200 and 400 GHz Schottky diode Multipliers Fabricated with Integrated Air-Dielectric (Substrateless) Circuitry

E. Schlecht, J. Bruston, R.P. Smith[†], S. Martin, A. Fung, R. Tsang, I. Mehdi
California Institute of Technology Jet Propulsion Laboratory, Pasadena, CA
[†]Cree, Inc., Durham, NC
MS 168-314
4800 Oak Grove dr.
Pasadena, CA 91109
310-354-4887 - erichs@merlin.jpl.nasa.gov

A novel semiconductor fabrication process has been developed at the Jet Propulsion Laboratory for realizing millimeter and submillimeter-wave monolithic integrated circuits. The process enables integration of the active devices, Schottky diodes, with planar metallic transmission lines. To reduce the RF losses in the passive circuitry, the semiconductor substrate under the transmission lines is etched away, leaving the metal suspended in air and held only by its edges on a semiconductor frame. The frame also allows the circuit to be handled and mounted easily, and makes the whole structure more robust. Moreover, this technology allows for the diodes to be positioned precisely with respect to the circuitry and can be scaled for higher frequency applications. Metallic beam-leads are used extensively on the structure to provide mechanical 'handles' as well as current paths for both DC grounding and diode biasing. To demonstrate the utility of this technology, broadband balanced planar doublers based on the concepts in [1] have been designed in the 200 and 400 GHz range. Extensive simulations were performed on the to optimize the diodes and design the circuits them around our existing device fabrication process. The calculated efficiencies are in the neighborhood of 35% over a wide band, with output powers of 70 mW at 200 GHz and 15 mW at 400 GHz. Preliminary results from the application of this technology at 200 GHz will be presented. Future plans for simplifying and improving the on-chip circuitry to broaden the bandwidth, reduce losses, and improve the yield will also be discussed.

The research described in this publication was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration

[1] Rizzi, B.J., Crowe, T.W., Erickson, N.R., "A High-Power Millimeter-Wave Frequency Doubler Using a Planar Diode Array," IEEE Microwave Guided Wave Lett., vol.3, pp. 188-190, June 1993.