Characterization of MgB_2 Superconducting Hot Electron Bolometers

D. Cunnane[1], J. H. Kawamura[1], M. A. Wolak[2], N. Acharya[2,] T. Tan[2], X. X. Xi[2], and B. S. Karasik[1]

[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 USA
[2]Physics Department, Temple University, Philadelphia, PA 19122 USA

E-mail: Daniel.P.Cunnane@jpl.nasa.gov

Abstract — Hot-Electron Bolometer (HEB) mixers have proven to be the best tool for high-resolution spectroscopy at the Terahertz frequencies. However, the current state of the art NbN mixers suffer from a small intermediate frequency (IF) bandwidth as well as a low operating temperature. MgB_2 is a promising material for HEB mixer technology in view of its high critical temperature and fast thermal relaxation allowing for a large IF bandwidth. In this work, we have fabricated and characterized thin-film (~ 15 nm) MgB_2-based spiral antenna-coupled HEB mixers on SiC substrate. We achieved the IF bandwidth greater than 8 GHz at 25 K and the device noise temperature < 4000 K at 9 K using a 600 GHz source. Using temperature dependencies of the radiation power dissipated in the device we have identified the optical loss in the integrated microantenna responsible as a cause of the limited sensitivity of the current mixer devices. From the analysis of the current-voltage (IV) characteristics, we have derived the effective thermal conductance of the mixer device and estimated the required local oscillator power in an optimized device to be ~ 1 μW.

Keywords (Index Terms) — Hot Electron Bolometers, MgB_2, Superconducting Devices, Terahertz Mixers