Terahertz spectral characteristics and optical properties of normal and pathological skin, cornea and their components

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***Abstract* — The prospect of development of the contactless diagnostics method of pathological skin and cornea in the terahertz frequency range was shown. The stimulation of the nerve cells growth by low-intensity terahertz radiation was observed. Probably the selection of terahertz radiation parameters allows expecting the acceleration of skin and cornea regeneration in-vivo.**

Keywords— Terahertz spectroscopy, skin, cornea, fibroblasts, nerve cells

I. INTRODUCTION

Contactless diagnostics of pathological processes of the skin, subcutaneous tissue and cornea without histological analysis is an important problem for regenerative medicine [1]. Besides diagnostic problems are actual to study the effect of pulsed terahertz radiation influence on the acceleration of the cells regeneration entered into the structure of the skin and cornea. Previous studies showed the changes of refractive indices and absorption coefficients of different layers of the skin [2].

In this paper, we revealed the terahertz spectral characteristics and optical properties features of human and animal skin and cornea in the frequency range of 0.1 – 2.0 THz. To analyze the obtained spectra the numerical simulation of reflection spectra of the main components of the subcutaneous tissue (fibroblasts and nerve cells) in the frequency range from 0.1 to 2.0 THz was carried out. Also the influence of pulsed terahertz radiation on nerve cells growth stimulation at the irradiation time of 5 minutes in the average power density range from 1 to 100 mW / cm^2 was shown.

II. II. MATERIAL AND METHODS

A. Terahertz reflectometric spectrometer

Experimental spectral characteristics and optical properties of the normal and pathological skin, cornea and their components were obtained using the technique of pulsed terahertz spectroscopy in reflection and transmission modes [3]. Study of the spectral features of fibroblasts and nerve cells was carried out in the three-dimensional numerical simulation environment CST Microwave Studio. Using the pulsed terahertz photometry technique the nerve cells growth was stimulated, which was estimated by morphometric method of the light microscope.

III. RESULTS

We experimentally investigated the changes of terahertz reflection spectra of skin, cornea and their components in the frequency range of 0.1-2.0 THz.

Numerical simulation of reflection spectra of nerve cells and fibroblasts showed the spectral lines connected with the radiation absorption and dimension effects (excitation of the standing waves in a biological object).

We investigated changes in nerve cells growth under the influence of terahertz radiation at power density of 1.081 mW / cm^2 and duration time of 5 minutes to get the stimulation effect of nerve growth (147 %, relative to the control sample).

IV. CONCLUSIONS

The terahertz spectral characteristics and optical properties of normal and pathological skin, cornea and their components were investigated in the frequency range of 0.1-2.0 THz. Low-intensity terahertz radiation stimulates the nerve cells growth. Probably the selection of terahertz radiation parameters allows expecting the acceleration of skin and cornea regeneration in-vivo. From a practical standpoint for complex cases the time domain terahertz spectroscopy would allow to contactless monitor the skin healing process, without injuring of regenerating skin of the patient.

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