INVESTIGATION OF GaAs SCHOTTKY BARRIER DIODES IN THE THz RANGE

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ABSTRACT

The properties of GaAs Schottky barrier diodes as video detectors and mixing elements were investigated in the frequency range from 0.8–2.5 THz. For the most sensitive diode, the video responsivity and system noise temperature were measured as a function of incident laser power. The highest video responsivity was 2,000 V/W at 214 µm and 60 V/W at 118 µm. For five diodes differing in doping, capacitance, series
resistance and anode diameter, the system noise temperature was measured at 214\,\mu m and 118\,\mu m. The best single sideband (SSB) values are 12,300 K and 24,200 K at 214\,\mu m and 118\,\mu m, respectively. The system noise temperature versus frequency is given over the range from 0.5 - 3 THz for two specific diodes demonstrating that the sharpness of the I-V characteristics is only of secondary importance for mixer performance at such high frequencies.

I. INTRODUCTION

In the submillimeter range (1mm-100\,\mu m, 300GHz-3THz) GaAs Schottky barrier diodes are used for mixing high frequency signals down to microwave frequencies, where conventional amplifiers are available. Gas lasers can be used as local oscillators (LO) providing sufficient power and spectral purity. The radiation of the local oscillator $\nu_{LO}$ and the signal $\nu_{sig}$ are coupled into the diode by using quasioptical techniques. Although Schottky barrier diodes have been already successfully used as receivers up to 2.5THz [1,2], there are few detailed investigations of performance as video and heterodyne detectors in the THz range [3,4,5,6].

A lot of difficulties have had to be overcome to extend the use of low-noise Schottky barrier diodes above 1 THz. On the one hand, there is the development and manufacture of Schottky diodes with higher doping and smaller anode diameters. This requires new techniques, which are described in detail in [7]. On the other hand, preparing an open structure mixer block becomes harder as the frequency increases. The dimensions of the long wire antenna are in the same order as the wavelength, and at $\lambda \approx 100\,\mu m$ this is about the limit of what can be achieved with present technologies.

This paper compares different diodes, one of them specially fabricates for frequencies above 1 THz.