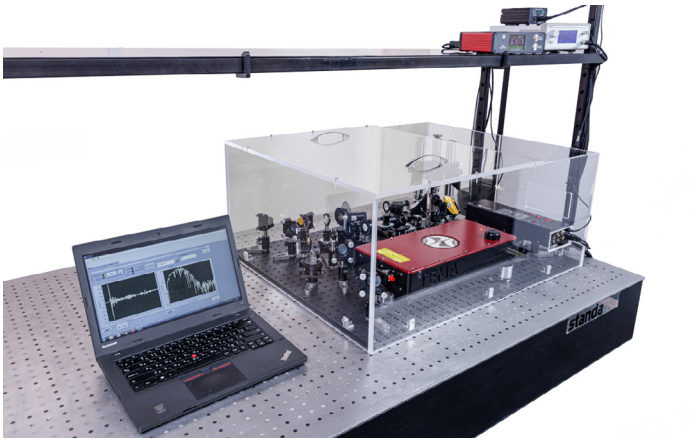
Impulse Terahertz Spectrometer ITS-2



Impulse Terahertz Spectrometer ITS-2 by TYDEX is integrated solution for broadband terahertz time-domain spectroscopy. Due to the use of femtosecond laser radiation, the spectrometer measures the time shape of the THz pulse using the electro-optical strobing. Then the shape is converted via Fourier transformation into the frequency spectrum of the complex amplitude of the electric field of THz pulse (It contains amplitude and phase information.) Thus, using the ITS-2 it is possible to obtain the spectral characteristics (such as transmission and reflection coefficients) and optical properties (complex refractive index, complex dielectric permittivity, absorption coefficient, complex conductivity) of materials in THz frequency range. ITS-2 offers high THz radiation power and wide operating frequency range.

To generate and register THz radiation, ITS-2 uses an IR radiation source, namely, a femtosecond laser Avesta TEMA-100. ITS-2 generates THz radiation by means of optical rectification of electric field of a femtosecond pulse in a lithium niobate crystal doped with magnesium oxide (MgO:$LiNbO_3$). Terahertz impulse is released through a prism of high-resistivity silicon (HRFZ Si). THz radiation is then detected by means of electro-optical strobing using a delay line and electro-optical detector EOD-NIR (manufactured by TYDEX).

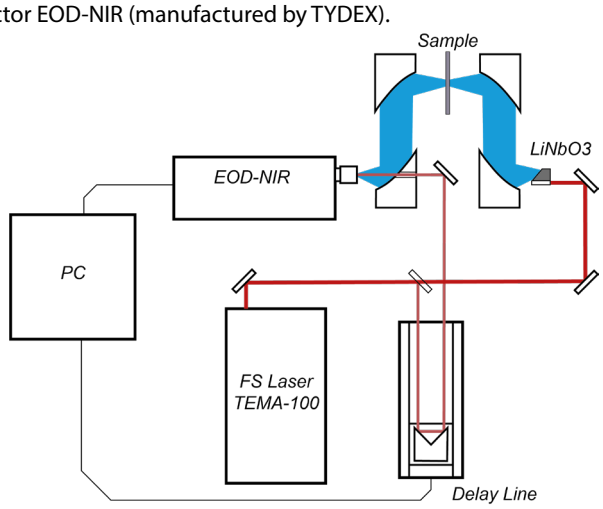


Fig. 1. ITS-2 layout diagram.

Generation and detection of the THz radiation is performed as follows. Laser radiation is split into a pumping beam and probing beam.

Pumping beam is focused into the THz generator (MgO:LiNbO3 crystal). THz radiation emitted from the generator passes through a set of parabolic off-axis mirrors. Consistently the THz beam becomes collimated and focused. Further the THz radiation is focused into the detecting EOD crystal.

Probing beam passes through the optical delay line, then is focused and overlaid with the THz radiation beam on the detecting EOD crystal.

The software controls recording and processing of the THz impulse waveforms.

Key features of the ITS-2:

- high output power of the THz radiation, no less than 100 μW;
- wide operating frequency range – 0.2 to 3 THz;
- configurable operation mode: transmission measurement, 45° reflection measurement, normal reflection measurement;
- a sample can be studied in a focused or collimated THz beam;
- bundled software to record and view waveforms, measure optical and spectral properties of materials.

Applications of the ITS-2:

- determination of spectral characteristics and optical properties of materials in THz frequency range (transmission and reflection coefficients, complex refractive index, complex dielectric permittivity, absorption coefficient, complex conductivity for thin conductive films on a dielectric substrate);
- food quality control;
- environmental monitoring of air quality;
- studying internal structure of layered composites;
- studying effects of high-power THz radiation on biological specimens.

Software functions:

- control the delay line;
- receive data from the EOD;
- record waveforms;
- view multiple waveforms and spectra;
- determine optical properties and spectral characteristics.

Operating modes of the ITS-2:

- transmission, THz beam angle of incidence = 0°;
- reflection, THz beam angle of incidence = 0° (optional);
- reflection, THz beam angle of incidence = 45° (optional);
- parallel beam measurements (optional).

Key specifications of the ITS-2:

Frequency range	0.2-3 THz
Maximum time delay	450 ps
Dynamic range	no less than 40 dB
Spectral resolution	no more than 40 GHz

Femtosecond laser:

Centre wavelength	1049 nm
Impulse duration	90 fs
Repetition rate	70 MHz
Average power	5,0 W

Source:

THz radiation source type	MgO:$LiNbO_3$
Prism material	HRFZ Si
Average radiation power	no less than 100 μW

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TYDEX®

Impulse Terahertz Spectrometer ITS-2

Detector:

Detector type	EOD-NIR
EO crystal	ZnTe
Electro-optical shutter modulation frequency	60 – 3000 Hz
Delay line length	150 mm
Delay line step	2.5 μm

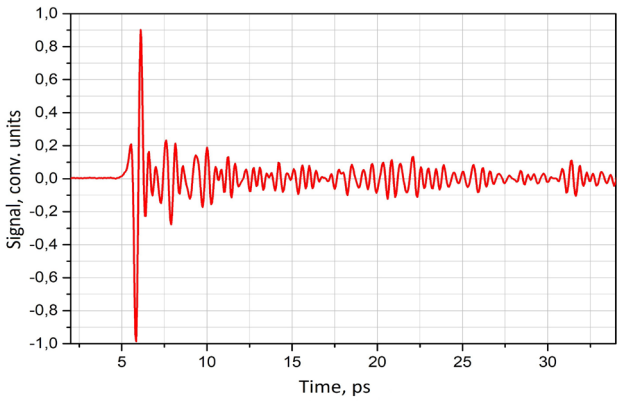

Fig. 2. Waveform of a THz impulse passing through air at 34% humidity.

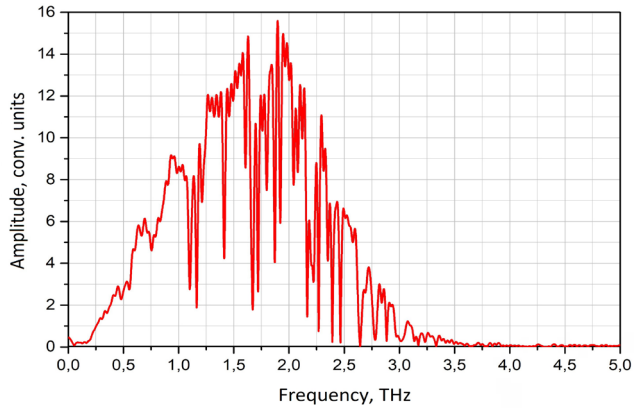

Fig. 3. Frequency spectrum of the air at 34% humidity.

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