

A terahertz chemical microscopy for an agar culture medium

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Abstract

In the field of life science, the research trends are to visualize ‘living’ materials as it is, whereas most of conventional imaging methods require pre-treatments to living samples. In our group, a terahertz chemical microscope (TCM) has been proposed and developed to investigate metabolism by the cell activity. Here the agar medium, which was generally used to cultivate cells, was immobilized on the sensing plate of TCM and the concentration of the glucose in the buffer solutions on it was detected as the terahertz amplitude shift. This result suggests that the TCM can detect the glucose in the solutions and it may possible to detect the cell activity cultivated on the agar mediums.

1. Introduction

Biophotonics technology; that is the combination of the biology and photonics, has attracted attentions of a lot of researchers of life science. The research trends are to visualize ‘living’ materials as it is, whereas most of conventional imaging methods requires pre-treatments to living samples; e.g. a two-photon excitation microscopy and a fluorescence microscopy are conventionally available to observe cells [1,2]. These types of microscopies can obtained precise image of samples, however, the strong excitation light are required for the two-photon microscopy and labeling to samples are required for the fluorescent microscopy, and therefore, serious damages to samples are sometimes coursed.

In our group, a terahertz chemical microscope (TCM) has been proposed and developed in order to visualize various types of chemical reactions in the solutions. Since this type of microscope utilizes ‘laser-excited-terahertz’ technique, the spatial resolution is not determined by the wavelength of the THz but the wavelength of the excitation laser. Thus, the current spatial resolution of several micrometers could be achieved [3-5].

In this work, the quantitative detection of the bio-related materials in the buffer solution is demonstrated as the primary study of the cell activity monitoring. The glucose was applied as the ample materials here, since its concentration is strongly related to the cell activities of metabolisms.

2. Experimental & Results

The TCM utilize sensing plates, which consist of the SiO₂ and Si thin films on the sapphire substrate. When the femtosecond laser irradiates the Si thin film from the substrate side of the plate, THz waves are generated and radiated into a free space due to the depletion field in the Si. This depletion field is changed by changing the chemical potential, which can be related to the chemical reactions, on the surface of the plates. Therefore, distributions of chemical reactions could be mapped as the amplitude of THz waves.

Figure 1 shows the sensing plate used in our experiment. The thicknesses of the SiO₂ and Si films are 275 nm and 150 nm, respectively. The agar mediums mixed with the glucose with the concentration of 0, 5, 15, 30 wt% were prepared and immobilized on the SiO₂. The agar medium is generally used to cultivate the cells. Figure 2 shows that the amplitude of THz waves when the concentration of the glucose was changed. The values indicated in the plot represent the concentration of the glucose. One can see that the amplitude decreased as increasing the concentrations. This result suggests that the TCM can detect the glucose in the solutions and it may possible to detect the cell activity cultivated on the agar mediums

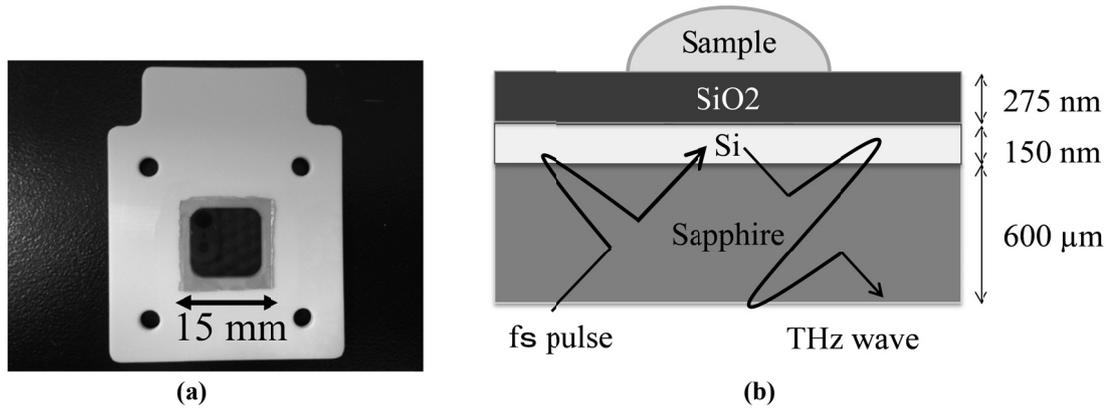


Fig.1 Sensing plate ((a) Photograph and (b) Schematic cross-section, respectively)

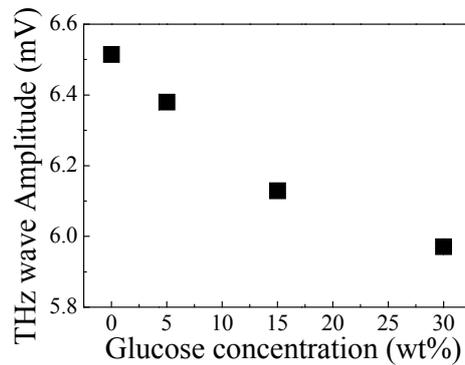


Fig.2 THz amplitude shift during the glucose concentrations were changed.

3. Summary

We measured glucose concentration changing which is basic research for investigate metabolism by the cell. Changes in the glucose concentration in the agar medium detected as terahertz amplitude shift. From examining the findings, TCM can detect the glucose and it may possible to detect the cell activity cultivated on the mediums.

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5. References

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