Master thesis

Plasmonic-based superconducting nanowire single photon detector

With the fast developments in single photon based applications, the Superconducting Nanowire Single Photon Detector (SNSPD) became an interesting field of research [1]. There is usually a tradeoff between the detection efficiency and the recovery time of the SNSPD. On the one hand, a large photon-active area with long wire will lead to a high detection efficiency. On the other hand, long wires have a high kinetic inductance, which will lead to longer recovery times.

Plasmonic resonances, with their large resonant absorption cross section, have been brought forward as an effective way to increase the efficiency of SNSPDs. Studying the plasmonic behavior of a superconducting material such as niobium will open the door for plasmonic-based SNSPD, which expected to have high detection efficiency as well as fast recovery time, due to smaller structure dimensions.

For this project, both the electrical and optical properties of niobium at very low temperatures play an important role which require high quality thin films. Therefore, sputtering deposition is utilized to have full control over all important deposition parameters in our clean room.

To study the plasmonic properties of niobium, we fabricate arrays of nanowires with different wire width and periodicity using laser interference lithography as a cost effective and large area fabrication technique. Further absorption enhancement could be obtained using the so called perfect absorber scheme [2]. Scattering matrix simulations reveal the optimum structure parameters to obtain the highest possible absorption in the near- and mid-infrared spectral regions. A prototype of the plasmonic-based SNSPD has been fabricated using standard electron beam lithography. We are currently investigating how the detector responds to the incident light.

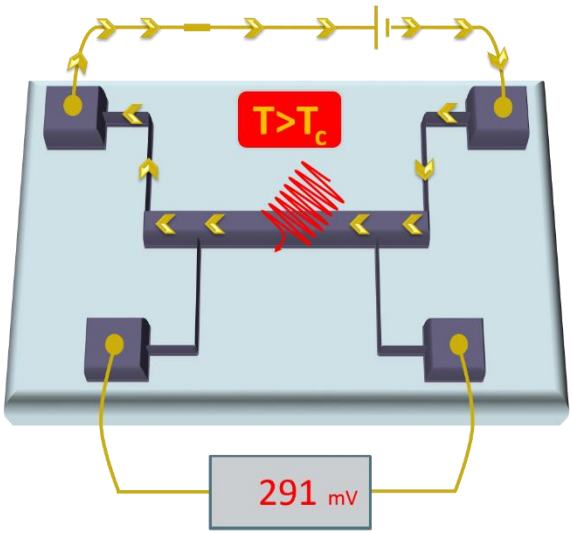
Literature: [1] C. Natarajan et al., *Supercond. Sci. Technol.* **25**, 063001 (2012). [2] A. Tittl et al., *Nano Lett.* **11**, 4366–4369 (2011).

Your work includes:

- Literature research for optimizing the detector parameters
- Thin film deposition and nanofabrication in our clean room facilities using lithographic tools and wet chemistry
- Characterization of the produced samples using different electronic, microscopic, and spectroscopic tools

Qualifications:

- Interest in and basic knowledge of optics, superconductivity, and solid state physics
- Reliable and safe working in laboratory and clean-room environments
- Basic skills in electronics and dealing with cryostats



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We are looking forward to your application!