

2.11. METHOD OF SPECTRAL DYNAMICS IN THZ AND GHz RANGES OF FREQUENCIES FOR PROBLEMS OF COUNTERTERRORISM

Trofimov V.A., Varentsova S.A.,
Lomonosov Moscow State University, Moscow, Russia

A method of THz spectral dynamics analysis (SDA) of medium response in the THz and GHz ranges, which was developed by us, is used for the treatment of experimentally measured signals, passed through explosives, including those hidden under covering materials. It allows us to follow the dynamics of many spectral lines in one set of measurements simultaneously and to obtain the full information about the spectrum dynamics of the THz pulse. Relaxation time of rotational transitions, for example, can be determined too. This information gives an opportunity to detect and identify materials despite the similarity in their THz spectra – which may be identical. We show that the spectrum dynamics of THz pulses, passed through the explosives hidden under plastic, cotton and leather barriers – covers, differ widely for these media. The modern problem of simulant for explosive is analyzed as well.

At present, the development of simple and highly effective methods for non-destructive analysis, remote detection of explosives and other energetic materials is one of the most modern defense-related problems. Over the past years many investigations and applications of terahertz radiation (T-ray) have taken place for problems mentioned above. The reason is that the spectra of many important non-organic and organic molecules lie in the terahertz range. As it well known, the basic method of the THz radiation application is a method of THz Time-Domain Spectroscopy (THz-TDS). It is based on the analysis of the Fourier spectrum of THz radiation, passed through or reflected from a substance. However, this method has an essential disadvantage because the spectra of many chemical materials of interest turn out to be similar to the spectra of harmless ordinary materials, such as soup, chocolate or sugar. This fact results in difficulties for identification on the basis of the Fourier method. In order to increase the efficiency of the THz radiation application for materials identification we have proposed some algorithms for dynamic analysis of the medium response spectrum under the action of a THz pulse with a few cycles. We named this method the THz spectral dynamics analysis (SDA) method.

The subject of this report is to demonstrate the applicability of THz SDA method for identification of explosives, including those hidden under various cover, and of simulant. We can distinguish simulants and explosives with very close THz spectra on the basis of the SDA method.

The important advantage of the proposed method is that the dynamics of spectral response can be obtained in the GHz and THz range simultaneously without the use of expensive receivers. It gives an opportunity to develop the multi-channel system for problem of identification of explosive.

It should be noted that the measurements of medium response to THz radiation for explosive samples were made in the Center for Terahertz Research, Rensselaer Polytechnic Institute, Troy, NY, USA.

This work was financially supported in part by the Russian Foundation for Basic Research (grant № 08-07-12007-ofi).