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Terahertz Bandpass Filters Using Superconducting CPW

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Extended Abstract

In terahertz (THz) radio astronomy, the superconducting on-chip spectrometer, featuring a large array and multi-object imaging, represents a novel and transformative technology. One crucial module is the THz on-chip bandpass filter based on superconductors, which can play an indispensable role in defining frequency band subsequent to the wideband antenna. This report focuses on two superconducting coplanar waveguide (CPW) bandpass filters operating at 350 GHz. These filters adopt quarter-wavelength (λ/4) stepped impedance resonators based on the low-temperature superconductor, aiming to expand their potential terahertz applications. A second-order filter with a classical Chebyshev response and a fourth-order filter with a quasi-elliptical characteristic are jointly developed to determine the roll-off performance. Both filters are patterned using superconducting niobium (Nb) film through optical lithography and the lift-off process. This approach can significantly reduce metallic losses in the THz band. All the chips integrated with transitions are evaluated through a quasi-optical system, which is constructed based on the sensitive Superconductor-Insulator-Superconductor (SIS) tunnel junction detector at cryogenic temperatures. The calibrated transmission responses match the simulations, indicating that the 4th-order quasi-elliptical filter exhibits sharp roll-off performance. The development of superconducting CPW filters opens opportunities for next-generation THz astronomical spectrometers with large arrays.

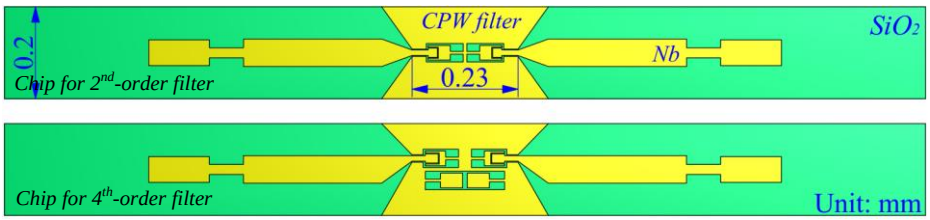

Figure 1. Layout configuration of the filter integrated chips.

References

1. Jiang-Qiao Ding, Jie Hu and Sheng-Cai Shi, "350 GHz Bandpass filters using superconducting coplanar waveguide," IEEE Transactions on Terahertz Science and Technology, vol. 12, no. 5, pp. 548~556, 2021.
2. A. Endo, K. Karatsu, Y. Tamura, et al., "First light demonstration of the integrated superconducting spectrometer," Nature Astronomy, vol. 3, pp. 989–996, Nov. 2019.