C184-E032

SHIMADZU
Excellence in Science

High Sensitivity Gas Chromatograph System

Tracera

Highly Versatile GC Analyzer for Trace Analysis

Tracera

Plasma Technology is the Future of GC Detection

The new Tracera GC System is now ready to solve your trace analysis needs. This system utilizes the new Barrier Discharge Ionization Detector technology coupled with a GC-2010 Plus capillary gas chromatograph to create a GC system that makes it possible to reveal trace components that are difficult to see by other GC detectors.

High Sensitivity

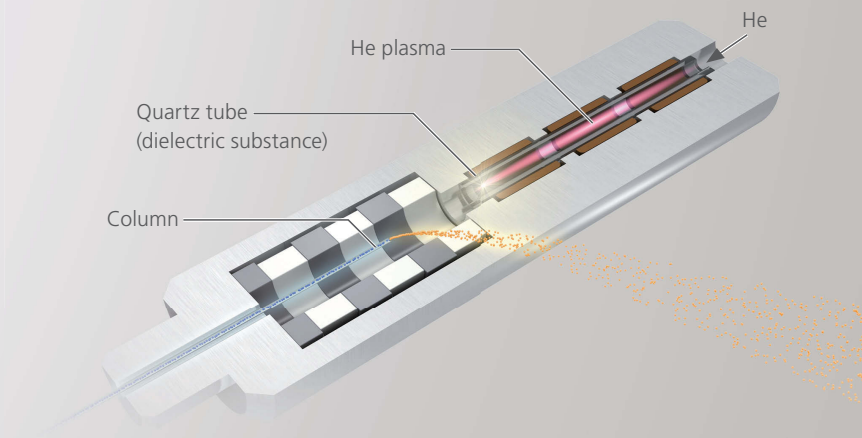
Detection Sensitivity Over 100x Higher than TCD, 2x Higher than FID

Novel Universal Detector

Single Detector Approach for Your Complex Analyses

Long-Term Stability

Long-Term Stability with New Discharge Design



Plasma Technology for Universal Trace Analysis

The barrier discharge ionization detector (BID) is a highly sensitive device that creates ionization from a Helium-based, dielectric barrier discharge plasma. A 17.7 eV plasma is generated by applying a high voltage to a quartz dielectric chamber, in the presence of helium at a relatively low temperature. Compounds that elute from the GC column are ionized by this He plasma energy and then detected by the collection electrode and processed as peaks.

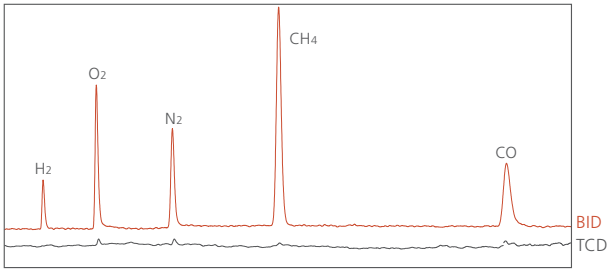
The BID was developed thru collaborative research with Dr. Katsuhisa Kitano, Center for Atomic and Molecular Technologies, Graduate School of Engineering, Osaka University, resulting in 3 U.S. patents and 4 patents pending.

Comparison of Detectable Compounds

Detector Type	Detectable Compounds
Barrier discharge ionization detector (BID)	All, except He and Ne
Thermal conductivity detector (TCD)	All, except carrier gas
Flame ionization detector (FID)	Organic compounds, except formaldehyde and formic acid

High Sensitivity

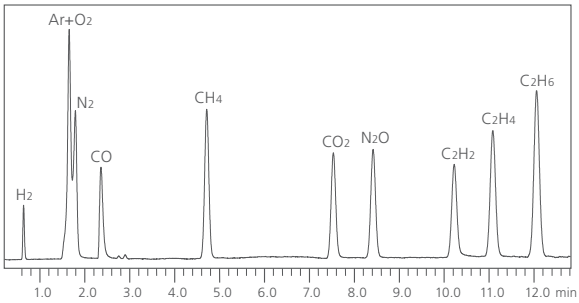
Detection Sensitivity Over 100x Higher than TCD, 2x Higher than FID



10 ppm concentration each component in He,
1:39 split analysis, 500 µL sample volume

Sensitivity Comparison Between BID and TCD

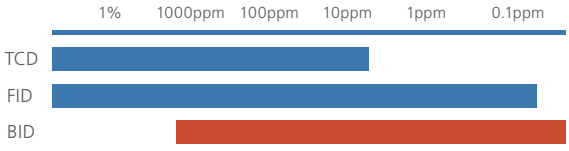
Sensitivities were compared using the responses of permanent gases. BID achieved over 200× higher sensitivity for organic compounds and several tens of times higher sensitivity for permanent gases.



5 ppm concentration each component in He,
1:5 split analysis, 1 mL sample volume

High-Sensitivity Analysis of Permanent Gases and Light Hydrocarbons

Conventional analytical techniques require a system configuration with multiple detection schemes to analyze for permanent gases and light hydrocarbons. The use of a methanizer and FID is often required to detect ppm levels of CO and CO_2. However, the BID replaces all of this hardware and allows for the highly sensitive detection of mixtures of inorganic gases and light hydrocarbons.

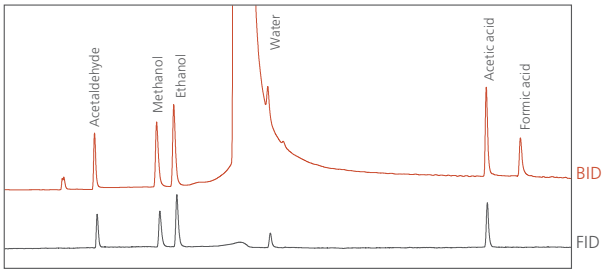


Comparison of Detectable Concentration Ranges

The detectable concentration ranges are guidelines only. They differ according to the compound structure, analysis conditions, and the GC instrument.

Novel Universal Detector

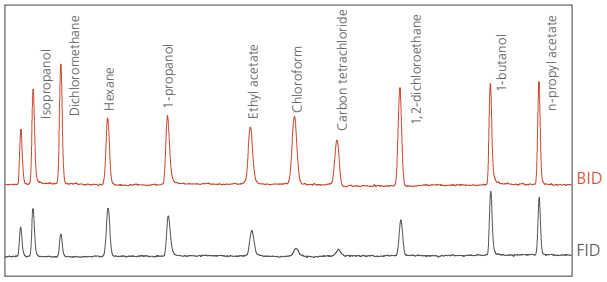
Single Detector Approach for Your Complex Analyses



100 ppm concentration each component in water,
1:24 split analysis, 0.5 µL sample volume

Sensitivity Comparison Between BID and FID

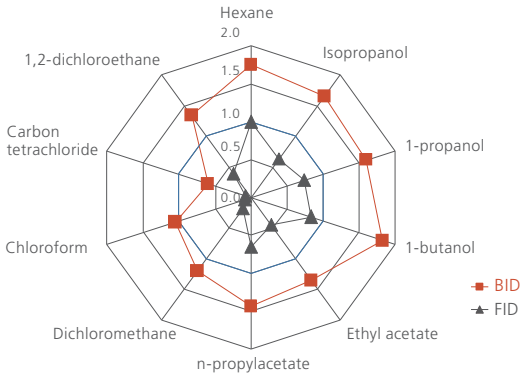
FID is a great choice for hydrocarbons due to its selectivity for the C-H bond. However, it exhibits a poor response to compounds with other functional groups such as: carbonyl, carboxyl, the hydroxyl group (-OH), aldehydes, or halogens. In contrast, the BID achieves superior sensitivity for such compounds, with less variation in relative response.



10 ppm concentration each component in n-C_6,
1:29 split analysis, 1µL sample volume

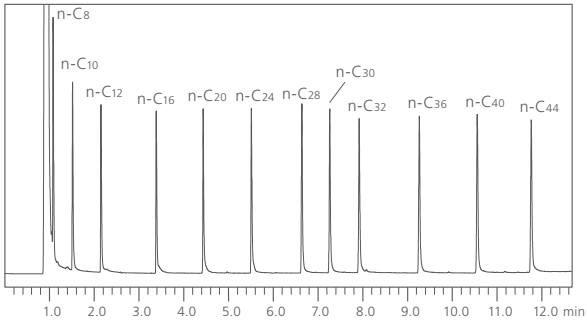
Sensitivity Comparison Chart

The chart to the right compares the responses of solvents of different classes to the FID and BID. All of the responses are normalized to that of hexane by FID. Across the different compound classes, the BID is more sensitive and exhibits a more consistent response than the FID.



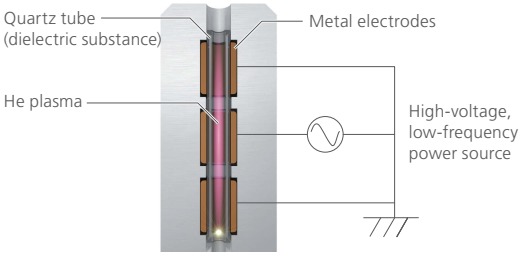
Handles High Boiling Point Components

With a maximum operating temperature of 350 °C, the BID is capable of analyzing for compounds up to n-C44.



Long-Term Stability

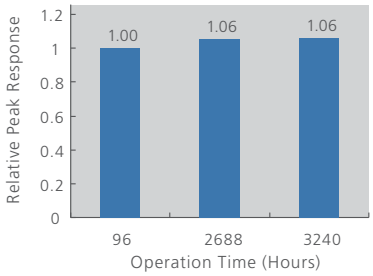
Long-Term Stability with New Discharge Design



The architecture of the BID was designed such that the plasma generation zone is maintained at near room temperature. The electrodes are positioned where they do not contact directly with the plasma. This robust design requires no routine maintenance or consumables.

Evaluation of Long-Term Stability

A sensitivity fluctuation test was performed for operation times of 96, 2,688, and 3,240 hours. When relative intensities of 2,688 and 3,240 hours vs. peak intensity at 96 hours are calculated, the difference was negligible.



Repeatability of Trace Gas Analysis

A series of sample loop analyses was performed at 5 ppm concentration of each component. The calculated area repeatability showed RSD% of 0.84 – 1.80.

	H_2	CO	CH_4	CO_2	N_2O	C_2H_2	C_2H_4	C_2H_6
1	2263	10988	24335	26144	22263	14507	32211	45399
2	2240	10936	23998	26184	22043	14466	32808	44402
3	2280	10932	24752	26537	22435	14781	32986	44883
4	2336	10462	24032	26413	22250	14705	32386	45049
5	2237	11009	23660	26413	22515	15210	32312	45202
6	2216	11058	24172	26348	22398	14915	32909	44878
7	2230	10949	23955	27004	22604	14941	32838	45059
8	2291	10956	24687	26642	22659	14992	32871	45295
9	2253	11011	24379	26550	22426	15246	33058	45515
10	2237	11189	24741	26679	22685	15075	32792	45751
Ave.	2258	10949	24271	26491	22428	14884	32717	45143
RSD%	1.57	1.71	1.54	0.95	0.90	1.80	0.92	0.84

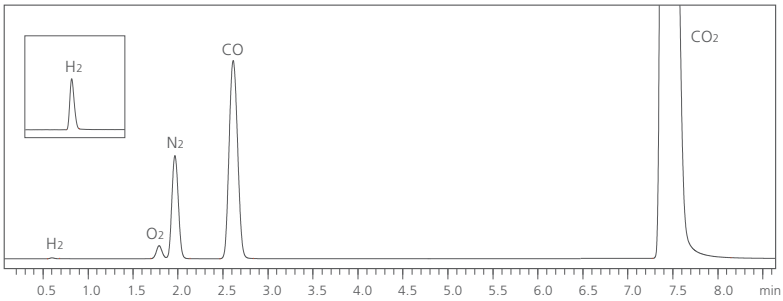
Applications

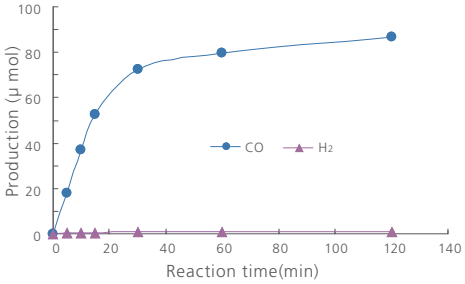
A Single System for a Variety Applications

The Tracera GC system is based on the GC-2010 Plus platform and includes a Barrier Discharge Ionization Detector. Making it a nearly universal Gas Chromatography tool.

Analysis of Reaction Products in Artificial Photosynthesis Research

Artificial photosynthesis is a technique to capture energy from the sun and store it chemically. It is expected to become the 4th renewable energy source along with photovoltaic, solar thermal, and biomass. Shown below is a result of simultaneous analysis of CO and H_2, which are generated in a photochemical-carbon dioxide reduction reaction.





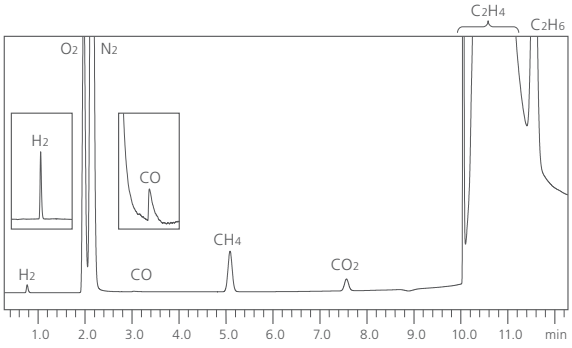
Data from Dr. Hitoshi Ishida and Dr. Yusuke Kuramochi, Department of Chemistry, School of Science, Kitasato University; PRESTO, Japan Science and Technology Agency

The production amount of CO is rapidly increased, then slows as the reaction nears completion.

The Tracera GC system allows simultaneous, high-sensitivity measurement of CO and H_2 using a single detector and carrier gas.

Analysis of Impurities in Ethylene

Ethylene is an important chemical used as a starting material in the production of many polymers. The purity of ethylene feedstock is essential to know. Below is an example of the analysis of impurities in ethylene.

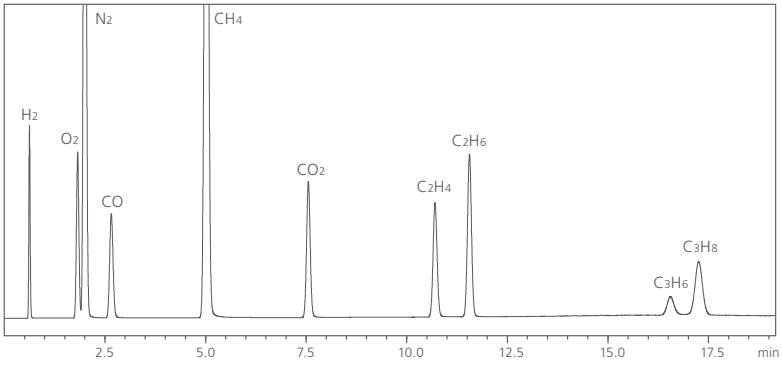


H_2 (30 ppm), CO (2 ppm), CO_2 (15ppm), and CH_4 (30 ppm) are detected as trace impurities.

The Tracera GC system allows simultaneous, high-sensitivity measurement of the permanent gases and light hydrocarbon impurities using a single detector and carrier gas.

Analysis of Lithium Ion Battery Gas

To evaluate the deterioration of lithium ion batteries, analysis of the gas produced during decay is required. The gas components are ideal for analysis by the Tracera system. Shown below is an example of the decay gas of lithium ion batteries.



The decay gas is extracted from a lithium ion battery, diluted, then introduced into the gas chromatograph.

The Tracera GC system allows simultaneous, high-sensitivity measurement of the lithium ion decay gases using a single detector and carrier gas.

Specifications

Tracera: GC-2010 Plus in Combination with BID-2010 Plus

BID-2010 Plus Specifications

Temperature range	Up to 350 °C
Minimum detectable amount *	1 pgC/s (dodecane, discharge gas flow rate 50 mL/min)
Dynamic range	10^5
Permitted gas	He (99.9999 vol. % or more purity)

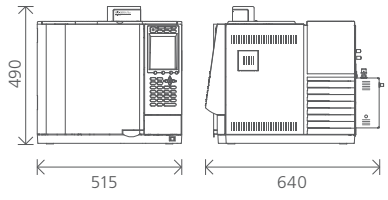
* Calculated by the same method used for MDQ of the Shimadzu FID.
Note: Analytical conditions such as columns, injection units, detectors, will vary depending on the application. For further detail, please contact your local Shimadzu representative.

GC-2010 Plus Specifications (Configuration - GC main body, Injection: SPL, Detector: BID)

Dimensions	515 (W) x 490 (H) x 640 (D)
Weight	31 kg
Power requirements	AC100V/115V/230V ±10%, 1800VA (Normal oven type) or 2600VA (High power oven type), 50/60Hz

Please refer to GC-2010 Plus brochure (C184-E019) for details.

Dimensions:



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