The voltage responsivity of videodetectors using submicron GaAs Schottky diodes has been investigated in the 0.7 - 3.7 THz range. Incident submillimeter power level, DC bias and video-load influences are discussed within the framework of existing theories. Various diode types differing in semiconductor parameter values as well as junction geometries are compared. The submillimeter frequency response is studied and interpreted in terms of plasma resonance effects in the epilayer.

Key words: videodetector, Schottky diode, submillimeter range, incident power, DC bias, junction geometry, plasma resonance.

Introduction

Since the early experiments performed on GaAs Schottky diode videodetectors in the 0.1 - 2 THz region (1), interests related to these fast devices have been regularly sustained in various frequency bands of the submillimeter range, extending up to ~7 THz (2-9). Practical improvements to this and other associated applications, such as harmonic generation and mixing, involved the consideration of factors such as junction geometry (8,10) or epilayer parameters.
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(8,11,12) discussed from the "RC-type" cut-off frequency point of view commonly used at microwave frequencies. Theoretical efforts also developed to consider specific phenomena pertaining to the FIR domain, namely carrier inertia effects and displacement current contribution in the ohmic region of the semiconductor (13,14), as well as departures from the static I(V) relationship due to non-instantaneous transport inside the space-charge region (15). A main conclusion of these studies -recently used to interpret some video-response results (16)—is the dominant part taken by the semiconductor plasma resonance to explaining the divergence of the diode frequency response from the classical $f^{-2}$ law.

The work presented here aims at comparing the performances of various diode types as videodetectors in the sub-millimeter range. For a valid comparison, testing conditions must be accurately defined. Consequently, after giving some details about our diode characteristics and describing the experimental procedures in the first two sections, a third section is devoted to quantitatively discussing the influence of key parameters such as FIR input power, DC bias level and videofrequency load, to conclude in defining optimal testing conditions for a given diode. In the fourth section, the videoresponses at 900 GHz are compared between different diodes and discussion sets up in terms of semiconductor parameter choice as well as junction geometrical characteristics. In a fifth section finally, the FIR frequency response is studied in the 1 - 4 THz range for one of our diode types giving the best performance, and discussion stresses upon the interpretation of the $f^{-4} - f^{-5}$ video-response falling off currently reported in the literature (1,4,6,8,9).

Diode characteristics

Apart from a limited number of samples processed on bulk material, the junctions were elaborated on Te-doped ($n = 2 \times 10^{16}$ to $4 \times 10^{17}$ cm$^{-3}$) OM-CVD epitaxially grown$^x$ GaAs on high conductivity, also Te-doped ($n_s = 2$ to $5 \times 10^{18}$ cm$^{-3}$), (100) oriented GaAs substrates. The diode production process has already been described (5,8), and a typical cross-sectional view of the device is shown Fig. 1(a). The contact metal currently used is a W-Co alloy with a gold overlay.

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