16th International Workshop on Low Temperature Detectors
20 24 July 2015

X-ray sensititve and energy-dispersive superconducting nanowire single-photon detectors

Main author:

ZHANG Xiaofu

Co-authors:

Andreas Engel, Physik-Institut, Universität Zürich
Andreas Schilling, Physik-Institut, Universität Zürich
Inderbitzin Kevin, Physik-Institut, Universität Zürich
Zhang Xiaofu, Physik-Institut, Universität Zürich

Superconducting nanowire single-photon detectors (SNSPD) for visible and infrared photons are highly interesting detectors applications in which speed and timing accuracy are crucial. These detectors also offer low dark counts and high detection efficiency in addition to a short dead-time and very small timing jitter [1]. Based on a very similar detector principle, X-ray sensitive superconducting strip line detectors were investigated earlier, (e.g. [2]), but without demonstrating the promising performance as observed in optical and infrared SNSPD.

We have recently proposed SNSPD sensitive to photons with energies of around 10 keV (X-SNSPD) made from Nb and TaN superconducting films with much larger film thickness as compared to optical SNSPD [3,4]. We have overcome the latching problem that was constricting the usefulness of the early strip line detectors, preserving at the same time the short dead-time. The X-SNSPD can also be operated at much lower relative bias currents than the optical counterparts. Therefore, they are practically dark-count free and detection efficiencies of up to a few percent for 6-keV photons have already been realized. Surprisingly, these thick-film X-SNSPD can also exhibit a certain energy-resolution which has not been observed in optical SNSPD.

Recently, amorphous WxSi1-x has been suggested as a promising superconducting material for SNSPD [5]. We have been investigating WxSi1-x-films as a prospective detector material for X-SNSPD, because of the good X-ray absorptance of tungsten and the advantages of amorphous films for the fabrication of more complex nanostructures. The realization of a short timing jitter and detection efficiencies of more than a few percent may require the integration of X-SNSPD on thin membranes or multi-layered films to achieve the necessary absorptance for keV-photons. We will present our current

understanding of the possibilities and limitations of X-SNSPD in view of our current results.

[1] Natarajan, Chandra M., et al. "Superconducting nanowire single-photon detectors: physics and applications." Superconductor science and technology 25(6), 063001 (2012).
[2] Parlato, L., et al. "X-rays operation of a thin film NbVN superconducting-strip particle detector." Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 348(1), 127-130 (1994).
[3] K. Inderbitzin, A. Engel, A. Schilling, K. Il'in and M. Siegel. "An ultra-fast superconducting Nb nanowire single-photon detector for soft x-rays." Applied Physics Letters Vol 101(16), 162601 (2012).
[4] Kevin Inderbitzi, Andreas Engel and Andreas Schilling. "Soft X-ray single-photon detection with superconducting tantalum nitride and niobium nanowires." IEEE Trans. Appl. Supercond., 23(3), 2200505 (2013).
[5] Marsili, F., et al. "Detecting single infrared photons with 93% system efficiency." Nature Photonics 7(3), 210 (2013).