§15. New THz Detection System Operating up to the 6 THz Rang

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Abstract

A new high-speed high-sensitivity sensor for THz frequencies has been proposed and a prototype has been developed. The prototype sensor consists of a parabolic mirror, a wire antenna and a Schottky barrier diode(SBD). Direct measurements have shown un-adjusted, preliminary sensitivity about 3 V/W at 6.3 THz. The sensor operation frequencies has achieved 6 THz range and a dramatic enhancement in the practicality of this component.

Proposal of New System Components

The purpose of this research was to propose a new structure for high-speed and high-sensitivity, receiver/interferometer systems, in order to develop the concept and to evaluate its capabilities. New developments are in much demand for the THz frequency band. Most high-speed, high-sensitivity THz receivers incorporate two essential technologies, a sensor for detecting the signal and an antenna and mirror for focusing the signal. SBD was used for the former component and parabolic mirror combined with wire antenna for the latter one, respectively. We have developed the new THz sensing system as shown in Figure 1. The mirror can be moved in the x direction with a micrometer (see Fig.1). Its focus is adjusted to the location of the 4-λ antenna. The SBD is soldered to the tip of the mount post that can be pushed up in the +z direction using the micrometer, and contacts to the 4-λ antenna and the SBD. The new sensing system is shown on the left in Fig.2, and the wire antenna contacting the SBD soldered onto the top of the mount post, together with the parabolic mirror, are shown on the right.

Performance in THz Waves

The THz source was a THz-, so-called submillimeter, laser pumped by CO2 laser. Measurements of direct sensitivity were performed in the 1 – 6 THz range. The direct detection sensitivity was expressed as the detected system output voltage divided by the simultaneous level of incident laser power (units of V/W). Figure 2 shows the direct sensitivity as a function of frequency. It shows the first time operation at 6 THz range using high speed/sensitivity sensor. The sensitivities of 3 V/W over 5 THz are 10 times larger than that of pioneering works using SBDs [1]. This system is usable over a wider range of frequencies than previous corner reflector with SBD [2] and corrugated field horns with one [3]. It should be noted here that no mechanical adjustments whatever, wire antenna length or location, are needed under frequency changes; thus, this is a marked improvement in convenience over previous antennas. The sensitivity, however, decreases at 5-6 THz range and observed anomalous at 3 THz. The absolute sensitivity depends on the function of the SBD in the detection system, on the location and linearity of the wireless antenna, and on other factors. These are presently imperfect in prototype, so it is expected that further improvements are possible. Heterodyne detection has also demonstrated up to 6THz range as shown in Fig. 3. The upper side band and lower one are clearly observed at 5.2 and 6.3 THz. The heterodyne, i.e. coherent, detection successfully achieved, so that this new system has been demonstrated practical use up to the 6 THz range for the interferometer which will be scheduled in the electron density measurements of the next fusion plasma projects.

References

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3) T. Yasui, C. M. Mann, T. Suzuki, H. Fujishima, S.Tsunekawa, and K. Mizuno, Proc. of 23rd International Conference on Infrared and Millimeter Waves, Essex, UK, Sep.(1998).

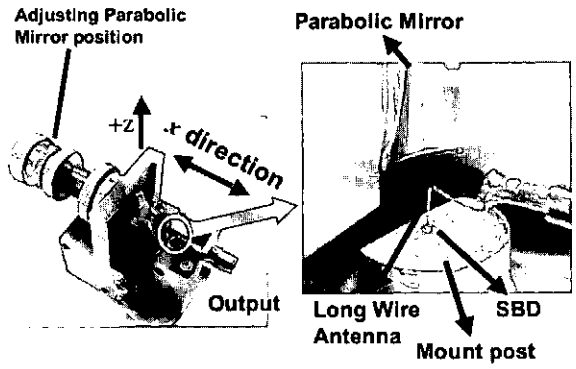

Fig. 1 Appearance of the new THz detection system (left) and a close up view (right) of the parabolic mirror, anntena and SBD Mount.

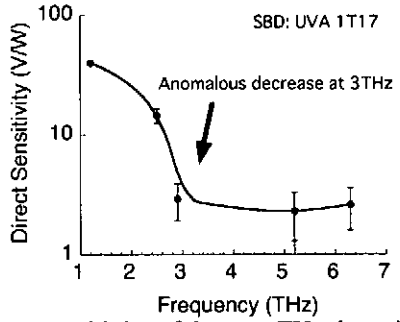

Fig. 2 Direct sensitivity of the new THz detection system from 1 THz up to 6 THz range.

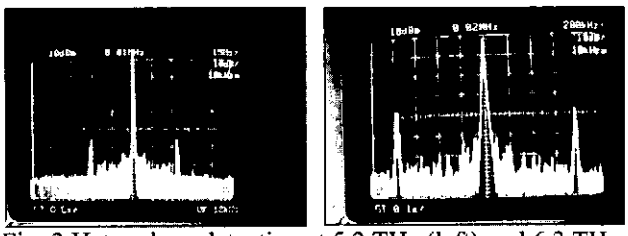

Fig. 3 Heterodyne detection at 5.2 THz (left) and 6.3 THz (right), respectively.