SIS ヘテロダインミキサアレイ平面集積化のための新しい構想とその実証試験

A New Concept for Planar Integration of SIS Heterodyne Mixer Array and the Concept-proof Experiment

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Large field of view molecular line observation is highly demanded in radio astronomy. However, on the other hand, it is a technically difficult to build large heterodyne receiver focal arrays, in particular with superconducting tunneling (SIS) mixers. One of the major difficulties in building a large format heterodyne array lies in the fact that a waveguide local-oscillator (LO) distribution network routed in a 3D space cannot be manufactured with conventional split block machining. In addition, in order to conduct dual polarization observation, one has to rely on non-planar polarization-separation components, like wire-grids or waveguide orthomode transducers (OMTs), which are inherently difficult to be incorporated into a compact array.

We are pushing forward the planar-integration idea to enable a quasi-planar heterodyne array by introducing on-chip membrane-based LO and signal waveguide probes, which greatly facilitate the LO distribution. This approach breaks the structural entanglement between the mixer circuits and the LO distribution network, so that the LO distribution network and the SIS mixers can be respectively accommodated in physically independent layers. Consequently, multiple pixels can be put on a single chip (called integrated circuit or IC hereafter), like in direct-detection cameras. To prove the concept, we designed and fabricated a single-pixel prototype with a dual-polarization and balanced mixing scheme, which is assumed to be readily expansible to many pixels. The experimental results show expected performance, which as comparable to the state-of-the-art performance that a traditional SIS mixer has achieved. The details of the concept and the concept-proof experiment are concluded in [1] and the fabrication process in [2].

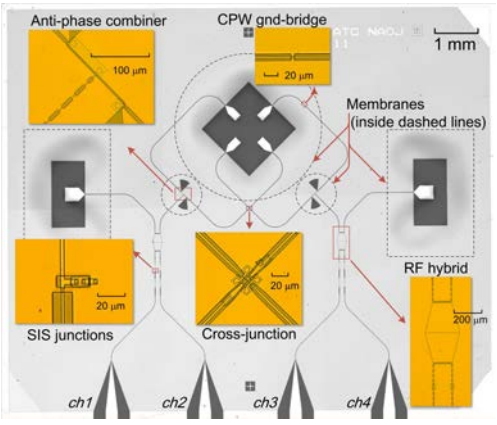

Fig. 1. The image of the front side of the mixer chip, with critical parts enlarged in the insets to show fine structures.

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[1] Shan, W., et al.: 2018, *IEEE Trans. Thz. Sci. Tech.*, **8**, 472.

[2] Ezaki, S., et al.: 2019, *IEEE Trans. Appl. Supercond.*, **29**, 1101405.