide strips eliminate polarization dependence in detection efficiency and enables to develop unprecedentedly large sensor areas. The wide strip widths also facilitate mass production using photolithography, which contribute to improve the yield of large-pixel number imaging sensors. These characteristics of SWSPD are likely to broaden its range of applications and contribute to further advancements in single-photon technology.

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