

■ Features

- Compact, space-saving design
- Not affected by water vapor in the environment
- Broadband measurement: 0.1 THz to 7 THz
- Excellent reproducibility

■ Applications

- Measurement of optical constants in the terahertz range
- Monitor of crystallinity
- Estimation of water content
- Evaluation of interaction with water
- Other applications of terahertz spectroscopy



■ Outline

The C12068 series are an attenuated total reflection (ATR) spectrometer integrating a terahertz wave emitter, detector and total reflection prism into a single unit. ATR spectroscopy using the C12068 series is unaffected by water vapor in the environment and ensures high stability and easy operability. Just placing a liquid or powder sample on the measurement surface allows easily acquiring information on intermolecular vibrations and crystal lattice vibrations.

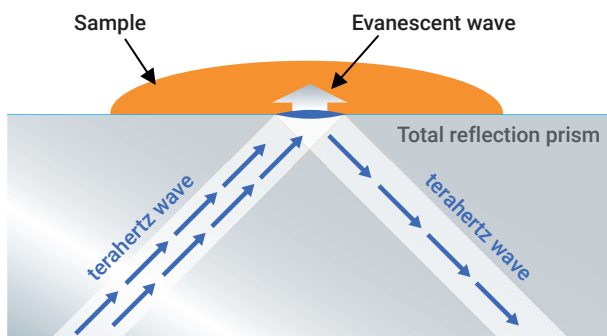
• What is a terahertz wave?

This is an electromagnetic wave useful for investigating the resonance frequency of intermolecular vibration.

<Terahertz wave: 0.1 THz to 10 THz (30 μm to 3000 μm), electromagnetic waves midway between light and radio waves.>

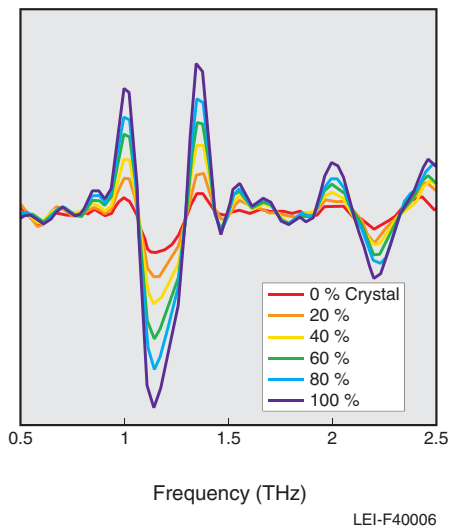
■ Measurement principle

The measurement principle is based on the attenuated total reflection (ATR) technique. As shown in the figure below, terahertz waves are totally reflected by the sample measurement surface on the total reflection prism. At this point, the evanescent wave exudes into the sample. The exuded evanescent wave interacts with the sample placed on the measurement surface, where the interaction attenuates the reflectance of terahertz waves. Detecting this attenuated reflectance yields spectral information (absorption coefficient, refractive index and complex permittivity) in the terahertz range from the sample.



■ Example of measurement

Figure 1: Evaluation of crystallinity in water



Evaluation of crystallinity is important for low solubility drugs. Evaluation in water is especially important since water affects the crystallization. This graph shows a secondary differential spectrum measured by changing the ratio of crystalline to amorphous nifedipine*¹ which is a low solubility drug. Note that the peaks increase with the ratio of crystalline nifedipine.

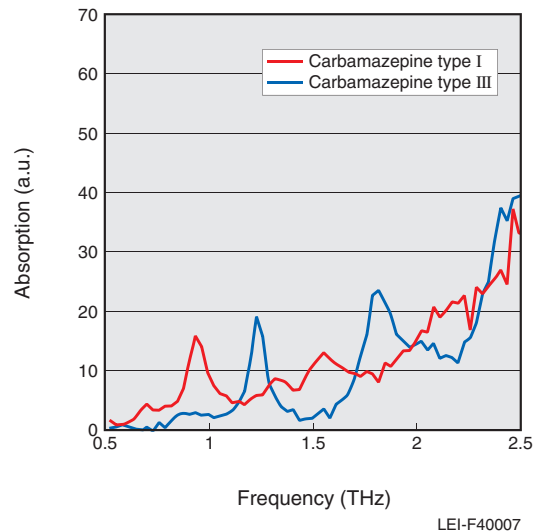
*¹ Nifedipine is a vasodilator.

Takebe et al., J. Pharm. Sci. **102**, 4065 (2013).

● Application example

R&D and evaluation of pharmaceuticals and foods

Figure 2: Discrimination of crystalline polymorphism



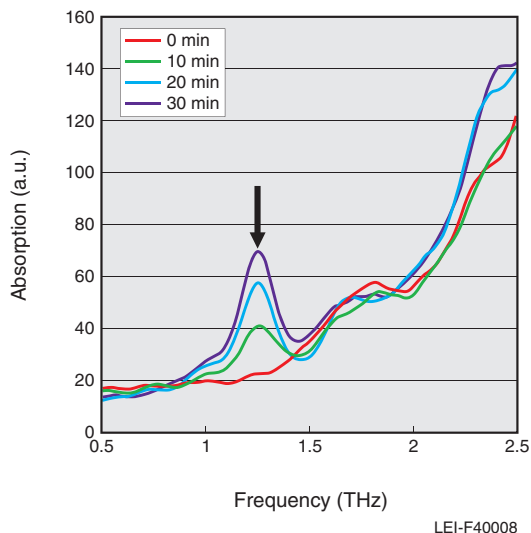
Evaluation of crystalline polymorphism*² is important since it affects the quality such as the solubility of pharmaceuticals, etc. This graph shows measurement examples of carbamazepine Type I and Type III which are crystalline polymorphs of the carbamazepine antiepileptic drug. These polymorphs can be clearly distinguished by their peaks.

*² Crystalline structure with the same chemical formula but with a different crystalline form.

● Application example

R&D and quality evaluation of pharmaceuticals, cosmetics and foods

Figure 3: Estimation of cocrystallization

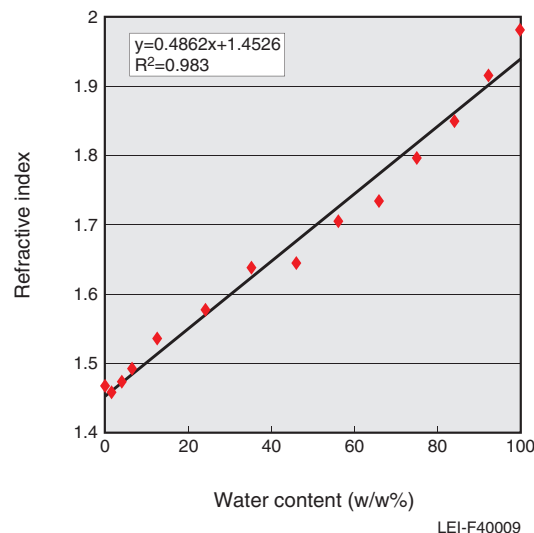


A cocrystal is a crystalline structure made up of two or more different molecules produced by hydrogen bonding, and is essential for pharmaceuticals. A cocrystal can be produced by grinding two chemicals. This measurement example shows how cocrystallization occurs by grinding phenazine and mesaconic acid. Note that the peak becomes larger as the grinding time increases.

● Application example

R&D and evaluation of pharmaceuticals

Figure 4: Water / moisture content in substances



Monitoring water / moisture content is essential in a wide range of processes and products including fuel, chemical synthetic processing, cosmetics and food products.

This graph shows the refractive index at 2 THz as a function of the water content in ethanol. The refractive index has a good correlation with water content.

● Application example

Water / moisture content evaluation of bioethanol, cosmetics, foods, etc.

Terahertz Spectrometer C12068 Series

■ Specification

Parameter	Value		Unit
	C12068-01	C12068-02	
Bandwidth *1	0.1 to 4.0	0.5 to 7.0	THz
Dynamic range *2	≥50		dB
Resolution	80 ±10		GHz
Measurement time *3	3		min
Measurement object	Powder, liquid		—
Control system	PC (windows10)		—
External control	USB 1.1		—
Laser class	Class 1		—
Dimensions (W × H × D)	Approx. 500 × Approx. 313 × Approx. 534		mm
Weight	Approx. 50		kg

*1 Bandwidth of generated terahertz waves. Measurable band changes depending on the object to measure.

*2 At peak frequency.

*3 Depends on the number of integrations.

■ General ratings

Parameter	Value	Unit
Voltage	Single phase 100 to 240	V
Frequency	50 / 60	Hz
Power consumption	450	V·A

■ Environment

Parameter	Value	Unit
Operating ambient temperature	+15 to +30	°C
Storage ambient temperature	0 to +45	°C
Operating ambient humidity *1	≤70	%
Ambient temperature stability during measurement *2	±2.5	°C
Place of use	Indoors, no direct sunlight, no vibration	—

*1 No condensation

*2 To obtain stable measurement results, keep the ambient temperature variation within ±2.5 °C by using an air conditioner and so on.

■ Control unit

Parameter	Specification
Main control unit (PC)	Hard disk ≥ 40 GB
	Memory ≥ 4 GB
	Monitor size ≥ 14 inches
	Software
Software	2 types (for measurement and analysis) attached

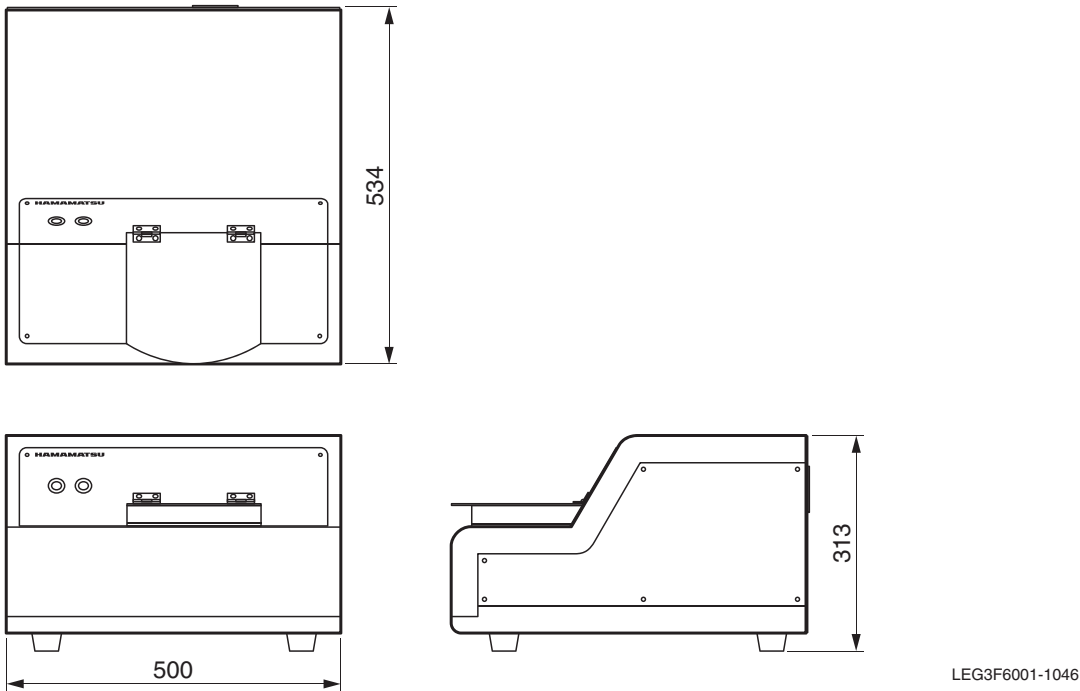
* The supplied software is guaranteed to work only with the control unit that is delivered with it as a set.

■ Precautions for measurement

- Strong acid and strong alkali samples cannot be measured.
- Do not apply a load to any part in this unit during measurement except for the supplied test jig.

Terahertz Spectrometer C12068 Series

Figure 5: Dimensions (unit: mm)



LEG3F6001-1046

● Information described in this material current as of February 2021. Specifications are subject to change without notice.

HAMAMATSU PHOTONICS K.K. www.hamamatsu.com

Laser Promotion Division, Business Promotion G.

1-8-3, Shinmiyakoda, Kita-ku, Hamamatsu City, Shizuoka, 431-2103, Japan, Telephone: (81)53-484-1301, Fax: (81)53-484-1302, E-mail: sales-laser@lpd.hpk.co.jp

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218 E-mail: usa@hamamatsu.com

Germany: Hamamatsu Photonics Deutschland GmbH.: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de

France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: infos@hamamatsu.fr

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777 E-mail: info@hamamatsu.co.uk

North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01 E-mail: info@hamamatsu.se

Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it

China: Hamamatsu Photonics (China) Co., Ltd.: 1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn

Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No.158, Section 2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw

Cat. No. LTHZ3001E01
FEB. 2021 IP