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1. Introduction

Development of terahertz (THz) wave detection technique is crucial for further advancement of various kinds of THz applications such as imaging and non-destructive inspection technique. Due to the existence of Dirac cones which can absorb all light [1], graphene and topological insulator are promising candidates for THz detection [2, 3].

In this study, we report the possibility of the THz wave detection utilizing multi-layered GeTe/Sb_2Te_3 system referred as interfacial phase change memory (iPCM) [4]. Recently, iPCM has received considerable attention as a next-generation non-volatile electrical memory material and the topological insulating material [5]. We confirmed that iPCM has high optical absorption in THz range compared with Ge-Sb-Te alloy material. Then we build a photoconductive-type optical detection system and measured the photo-induced change in the electrical resistance of the iPCM sample.

2. Experiments

The iPCM sample investigated was a thin film of $[(GeTe)_2(Sb_2Te_3)_4]_8$ composed of 1.0 nm GeTe sub-layers and 4.0 nm Sb_2Te_3 sub-layers. The film was deposited on Al_2O_3 or high-resistance Si substrates using a helicon-wave sputtering system. The THz transmission spectra of iPCM and Ge-Sb-Te alloy were measured with THz time-domain spectroscopy system. In photoconductivity measurement, the photo-induced change in the applied bias voltage (0.2 V) was amplified by 1000 times with a voltage preamplifier and recorded. THz pulse were generated by optical rectification of femtosecond laser pulses with $LiNbO_3$ crystal prism and focused to 1 mm spot onto the sample. The power of THz pulse was 225 μW and the repetition rate was 1 kHz. Both the transmission spectroscopy and the photoconductivity measurements were carried out at room temperature.

2. Results and discussion

The result of the THz transmission measurement clearly indicates that the amplitude of transmission spectra from 0.1 to 4 THz obtained in the iPCM sample is smaller than that in the alloy sample which has the same atomic composition. In this frequency range, no significant peak or dip are observed in the difference spectrum between iPCM and alloy results. Therefore, the SL structure can enhance the absorption coefficient for THz wave.

Figure 1 shows the THz induced response of the system output. Just after the THz pulse excitation, instantaneous decrease in the output signal, which corresponds to the decrease in the electrical resistance of the sample, followed by the relatively slow recovery was observed. This result indicates that our iPCM-based photoconductivity measurement system is capable of THz detection at room temperature. For better understanding, quantitative evaluations as a photodetector such as sensitivity, response time, and bias voltage dependence are necessary.

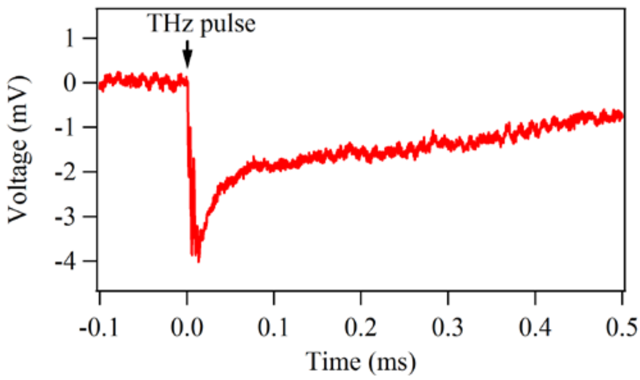

Fig. 1. THz pulse induced change in the system output voltage measured at room temperature.

3. Conclusions

In this study, we have proposed and demonstrated the iPCM-based THz detection. The THz transmission spectroscopy was performed and found that the multilayered structure increases the photo absorption for THz radiation. We carried out the photoconductivity measurement and found that decrease in the electrical resistance of the sample were induced by irradiation of THz pulse. This result suggest that our system can be used for THz detection at room temperature.

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