Extended Abstract

Advanced Superconducting Nanowire Single Photon Detectors for Photonic Quantum Technologies [†]

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In the field of quantum technologies, the superconducting nanowire single photon detector (SNSPD) is nowadays well recognized as a key enabling device. SNSPDs combine high detection efficiency in the visible and near IR spectral ranges, timing jitter as low as 10 ps, low dark count rate ($<100 \text{ s}^{-1}$) and cut-off frequency above 100 MHz. These features make it particularly attractive e.g. for fundamental quantum optics experiments and quantum communications.

Plug-and-play SNSPDs with fibered optical access, as shown in Figure 1, are based on a meander nanowire defined by patterning an ultrathin ($<10 \text{ nm}$) superconducting film. The device is designed so that absorption of a single photon is enough to brake locally the superconducting order, and to induce a measurable change of the wire's resistance. Until recently, such devices displayed two main limitations: (1) their efficiency did not exceed $\sim 40\%$ due to the limited optical absorption of the thin film; and (2) their response was strongly polarization-sensitive, due to the optical anisotropy of the nanowire. I will present two different approaches which enable to get very high ($>90\%$ [1]) and polarization-insensitive [2,3] detection efficiency. We consider designs based on the integration of the nanowire within an optical microcavity (compatible with the plug-and-play configuration) or on top of an optical waveguide (preferred approach for integration in photonic circuits). I will finally discuss novel application prospects of such detectors, with emphasis on photon-number resolution.

Figure 1. (a) Top-view scanning electron micrographs of the NbN superconducting nanowire used as active core in SNSPDs; (b) SNSPD device mounted on a print circuit board with fibered optical access.

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