Electronics/Computers

670-GHz Schottky Diode-Based Subharmonic Mixer With CPW Circuits and 70-GHz IF

This technology can be used in terahertz imaging applications.

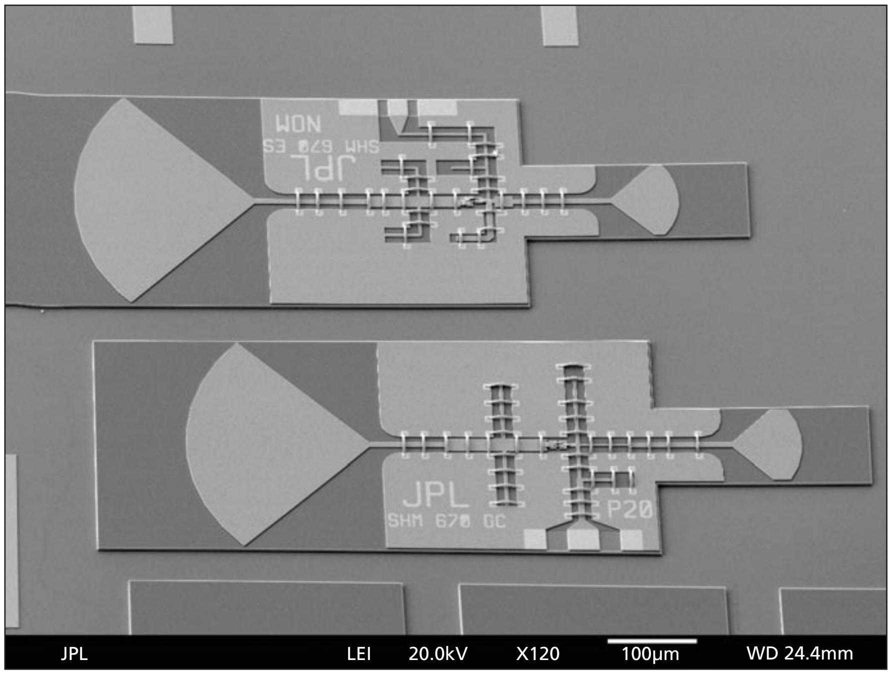
NASA's Jet Propulsion Laboratory, Pasadena, California

GaAs-based, sub-harmonically pumped Schottky diode mixers offer a number of advantages for array implementation in a heterodyne receiver system. Since the radio frequency (RF) and local oscillator (LO) signals are far apart, system design becomes much simpler.

A proprietary planar GaAs Schottky diode process was developed that results in very low parasitic anodes that have cutoff frequencies in the tens of terahertz. This technology enables robust implementation of monolithic mixer and frequency multiplier circuits well into the terahertz frequency range. Using optical and e-beam lithography, and conventional epitaxial layer design with innovative usage of GaAs membranes and metal beam leads, high-performance terahertz circuits can be designed with high fidelity.

All of these mixers use metal waveguide structures for housing. Metal machined structures for RF and LO coupling hamper these mixers to be integrated in multi-pixel heterodyne array receivers for spectroscopic and imaging applications. Moreover, the recent developments of terahertz transistors on InP substrate provide an opportunity, for the first time, to have integrated amplifiers followed by Schottky diode mixers in a heterodyne receiver at these frequencies. Since the amplifiers are developed on a planar architecture to facilitate multi-pixel array implementation, it is quite important to find alternative architecture to waveguide-based mixers.

Transmission lines such as microstrips and striplines are very lossy at terahertz frequencies, and therefore have a detrimental effect on the performance of Schottky diode mixers, and they have higher conversion loss and noise temperatures. These mixers were designed using CPW coupling structures, which have lower loss and are more amenable to planar architecture and higher level of integration. CPW lines were used to couple the RF and LO signal to a pair of antiparallel diodes. The LO is injected from one end where there is a CPW impedance-matching network and a quarter-wavelength short-circuited stub (at the LO frequency), which shorts the RF at the LO end of the circuit. On the RF end, there is a CPW impedance-matching network and an open-circuited, quarter-wavelength stub (at the LO frequency), which acts as a short at the LO frequency at the RF end of the circuit. The IF is taken out through a CPW filter from the RF end of the diodes.



A photograph of the fabricated **Subharmonic Mixer** devices.

In an integrated receiver system, the CPW lines — both for the RF and LO — can directly connect to low-noise amplifiers for the RF and frequency multiplier output for the LO.

Most of the reported results for subharmonic mixers at 670 GHz use low-loss waveguide coupling structures and metal housing. At the time of this reporting, this is the first time a planar CPW topology has been used to design and develop a subharmonic mixer at these frequencies. This design architecture easily leads to seamless integration with planar CPW amplifiers and can be used for multi-pixel heterodyne arrays.

This work was done by Goutam Chattopadhyay, Erich T. Schlecht, Choonsup Lee, Robert H. Lin, John J. Gill, Imran Mehdi, and Seth Sin of Caltech; and William Deal, Kwok K. Loi, Peta Nam, and Bryan Rodriguez of Northrop Grumman for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
E-mail: iaoffice@jpl.nasa.gov

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