The research method of a qualitative analysis of the composition of the blood in the terahertz frequency range

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Introduction

The study of biochemical parameters of blood has an important role in the diagnosis of diseases, in honesty for patients diabetes mellitus. Of particular interest in this area is the study of the interaction of terahertz (THz) radiation with components of human blood. THz frequency range is remarkable in biomedicine in that it contains resonance frequencies of specific vibrational and rotational modes of biomolecules, therefore, using THz radiation, we can evaluate and determine the state of biological molecular bonds. In addition, THz radiation is very sensitive to different types of conformation of H_2O molecules with the rest of molecules contained in bio-samples. In the course of this work, the effect of bilirubin, triglyceride, uric acid, creatinine concentrations on the spectra of the refractive index and absorption of human blood in the THz frequency range was investigated, the results of which can be useful in the development of a method for analyzing blood composition.

Subject of study

The paper presents the study of blood biochemical composition (bilirubin, creatinine, triglycer-ides, uric acid) effect on its optical properties, i.e. refractive index and absorption coefficient, in terahertz fre-quency range was investigated.

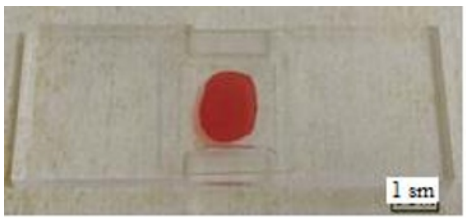

Fig. 1. Measuring cell with a blood sample

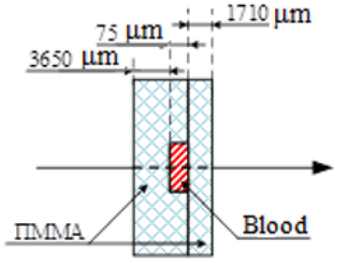

Fig. 2. Scheme of the measuring cell

Method

To obtain the values of the refractive index and the absorption coefficient, the method of terahertz time-domain spectroscopy was used in the transmission mode. Concentrations of total bilirubin, creatinine and triglycerides were measured in blood serum by the colorimetric method, the pseudokinetic method and the enzymatic method, respectively. The glucose level was determined in blood plasma by the enzyme method. All measurements of blood component concentrations were carried out at the Almazov National Medical Research Centre.

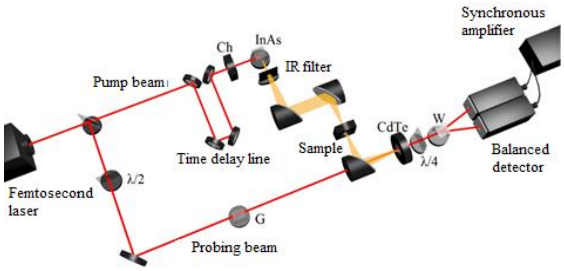

Fig. 3. Scheme of terahertz pulse spectrometer: λ/2 - half-wave plate; G - the Glan prism; Ch - breaker; λ/4 - the quarter-wave plate; W - the Wollaston prism

Main results

The optical properties of blood with various biochemical composition were ob-tained using terahertz time-domain spectroscopy at the

frequency of 0.4THz. It is shown that the refractive indices and the absorption coefficients of blood decrease with an increase in the concentration of bilirubin and creatinine. It has also been found that with an increase in the concentration of uric acid and triglycerides, the refractive index of blood increases and the absorption coefficient of blood decreases, respectively. The correlation between the refractive index and the concentration of triglycerides and the correlation between the blood absorption coefficient and the concentration of uric acid were not revealed.

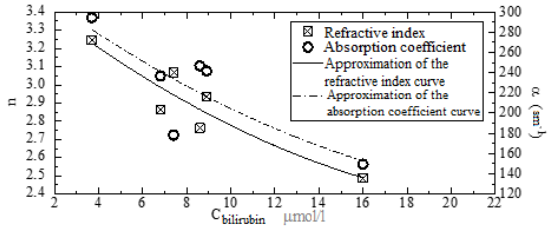

Fig. 4. Dependence of optical properties of blood on bilirubin concentration

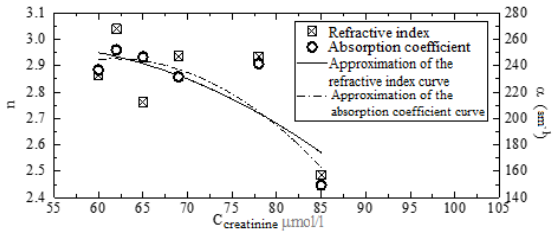

Fig. 5. Dependence of the optical properties of blood on the concentration of creatinine

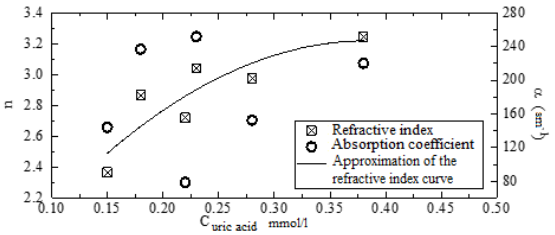

Fig. 6. Dependence of the optical properties of blood on uric acid

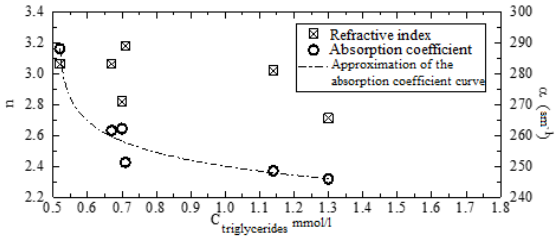

Fig. 7. Dependence of the optical properties of blood on the concentration of triglycerides

Practical significance

The observed correlations between the concentrations of blood components and the optical properties are useful in the development of a new technique for blood analysis.

References

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