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Room Ambient condition graphene based THz detection

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Abstract - Graphene with its unique electric, thermal, and optical properties has proven to be a promising candidate for many of the next generation electronics application. In this report, we try to provide a clear undeniable evidence that proves our success in the development of a THz nano-sensor using the graphene nano-carbon material as a mean to utilize the thermoelectric current that can be generated due to the bolometric effect at room ambient conditions.

1. Introduction

The Terahertz (THz) region of the electromagnetic spectrum is of interest for wide range of applications. The realization of THz spectral-imaging systems for applications of such devices requires frequency-tuneable compact sources and detectors, not to mention the compatibility for such conventional semiconductor micro fabrication techniques is highly desired. The unique band structure alongside the associated carrier properties, of Graphene make this material of an ideal interest for application utilizations as broadly tuneable sensors, for specific application to the (THz) regime. The gap-less spectrum characteristic of single-layer Graphene, as well as the small forbidden gap that appears in bilayer Graphene, is ideally well matched to the low (meV) energy of photons in the THz regime, which is in a marked contrast to conventional semiconductors whose relevant band gaps are typically several orders of magnitude larger. characterization of Graphene sample device prepared using the well-known mechanical exfoliation technique, Hence after we take a look at the electrical properties based on low-temperature magneto-transport investigations. These studies demonstrate the formation of open quantum-dot structures in small Graphene flakes, contacted by sub-micron scale metal electrodes. The observation of quantum fluctuations in the magneto-resistance of these structures indicates the presence of quantised dot states, whose characteristics may be of use in THz sensing. Hence, developing a terahertz detectors with high sensitivity and frequency resolution. This objective was achieved by utilizing an in-situ gate control of the confined energies of these structures, thus the interest in developing frequency-selective and tune-able detectors.

2. Objective behind the Study

This Study focuses on the outstanding conductive characteristics of the Graphene material, at the Room Temperature Condition. Hence, these Carbon atoms are able to show very high potentials as THz sensing Devices. In short terms, the aim of this study is; to demonstrate the possible mode range of operation that may be expected of the THz Graphene device sensor for Practical utilizations.

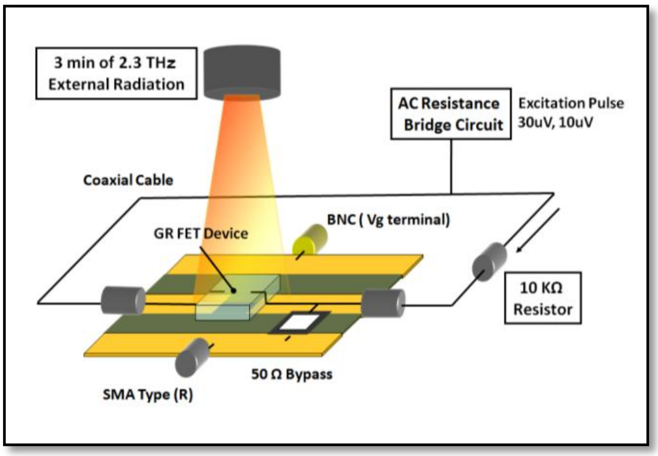

Fig. 1 Experimental layout of the THz range bolometric detection. the setup is designed to increase the bolometric detection measurement.

3. The Approach & Methods:

Following the previous study in semiconductor QD THz sensor [1], already a basic frequency characteristic has been clarified by use of conventional microwave trans-conductance measurement [3]. Following such high frequency measurements, BGR two-terminal strip line has been prepared as a QD and the microwave trans-conductance measurements has been performed by a microwave transmitter, high frequency detective oscilloscope, the observation of such high frequency characteristics in BGR QD shows a strong response up to several ten GHz region. Therefore, we clarify two important characteristics, on the power and the intensity components of the microwave transmissions. The difference of the two-measurements has an important information and also the both show a clear response up to high frequency region. Therefore, it is found that the BGR QD should work in a broad frequency range up to 40 GHz.In order to demonstrate the possible mode range of operation that may be expected for the THz Graphene device sensor, we present our results of recent experiments in which we have investigated the THz photo-response of III-V based semiconductor nana structures, namely quantum point contacts. These experiments reveal interplay of different photo-response mechanisms, primarily involving rectification of THz radiation in the presence of non-linearity in the transport, and bolometric heating of the Nano-sensor. These studies provide a valuable framework in which to analyze the photo response of Graphene THz sensor.

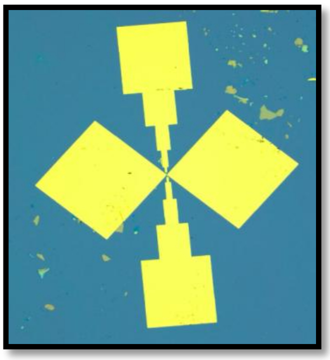

Fig. 2. The graphene sensor device layout, the antenna dimensions are matched to the low THz region of (1 - 4) THz .

4. Results & Findings.

It was confirmed experimentally that the Graphene Sample shows a very fast response even at the boarders of the 40 GHz band. More deeply, the high tendency to detect THz efectivrly at room conditions.

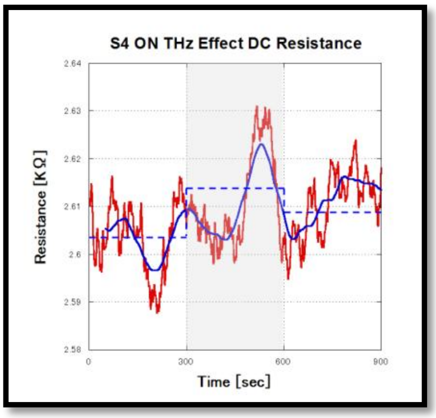

Fig. 3 The grapheme response for detecting the THz radiation at ambient conditions.

Grphene Carbon Material will be looked at as a good Candidate for Room Temperature, High Frequency Sensing Devices. Where low power consumption device are difficulty can maintain their steady performance.

5. Conclusions

Based on the room temperature device performance in this study, it can demonstrate a possible operation for graphene QD as a GHz-THz sensor. Also, based on our previous study in semiconductor THz sensor [1], it has been found that even in case of the graphene two-terminal QD system,such device performance can be expect [3.4], the microwave-sensing characteristic should be an almost similar response at room temperature. The recent results of this study and of the former GHz response study have revealed numerous complementary areas for improvement in order to extend microwave photoresponse past the previous reports of 40 GHz and further to improve THz detection

Finally, to demonstrate the possible of modes of operation that may be expected for graphene THz sensors, we present the results of recent experiments [2,3] in which we have investigated the THz photo-response of III-V based semiconductor nanostructures, namely quantum point contacts. These experiments reveal an interplay of different photo-response mechanisms, primarily involving rectification of THz radiation in the presence of non-linearities in the transport [2], and bolometric heating of the nanosensor. These studies provide a valuable framework with which to analyse the photoresponse of graphene THz sensors.

Acknowledgements

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