NONINVASIVE EXPRESS DIAGNOSTICS OF PULMONARY DISEASES BASED ON CONTROL OF PATIENT'S GAS EMISSION USING METHODS OF IR AND TERAHERTZ LASER SPECTROSCOPY

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Introduction: We discuss abilities of methods of IR and terahertz laser spectroscopy for noninvasive express diagnostics of pulmonary diseases on a base of analysis of absorption spectra of patient's gas emission, in particular, exhaled air. Experience in the field of approaches to experimental data analysis and hard-ware realization of gas analyzers for medical applications is also discussed.

THZ GAS ANALYZER (80 – 1000 μm): Development of a technical basis and application of laser photo-acoustic spectroscopy (LPAS) method for registration of different chemical compounds in spectral range from 2 to 11 μm were studied. In difference from IR range where characteristic frequencies of localized oscillations of single chemical bonds in molecules are located, spectral response of molecular systems in THz range provides information about molecular motion corresponding to a molecule itself and its oscillations and rotation. Such motions are intrinsic for polypeptide, polysaccharide, and polynucleotide chains in complex biopolymers. Molecules spectra in THz range has intensive absorption lines, which characterize investigated materials definitely. For registration of radiation absorption the laser beam of THz laser is directed to the resonant PAD, which is filled with the sample of analyzed air, previously taken from the patient. PAD has a window with low absorption coefficient in the THz range. Additional detector for beam attenuation recording can be placed at the output of the PAD. Generated acoustic waves are recorded by microphone when amplitude-modulated laser beam absorbed in the gas in the PAD volume.

Conclusion: Proposed approach has a number of differences from other implementations of optical THz spectroscopy. First of all, it should be noted that this system has high conversion efficiency of the laser pump into the THz range (>0,1%) and high absolute value of the power in THz (hundreds of mW) in comparison with other methods, that reduces the sensitivity requirements of THz radiation detectors and, in particular, allows using pyrodetector as a reference. Another important factor is the narrow THz bandwidth due to the physical features of the laser with optical pumping. This may be critical in the case of detecting real gaseous markers with inevitable presence of water vapor. Since the laser bandwidth with optical pumping may be substantially less than 1 cm^{-1} (as opposed to other sources in this spectral range) referring to water absorption lines can be used, that substantially improves the detection sensitivity threshold. In addition, such systems are very compact and permit to creation of mobile applications for the laboratory diagnostics of human diseases.