Solid-state non-stationary spectroscopy of 1-2.5 THz frequency range

V.L.Vaks[1], A.V.Illyuk[1], A.N.Panin[1], S.I.Pripolsin[1],
D.G. Paveliev[2], Yu.I Koshurinov[2]
[1] *Institute for physics of microsructures RAS, Nizhny Novgorod, Russia*
[2] *N.I.Lobachevsky Nizhny Novgorod State University, Nizhny Novgorod, Russia*

The THz frequency range is attractive for spectroscopic investigations, since many strong molecule lines lie in this range. Absorption lines of light hydrides and vibration motions of many molecules lie here. It gives possibility of studying molecules (for example metalloorganic molecules) which absorption lines in other frequency ranges are very weak.

The high precision, time-domain spectroscopy is unique method of analysis of multicomponent gas mixtures. This method has the sensitivity at level of 0,2 ppb, has high selectivity and possibility of measuring the investigated substances concentration. Besides, this method is simple to using.

Nowadays there exist two approaches for THz pulse generation for tabletop devices. These are photoconductive switches illuminated by femtosecond laser pulses, and optical rectification using ultrashort laser pulses in nonlinear crystals. However the problem of frequency stability and bad resolution provides a fundamental limitation for these methods in high precision spectroscopy. This method is not suitable for high resolution spectroscopy. The second way is the classic approach to transfer the microwave methods to THz frequency range which is elaborated in IPM RAS.

The spectrometer of 1-2.5 THz frequency range (with registration of a signal in time area) based on solid-state radiation sources is considered in this report. The necessity of development the new THz sources is concerned with the fact, that the present emission sources (such as back-wave oscillator (BWO)) are extremely expensive and have large sizes and quite short time of exploitation. They operate in the frequency range from 100 up to 1250 GHz and are base for creation of the synthesizers for precision measurements.

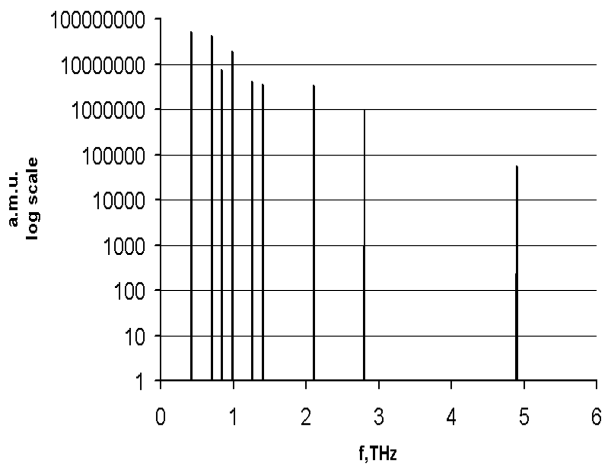

Fig.1. The measurements of spectral distribution after multiplier

Our approach consists of the application of the solid-state synthesizers of millimeter wavelength range based on e.g. Gunn generator (97.5-117 GHz) with PLL of reference generator and frequency multipliers on quantum semiconductor structures. Over the last several years, the superlattice structures are more effective for frequency transformation and detection, since the lower values of inertness and parasitic capacitances and presence of negative differential conductivity (till 1 THz) on the volt-ampere characteristic. The results of measurements of spectral distribution up to 4.9 THz after multiplier by using the Furie spectrometer on silicic helium bolometer are shown on Fig 1. The measurements of spectral line of methanol at 1062 GHz were carried out.

This work was supported by RFBR (grants 07-03-91143, 06-08-01332-a, 03-02-17088), ISTC (project 3174 «Development and study of integrated receivers for operation frequencies 0.5 – 1 THz»), SCIENCE FOR PEACE PROGRAMME (CBP.NR.SfPP 981415, “Integrated Spectrometers for Chemical Agents Detection and Atmosphere Monitoring”).