

Study of dry pellets of blood plasma using THz spectroscopy

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Abstract— This work is devoted to the development of a suitable phantom of a biological object for measurements in the THz frequency range and for approbation with various diagnostic methods developed in different THz laboratories. The phantoms were represented as a pellet of human and a laboratory rat blood plasma in the diabetic and the control groups. These objects were analyzed in various laboratories, using THz pulsed spectroscopy and a high-resolution THz spectrometer based on a backward wave oscillator. The components of the dry blood plasma were identified by the detected spectral lines.

Keywords— biological object, phantom, blood plasma, diabetic, THz frequency range

I. INTRODUCTION

Blood glycation has been accepted to be a simple but efficient marker for diabetes. Increased glucose concentration leads to glycolisation of proteins (human or animal albumin), which is a nonenzymatic process of glucose attachment to the amino groups of proteins. As shown in some experiments of O.P. Cherkasova, V.L. Vaks, and O.A. Smolyanskaya, the blood plasma is the most promising object of study, since changes among its composition caused by pathological processes may considerably affect the optical properties of the blood plasma of human or animals within the THz frequency range. However, liquid samples are difficult to study, since they cannot be stored for a long time, their biochemical properties change during the experiment. In this article, it was decided to analyze a comfortable phantom of a biological object for measurements in the THz frequency range.

II. MATERIAL AND METHOD

Venous blood was obtained from patients (Clinical diagnostic laboratory of Almazov National Medical Research Centre) of the control and diabetic groups, centrifuged to obtain blood plasma, dried and pressed into a pellet. The same samples were prepared from venous blood of laboratory rats of the control and diabetic groups. The diameter of each pellet was 5 mm while the measured thickness was 0.95 – 1.81 mm.

In this work, the samples were studied on a pulsed terahertz setup in transmission mode in two different laboratories (ITMO

University [1] and MSU [2]). A high-resolution terahertz spectrometer based on a backward wave oscillator (IPM RAS [3]) was also used.

Biochemical parameters were measured to control the results of the study in the clinical diagnostic laboratory of Almazov National Medical Research Centre.

III. RESULTS AND DISCUSSION

The refractive index spectra and the absorption spectra of blood plasma of rats and patients in the control and diabetic groups were presented. Based on the results, it was found that there are differences between blood plasma with and without diabetes.

Using a high-resolution THz spectrometer, the spectral lines of substances such as carbonyl sulfide (OCS), methyl mercaptan (CH₃SH), butyronitrile (C₃H₇CN), acetaldehyde (CH₃CHO), formic acid (HCOOH) were detected in blood plasma samples. The rat blood plasma of the diabetic group differs from the control group by the presence in the spectrum the lines of acetone (CH₃COCH₃), propionitrile (C₂H₅CN) and methyl formate (CH₃OCHO).

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