Impact of the Stoichiometry of MoSi Thin Films on the Sensitivity of Superconducting Nanowire Single-Photon Detectors

S. Grotowski[1], D. Pecijareski[1], H. Le Petit-Delacour[1], L. Zugliani[2], C. Schmid[2], S. Strohauer[1], F. Wietschorke[2], M. Althammer[3], R. Gross[3], K. Müller[2], J. J. Finley[1]

[1]*Walter Schottky Institute, TUM School of Natural Sciences, Technical University of Munich, Germany*

[2]*Walter Schottky Institute, TUM School of Computation, Information and Technology, Technical University of Munich, Germany*

[3]*Walther-Meißner-Institute, Bayerische Akademie der Wissenschaften, Germany*

Superconducting Nanowire Single-Photon Detectors (SNSPDs) are a leading technology for the realization of photonic quantum technologies, as they combine high system detection efficiency and high maximum count rates, while maintaining low dark counts and low timing jitter. Thin superconducting MoSi films are of high interest for single-photon sensing in the near to mid-infrared regime due to their low superconducting energy gap. Multiple studies investigated tailoring the stoichiometry of superconducting materials for enhancing sensitivity [1, 2].

In this contribution, we present our recent progress on the investigation of the sensitivity of SNSPDs made from different Mo_xSi_{1-x} composites. A reduction of Mo content results in a decrease of the superconducting properties such as T_c [3]. To study the influence on detector sensitivity we fabricated SNSPDs from three thin films with Mo concentrations of 53%, 61% and 74%. By measuring the count rate as a function of bias current we determine the detection current, defined as the current at which the SNSPD starts to detect photons at a given wavelength. In Figure 1a) we present the photon energy dependence of the detection current normalized to the depairing current for different nanowire widths, for a detector made from $Mo_{0.53}Si_{0.47}$. With increasing photon energy, the detection shifts towards lower normalized bias currents in a linear fashion. Furthermore, narrower nanowires require lower detection currents due to their reduced cross-section. In Figure 1b) we show a comparison of the different stoichiometries where all devices are illuminated with a wavelength of 1550 nm. The normalized detection current is increasing with increasing Mo-concentration. This means that for the same photon energy, the detector needs to be biased closer to its critical value to generate a detection event.

To conclude our results, we identify that detectors with the lowest Mo-concentration of 53% have the highest sensitivity. These results show how the material stoichiometry can be used to enhance the sensitivity range of MoSi SNSPDs.

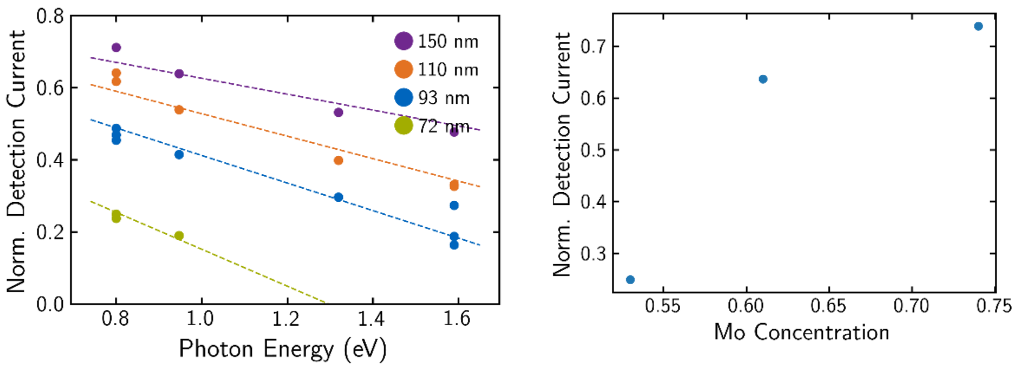

Fig. 1 a) Normalized detection current measured at different photon energies for different nanowire widths fabricated from $Mo_{0.53}Si_{0.47}$. b) Normalized detection current for different Mo concentrations ranging from 53% to 74%.

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References

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